

Guide to the Elimination of Catheter-Related Bloodstream Infections



About APIC

APIC's mission is to improve health and patient safety by reducing risks of infection and other adverse outcomes. The Association's more than 12,000 members have primary responsibility for infection prevention, control, and hospital epidemiology in healthcare settings around the globe. APIC's members are nurses, epidemiologists, physicians, microbiologists, clinical pathologists, laboratory technologists, and public health professionals. APIC advances its mission through education, research, consultation, collaboration, public policy, practice guidance, and credentialing.



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Scanning electron micrograph (SEM) depicting a number of red blood cells found enmeshed in a fibrinous matrix on the luminal surface of an indwelling vascular catheter; magnified 7766x.

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Abbreviations and Acronyms

ACHS	Australian Council on Healthcare Standards
APIC	Association for Professionals in Infection Control and Epidemiology
AVA	Association for Vascular Access
CA-BSI	Catheter-associated Bloodstream
CDC	Centers for Disease Control and Prevention
CHG	Chlorhexidine gluconate
CLABSI	Central line-associated bloodstream infection
CMS	Centers for Medicare and Medicaid Services
CRBSI	Catheter-related bloodstream infection
CVC	Central venous catheter
CVC-BSI	CVC-associated bloodstream infection
HAI	Healthcare-associated infection
IDSA	Infectious Diseases Society of America
IHI	Institute for Healthcare Improvement
INS	Infusion Nurses Society
IP	Infection preventionist
TJC	The Joint Commission
NHSN	National Healthcare Safety Network
PICC	Peripherally inserted central catheter
SHEA	Society For Healthcare Epidemiology of America
U.S.	United States

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Background

This document forms part of a series of APIC Elimination Guides designed to assist APIC members in local, national, and international efforts to eliminate specific preventable healthcare-associated infections (HAIs).

APIC's decision to develop a "*Guide to the Elimination of Catheter-Related Bloodstream Infections*" was driven largely by its members' need for simple, practical implementation tools. This Guide is a companion piece to APIC's 2007 multi-prong training program "*Eliminating Catheter-Related Complications*."¹ They differ in that this Elimination Guide is being made freely available to all APIC members and has been designed to include very specific, step-by-step guidance to facilitate the bedside implementation of relevant clinical evidence and practices demonstrated to reduce catheter-related bloodstream infections (CRBSIs).

Users of this Guide are reminded that although the terms CRBSI, catheter-associated-bloodstream infection (CA-BSI) and central line-associated bloodstream infection (CLABSI) are often used interchangeably, the events to which they refer are not identical. Part 7 of this Guide provides a detailed description of these terms. It also compares and contrasts them.

Importantly, from January 1, 2010, United States (U.S.) hospitals seeking accreditation with The Joint Commission (TJC) are expected to have fully implemented National Patient Safety Goal (NPSG) 07.04.01.² This Goal stipulates that hospitals implement best practices or evidence-based guidelines to prevent CLABSIs including short- and long-term central venous catheters (CVC) and peripherally inserted central catheter (PICC) lines. The primary focus of this Guide is infectious complications of infusion therapy via CVCs, not peripheral short term IV therapy.

As well, the 2008 U.S. Centers for Medicare and Medicaid Services (CMS) Inpatient Prospective Payment System (IPPS) reforms included vascular catheter-associated infections as one of the targeted conditions.³ Since October 1, 2008, under those reforms, vascular catheter-associated infections, including CRBSIs, acquired during a hospital stay may not qualify for higher payment rates. These CRBSIs are defined precisely by ICD-9-CM code 999.31 which stipulates "infection due to a central venous catheter". ICD-9-CM code 999.31 includes infection due to Hickman catheters, peripherally inserted central catheters (PICC) or portacaths (port-a-cath) Triple lumen catheter or umbilical venous catheter. It excludes infections due to arterial catheters, peripheral venous catheters or urinary catheters.

Further, the high incidence, morbidity, and cost attributed to CRBSIs compel expert organizations like APIC to adequately prepare their members with the best and most appropriate tools and resources to alleviate the current CRBSI burden.

This Guide has been developed by a representative sample of expert APIC members from around the globe in the hope that its content will reduce the global incidence of CRBSIs and make the work of the infection preventionist in 2009 and beyond less difficult and more effective.

Reference in this Elimination Guide to any trademark, proprietary product, or company name is intended for description only and does not constitute or imply endorsement or recommendation by any of the Guide's authors.

Note: All costs cited in this Guide are in United States dollars.

Purpose and Objectives

The purpose of this document is to provide a series of practical strategies, tools, and resources for infection preventionists and quality teams to use in their efforts to prevent CRBSIs. The strategies, tools, and resources included in this document build on and are entirely consistent with the general recommendations included in coexistent CRBSI directives produced by other U.S. bodies including the Centers for Disease Control and Prevention (CDC), Institute for Healthcare Improvement (IHI), Infusion Nurses Society (INS), The Joint Commission (TJC), the Society for Healthcare Epidemiology of America (SHEA) and The Association for Vascular Access (AVA).

Specific objectives of this Elimination Guide include:

- Avoiding duplication of existing credible information and expert guidance by providing adjunct material;
- Assisting users to meet their relevant pay-for-performance and NPSG obligations in relation to CRBSI prevention;
- Outlining recommended CDC methods for bloodstream infection surveillance in patients with central lines, including surveillance-specific case studies;
- Using real life organizational case studies to:
 - illustrate the range and type of quality improvement methods employed at different types of facilities to reduce CRBSI incidence;
 - identify possible obstacles to CRBSI reductions and suggest alternate solutions;
 - describe how an organization can gauge CRBSI elimination success; and
- Providing practical tools such as checklists, decision trees/algorithms, and policies relating to CRBSI elimination.

Scope

Intended Audience

This Guide has been developed primarily for use by infection preventionists and quality improvement professionals. The content of this Guide reflects the volume and quality of CRBSI prevention successfully undertaken in the U.S. However, APIC is confident that it will also be useful in other international clinical settings.

Target Settings

The recommendations included in this Guide are intended mainly for use in inpatient settings, including the intensive care unit (ICU). However, at their discretion, some users may find some of these recommendations useful in non-inpatient settings.

Target Devices

The authors acknowledge that the two main challenges in intravenous (IV) therapy are the prevention of infection and the maintenance of patency. The recommendations in this document target vascular access devices including central and peripheral lines. Given the substantially larger proportion of CRBSIs attributed to central line use, this document focuses mainly on prevention measures applicable to central lines; however, these recommendations are often also effective in prevention of peripheral line infections.

The main types of CVCs are:

1. Nontunneled CVCs
2. Tunneled CVCs
3. Peripherally inserted central catheters (PICCS)
4. Implanted ports

Nontunneled CVC is a single, dual, or triple lumen catheter that is placed either in the internal jugular or subclavian vein with the distal tip lying in the superior vena cava. The catheter is inserted by a licensed healthcare professional and may be placed in the patient care area. It is the catheter of choice for emergency and short-term use.

Tunneled CVC is placed when the patient needs the device for long-term therapy. It is surgically inserted and literally tunneled under the skin in a subcutaneous pocket. Tunneled catheters often have a cuff on the external lumen near the exit site which aids in securing the catheter as subcutaneous tissue grows into the cuff. The cuff also acts as a barrier to skin organisms that may invade the percutaneous tract.

Table 5-1. Types of Central Catheters^{4,5}

<p>Nontunneled CVCs</p> <ul style="list-style-type: none"> • Used for short-term therapy • Inserted percutaneously <ul style="list-style-type: none"> ◦ Subclavian vein ◦ Internal jugular vein ◦ Femoral vein • Has from 1 to 5 lumens or ports • Usually from 15 to 30 cm in length 	
<p>Tunneled CVCs</p> <ul style="list-style-type: none"> • Used for long-term therapy • Inserted surgically or may be inserted by Interventional Radiology • Small Dacron cuff sits in subcutaneous tunnel • No dressing is required after cuff heals unless the patient is immunocompromised • Line initially sutured with sutures removed in 7–10 days • External portion of the catheter can be repaired 	
<p>Peripherally Inserted Central Catheters (PICCs)</p> <ul style="list-style-type: none"> • Used for short-, intermediate-, and long-term therapy • May be single, dual, or triple lumen • Inserted percutaneously <ul style="list-style-type: none"> ◦ Basilic vein ◦ Brachial vein ◦ Cephalic vein • Advanced into the superior vena cava to the juncture of the SVC and right atrium. • May be inserted by specially trained health professional with the use of ultrasound and modified Seldinger technique 	
<p>Implantable Ports</p> <ul style="list-style-type: none"> • Used for long-term therapies • Surgically implanted • Consists of metal, titanium, or plastic housing with a dense silicone septum in the center • Catheter placed in superior vena cava • Accessed with a special needle with a deflected tip • Dressing required until insertion site healed 	

Differentiating between CRBSIs and CLABSIs

Although the terms are often used interchangeably to describe intravascular device (IVD)–related bloodstream infections, there are discrepancies between CRBSI and CLABSI that can be confusing. The confusion impacts clinicians and infection preventionists when they are developing plans for measuring and eliminating bloodstream infections in patient populations.

CRBSI is a rigorous clinical definition, defined by precise laboratory findings that identify the CVC as the source of the BSI and, used to determine diagnosis, treatment, and possibly epidemiology of BSI in patients with a CVC. It is not typically used for surveillance purposes and there is little data available for comparison. Typically, the term CRBSI is more likely to be used in clinical research.

Using the CRBSI definition requires more resources than use of the CLABSI definition as hospitals must have the capacity to correctly collect and label blood culture sets drawn from the CVC and a peripheral phlebotomy as well as culturing the CVC segment/ tips. Typically this rigorous approach requires a research study and staff.

CLABSI is a term used only for surveillance purposes to identify BSIs that occur in the population at risk (patients with central lines). Use of this term and CDC’s National Healthcare Safety Network (NHSN) CLABSI definition may lead to an overestimation of the infection rate compared to the use of the rigorous CRBSI criteria. Researchers have recently highlighted the serious implications for organizations and individual clinicians when CLABSIs are misclassified.⁶

Healthcare professionals need to understand the differences between the terms CRBSI and CLABSI and how they are used by various agencies. The CDC distinguishes between the two in the following way:

CRBSI criteria require one of the following:

- A positive semi quantitative (>15 colony-forming units [CFU]/catheter segment) or quantitative ($>10^3$ CFU/catheter segment) cultures whereby the same organism (species and antibiogram) is isolated from the catheter segment and peripheral blood
- Simultaneous quantitative blood cultures with a $\geq 5:1$ ratio CVC versus peripheral
- Differential period of CVC culture versus peripheral blood culture positivity of >2 hours

A CLABSI as defined by CDC, is a primary (i.e., no apparent infection at another site) BSI in a patient that had a central line within the 48-hour period before the development of the BSI. BSI is defined using either laboratory-confirmed bloodstream infection (LCBI) or clinical sepsis (CSEP) definitions (see Definition of Terms). In the CDC/NHSN definition of CLABSI, *there is no minimum period of time that the central line must be in place in order for the BSI to be considered central line–associated. **The culture of the catheter tip is not a criterion for CLABSI.***

It is also important to note that CDC/NHSN definition of CSEP only applies for patients equal to or younger than 1 year of age.

Although IHI uses CRBSI and CLABSI interchangeably, BSIs are considered to be associated with a central line if the line was in use during the 48-hour period before the development of the BSI.⁷

TJC does not define either CRBSI or CLABSI, but does define a central line as “a catheter passed through a peripheral or central vein, ending in the superior vena cava or right atrium, for measurement of central venous pressure or for infusion of hyperosmolar solutions.”²

The Society for Healthcare Epidemiology of America/Infectious Diseases Society of America *Compendium of Strategies to Prevent Healthcare-Associated Infections*⁸ uses the CLABSI terminology throughout and refers to CDC's NHSN for definitions and protocols.

In its 2008 IPPS, the U.S. CMS uses the term “vascular catheter associated infections” when referring to IVD-related BSIs. The ICD9-CM code defines which catheters are included or excluded.

In 2005, Safdar and colleagues undertook a comprehensive meta-analysis to identify the most accurate methods for diagnosing IVD-related BSIs and noted the wide range of device-related infections from asymptomatic cases of colonization to septic shock caused by bacteremia or candidemia. These authors also commented on the unreliability of diagnosing IVD-related BSI using clinical findings due to their poor specificity and sensitivity.⁹

Pathogenesis, Epidemiology, Cost, and Preventability of CRBSIs

Crnich and Maki elegantly detailed the potential sources of CRBSI as well as the mechanisms by which pathogenic organisms can enter the extraluminal or intraluminal surface of an indwelling vascular device.¹⁰ They suggested that the major sources are either device colonization or infusion of contaminated fluid. Organism access to the device surface occurs by either:

1. Invasion of the percutaneous tract (during insertion or in the subsequent days)
2. Contamination of the catheter hub during guidewire insertion or during manipulation
3. Seeding from a remote source of localized infection¹⁰

The substantial morbidity and mortality associated with vascular catheter use in the U.S. is well described by Raad and colleagues who suggest an attributable mortality of between 12% to 25% associated with vascular catheter related bacteremia among critically ill patients.¹¹

In 2008 a joint publication from the Society for Healthcare Epidemiology of America and the Infectious Diseases Society of America suggested that the noninflation-adjusted attributable cost of each case of CLABSI ranged from \$3,700 to \$29,000.⁸ A more recent CDC publication reported that an estimated 92,011 CLABSIs occurred annually in the U.S. The average attributable per patient costs adjusted by 2007 Consumer Price Index for all urban consumers and inpatient hospital services ranged from \$5,734 - \$25,546.¹² In earlier research described more fully below, Pronovost suggested that each year in the U.S. CVCs caused approximately 80,000 CRBSIs and 28,000 deaths in ICU patients.¹³ Further, he estimated the average cost of care for each patient with CRBSI is \$45,000 with an estimated \$2.3 billion annual cost to the U.S. healthcare system.

Pronovost's Michigan Health and Hospital Association (MHA) Keystone Center for Patient Safety and Quality Keystone ICU project is one of the most successful recent collaborative efforts to reduce CRBSIs. The Keystone Project involved the contribution and analysis of data from 103 ICUs in 67 hospitals. These hospitals implemented five evidence-based procedures (hand washing, use of full-barrier precautions during CVC insertion, skin cleaning with chlorhexidine, avoiding use of the femoral site and removal of unnecessary catheters) and were able to reduce the median rate of CRBSI infections per 1000 catheter-days from 2.7 infections at baseline to 0 at 3 months after implementation of the study intervention ($P \leq 0.002$). Pronovost and colleagues reported that the mean CRBSI rate per 1000 catheter-days decreased from 7.7 at baseline to 1.4 at 16 to 18 months of follow-up ($P < 0.002$).¹³ Team building, the development of a safety culture, leadership support, and daily multidisciplinary rounds and goal setting were critical to achieving these results.

An earlier systematic literature review undertaken by the Agency For Healthcare Research and Quality reported substantial variation in CLABSI infection rates from 19 studies ranging from 2.7 to 45.9 CLABSI per 1000 catheter-days.¹⁴

Although comprehensive HAI surveillance data is generally limited in non-U.S. settings, a recent multicenter consortium of 78 ICUs from 13 countries with limited resources aggregated 10 years worth of CVC-related BSI data to report reductions in CLABSI from an initial 16.1 to 10.1 CLABSIs per 1000 central line days.¹⁵ In Australia where standardized national surveillance of HAIs is in its infancy, investigators recently reported a

profound reduction in CRBSIs over 8 years. The reduction was associated with the implementation of multiple interventions including targeted surveillance, prompt review of CRBSI cases, weekly team meetings, and regular reporting to clinical areas.¹⁶

A recent report on the estimated annual proportion of preventable HAIs suggests that by adopting proven quality improvement programs U.S. hospitals could potentially prevent 18% to 66% of their current catheter-associated BSI burden. This would account for between 84,550 and 203,891 infections and prevent between 10,426, and 25,145 deaths. The estimated total of avoidable catheter-associated BSI costs (in 2008 dollars) ranged from \$1.71 billion to \$21.37 billion.¹⁷

Over the past decade, the pooled mean annual CLABSI incidence rate per 1000 central line days reported to CDC from 1997 to 2007 for five major ICU types declined for each ICU type. Further study is needed to assess the contribution of specific prevention efforts and participation in national surveillance to observed declines.¹⁸

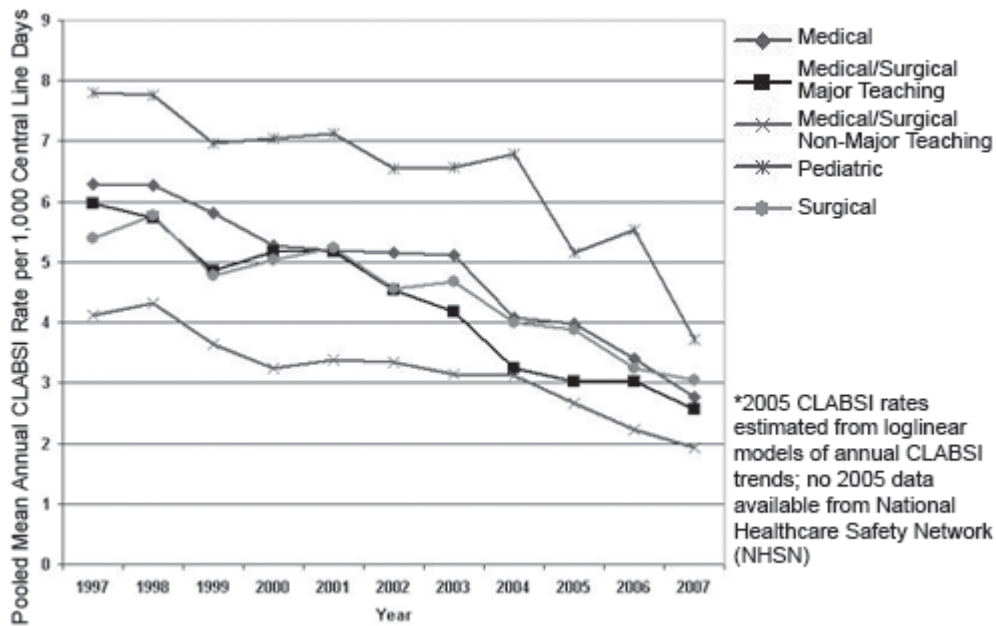


Figure 7-1. CLABSI by ICU Type: U.S. 1997–2007 (Source: CDC http://www.cdc.gov/ncidod/dhqp/SHEA_Abstract2.html Accessed 15th April 2009)

The Evolution of CRBSI Prevention Efforts

For more than 20 years the CDC has provided detailed guidance regarding prevention of vascular catheter infections. Emerging technologies, improvements in the evidence base, and promotion to facilities' administration and infection prevention staff of "bundled" prevention measures to be used during catheter insertion have revolutionized the strategies employed by clinicians to reduce CRBSIs.^{10,13,19} It is important to note that these initial "bundles" did not include recommendations regarding IV maintenance.

Prior to these strategies the most often used prevention measures focused on provision of education to healthcare workers regarding aseptic technique, handwashing, line insertion, and maintenance.²⁰ Additional recommendations included the routine use of specialized IV teams; maximum sterile barrier precautions for insertion, dressings, filters, impregnated cuffs, hubs, and connectors; as well as recommendations regarding timely removal of IVDs and the use of antibiotic locks.^{8,10,11,14,19,21}

In 2007 an academic group based in the United Kingdom undertook a rigorous systematic literature review of existing evidence and guidelines relating to the prevention of infections associated with the use of central venous access devices.²² The researchers promoted 47 separate recommendations each of which was assigned to a specific intervention category including:

- Healthcare worker and patient education
- Asepsis
- Catheter selection
- Catheter site selection
- Maximum sterile barrier precautions
- Cutaneous antisepsis
- Catheter and catheter site care
- Catheter replacement strategies
- General catheter management strategies

Most recently, nontechnological approaches to CRBSI prevention have been highly successful and significantly reduced CRBSI rates and their negative clinical and financial impacts. These strategies have included rigorous measurement, achievable interventions, and widespread modification of organizational culture to embrace safety and staff empowerment.²³ Proponents of these strategies advocate additional benefits related to their generalizability, sustainability, and potential for large scale implementation. It is most likely that future approaches to CRBSI prevention will build on this work.¹³

In its 2009 *HHS Action Plan to Prevent Healthcare-Associated Infections*, HHS recommends ten specific recommendations relating to aseptic insertion of vascular catheters and appropriate maintenance of vascular catheters. Compliance with these recommendations is expected to facilitate achievement of the national targets for prevention of intravascular catheter-associated infections. HHS sourced these recommendations from the CDC's existing Category 1A recommendations.^{12,21} The HHS recommendations are as follows.¹²

For Aseptic Insertion of Vascular Catheters

1. Maintain aseptic technique during insertion and care of intravascular catheters.
2. Use aseptic technique including the use of a cap, mask, sterile gown, sterile gloves, and a large sterile drape for the insertion of CVC, including for PICC and guide wire exchange.
3. Apply an appropriate antiseptic to the insertion site on the skin before catheter insertion and during dressing changes.
4. Although a preparation containing a concentration of chlorhexidine gluconate greater than 0.5% is preferred, tincture of iodine, an iodophor, or 70% alcohol can be used.
5. Select the catheter, insertion technique, and insertion site with the lowest risk for complications (infectious and noninfectious) for the anticipated type and duration of IV therapy.
6. Use a subclavian site (rather than a jugular or a femoral site) in adult patients to minimize infection risk for Nontunneled CVC placement.*
7. Weigh the risk and benefits of placing a device at a recommended site to reduce infectious complications against the risk for mechanical complications (e.g., pneumothorax, subclavian artery puncture, subclavian vein laceration, subclavian vein stenosis, hemothorax, thrombosis, air embolism, and catheter misplacement).

* *Note:* The American Society of Diagnostic Interventional Nephrologists and the Association for Vascular Access (AVA) recognize that the bioburden on the chest is lower than on the neck but they do not agree with using the subclavian site over the IJ site as this is contraindicated in renal failure and pre-renal patients, or in any patient with a serum creatinine level >2.

For Appropriate Maintenance of Vascular Catheters

8. Use either sterile gauze or sterile, transparent, semipermeable dressing to cover the catheter site.
9. Promptly remove any intravascular catheter that is no longer essential.
10. Replace the catheter site dressing when it becomes damp, loosened, or soiled or when inspection of the site is necessary.

Evolving Knowledge and Future Trends in CRBSI Prevention and Technologies

Increased understanding of the role of biofilms and adherence to indwelling devices, including CVCs, has added an exciting dimension and a significant challenge to device-related infection prevention.²⁴ Aslam recommends the following four interventions to reduce biofilm-related potential for infection²⁵:

1. Prevention of device contamination initially
2. Initial microbial cell attachment minimization
3. High-dose antibiotic or antibiofilm agent in a catheter lock solution
4. Removal of the infected device

IVDs impregnated or coated with agents such as CHG or silver sulphadiazine have been employed in efforts to prevent catheter colonization and to reduce CRBSI although their impact is debatable.^{11,26,27} More recent advanced technologies include antibiotic-coated catheters and silver-impregnated catheters.¹¹ Despite these technological advances, Raad and colleagues caution that a multi-pronged approach to CRBSI prevention is still required and should include a combination of novel preventative measures such as:

- Antiseptic techniques
- Novel technologies
- Prudent catheter insertion and timely removal¹¹

This multi-pronged approach is consistent with more specific recommendations currently advocated by key agencies, clinical champions, and professional bodies.^{1,2,8,12,23,28}

Some recent IV devices designed to improve patient or healthcare worker safety may actually require clinicians to rethink their traditional CRBSI prevention strategies. This requirement arises from the devices' complex engineering or design either of which may potentially challenge or eliminate the effectiveness of traditional clinical practices such as disinfection of injection and access caps. Difficulties disinfecting the access caps of needleless catheter connectors are one such example which appears to have stimulated the development of additional sophisticated CRBSI prevention technologies.²⁹

As well, infected thrombus of the great vessels secondary to vascular catheter use continue to pose a risk to patients. Future technologies may also include agents or materials that prevent thrombus formation.

Contemporary Issues and Evolving Viewpoints in CRBSI Reduction

During the development of this Elimination Guide the authors identified several clinical, surveillance, and device use issues that are impacting contemporary CRBSI elimination. Given the need for users of this Guide to be familiar with these issues, the authors decided to acknowledge them specifically and offer insights where relevant.

The Risk of Using Needleless Connectors

In late 2008 SHEA and Infectious Diseases Society of America (IDSA) issued a guidance document that included the statement *“Do not routinely use positive-pressure needleless connectors with mechanical valves before a thorough assessment of risks, benefits, and education regarding proper use.”*⁸

Contamination introduced through the hub of a catheter has long been recognized^{30–33} and preceded the first reported concerns regarding needleless injection port technology use and increased rates of primary BSI in the mid-1990s.³⁴ These technologies, also referred to as needleless connectors, were introduced in the 1990s in an effort to reduce the potential for IV-access related needlestick injuries.³⁵ They reduce that potential by eliminating unnecessary use of needles and, in some cases, prohibiting needle access.³⁶ Their design has evolved from blunt cannula systems, typically split septum, to luer activated devices (LAD) with a variety of internal mechanisms. When accessed and de-accessed these devices exhibit different forms of fluid displacement depending on their design. Clinicians must be educated and their practices monitored to ensure that the techniques they use for accessing and deaccessing are appropriate for the specific LAD.³⁶

When split septum needleless connectors were initially introduced, BSI outbreaks were reported.^{37–39} Investigations identified failed infection control practices, including a lack of education to healthcare workers at the time of conversion, as major risk factors for BSI.^{37,38} As healthcare worker education and infection control practices improved, there was more than a decade of low needleless connector-associated BSI. Since 2004, hospitals in the U.S.^{34,36} and Australia^{42,43} have reported increases in BSIs temporally associated with a change from split septum technology to various forms of LADs including positive pressure LADs. Other reports of increased BSIs have been associated with a change from a standard LAD to a positive pressure LAD^{40,41} or more recently, from one brand of LAD to another. “The issue is complex and reports over the last several years have been inconsistent. However the infection preventionist should be aware of the risks associated with this product category and be involved in any changes within their facility relating to needleless connectors. As recommended by SHEA/IDSA in their Strategies to reduce BSIs, a thorough assessment of the risks should be completed prior to introduction of a new device.”⁸ That assessment should include review of available published scientific and clinical evidence and consideration of the device’s unique design.

Global thought leaders postulate that there are design-related potential risk factors for BSI specific to needleless connectors.³⁵ One of these potential risks is an access site that may be difficult to clean and disinfect. Infection preventionists should consider results and conclusions of well designed, microbiological and scientific studies to evaluate this feature. Other design-related features that should be considered include the:

- Presence of internal or external device mechanisms or structures which may harbor bacteria^{44,45}.
- Ability of the device to facilitate non-tortuous fluid pathways and promote or impede complete flushing.^{34,40,46,50}
- Requirement for and practicality of any specialized procedures as identified in the needleless connector’s directions for use.

The multiple risk factors and possible limitations of some published studies may confound efforts by clinicians and researchers to make an accurate assessment of the BSI risks associated with use of a needleless connector. As a result, patient safety may be jeopardized. However, since Hall's seminal paper in 2004,⁴⁷ the growing number of reports of increased BSIs temporally associated with use of needleless connectors with or without fluid displacement features^{40,43,48–50} suggest that there is a need for organizations to give additional consideration to these general IV infusion and connector-specific issues:

1. The hospital's policies and manufacturer's recommendations for
 - disinfecting the needleless connector's connection surface.
 - disinfecting the catheter hub when connectors or tubing are changed.
 - appropriate times, if any, to ever disconnect a continuously infusing fluid.
 - differences in the change interval between tubing used continuously versus intermittently.
 - how to manage connectors and intermittent tubing between uses.
 - frequency of change of needleless connectors
 - maximum number of accesses
 - methods for monitoring and preventing inadvertent misuse of needleless connectors⁴⁸.
 - product assessment and evaluation including thorough assessment of risks and benefits
2. Ensuring the provision at the bedside of a convenient supply of:
 - blunt cannulas if using blunt cannula accessed split septum technology; or
 - sterile end caps to protect the male Luer end of the tubing between uses if using a luer accessed technology; and
 - alcohol pads for the purpose of adequately cleaning the connectors and hubs
3. Providing training and quality improvement processes to ensure compliance with recognized CRBSI prevention policies and procedures.
4. Ensure that appropriate surveillance is in place to evaluate the impact of any device and/or process changes and to enable timely detection of unexpected negative consequence to patients or staff.

This issue remains highly controversial and unresolved. The infection preventionist should diligently assess peer-reviewed literature specific to a particular device and also clearly understand the detail and appropriateness of manufacturer's specific recommendations.

In their recent response to criticism of SHEA and IDSA's recommendation, Mermel and Marschall proclaim their support for future design and manufacturing processes capable of delivering "fail-safe engineering advances" that will eliminate the risk of infection from use of these devices in environments as complicated as the typical modern healthcare setting.⁵¹ Infection preventionists should work with medical industry representatives to provide information that will enhance industry's ability to implement design advances to further reduce and eventually eliminate BSI risk associated with needleless connectors.

Until the problem is resolved, further investigation is needed. Before organizations adopt specific needleless connector technologies, clinicians, procurement staff, and administrators should also consider the existing and missing literature to determine the extent to which an alternative design of needleless connector may impact a patient's safety. Ethical, professional, and legal obligations compel healthcare organizations to provide appropriate and safe equipment despite the short-term attractiveness of bundled or high volume contractual offerings.

The Value and Role of Collecting Data to Determine “CL utilization ratio” and Its Implications

The central line utilization ratio (CLUR) is a measure of patient days in which central lines were used. The formula for calculating the CLUR Ratio is:

$$\frac{\# \text{ central line days}}{\# \text{ patient days}}$$

The CLUR measures invasive practices; in this case, the presence of a central line which is a known extrinsic risk factor for CRBSI. Some infection preventionists consider collection of patient days and central line days to calculate the CLUR as a burdensome and low return activity. The real utility of CLURs is that they can be a good indicator of quality of care given that reductions in CLURs may indicate reduced duration of catheterization.

Despite the ability to use the CLUR as an indicator of invasive practices, facilities are also encouraged to have a mechanism in place to question the need for a vascular device on a daily basis. As well, an additional unmet need is the methodology to capture infections and device days in other populations, such as cancer chemotherapy patients, who use long-term catheters.

The authors of this Elimination Guide agreed that infection preventionists could best apply and interpret CLUR measurements within their own individual organization between time periods rather than comparing to national benchmarks.⁵²

In addition, there is a likelihood of improved efficacy of real time monitoring of central line insertion using a carefully designed form such as the NHSN’s Central Line Insertion Practices Adherence Monitoring Tool which is available at <http://www.apic.org/eliminationguides>.

Surveillance in Dialysis Settings

In non-inpatient settings, CLABSI surveillance methodology can be problematic given that the most widely accepted CDC NHSN protocol requires collection of device days as a denominator in the calculation of BSI rates. Also, the CDC’s requirement that BSI is defined using either LCBI or CSEP definitions (see Definition of Terms) may make it difficult for outpatient hemodialysis staff to appropriately classify these events.

As an alternative, the CDC recommends surveillance of dialysis events using the definitions described in the following text. The CDC’s NHSN currently has a capacity for data recorded on the Dialysis Event form to be evaluated with a computer algorithm to determine whether each incident meets the definitions of one or more events.⁵³

The NHSN surveillance of dialysis events includes the following event definitions:

Local access infection: Pus, redness, or swelling of the vascular access site and access-associated bacteremia was not present *and* patient was hospitalized or had initiation of an IV antimicrobial agent.

Access-associated bacteremia: Blood culture positive with source identified as the vascular access site or unknown.

Vascular access infection: Either local access infection or access-associated bacteremia.

In developing this Guide, the authors sought novel appropriate alternative denominator data that infection preventionists could collect. There were few tested methodologies; however the Australian infection preventionists have used and been satisfied by the Australian Infection Control Association (AICA) definitions for dialysis unit access-related BSIs.⁵⁴ They are included below as a workable alternative for hospitals interested in access-associated bacteremia measurement in this setting. It is worthwhile noting that both the CDC and Australian methodologies calculate rates stratified by access type and also use patient months as a denominator.

Australian Dialysis Unit Access-related BSI

These are the definitions and methods used to monitor access-associated bacteremia in Australian outpatient hemodialysis settings.

Hemodialysis-associated BSI is defined as a BSI without apparent focus of infection or where there is clinical infection at the site of vascular access.

$$\frac{\text{Positive BSI AND Local access infection or no identifiable source of bacteremia} \\ \text{AND Hospitalization or in-unit IV antibiotic start}}{\text{Rate per 100 patient months, stratified by vascular access type.}}$$

Vascular access types are:

- Graft
 - Synthetic (e.g., PTFE, Thoratec)
 - Native vein
- Fistula
- Temporary catheter (noncuffed)
- Permanent catheter (cuffed)

General Notes

Rates will be calculated separately for each type of vascular access.

Number of chronic hemodialysis patients

Total patients (= the sum of patients with grafts, fistulas, temporary catheter, and permanent catheters).

Patient months

Number of chronic hemodialysis patients with specified vascular access type multiplied by months of surveillance.

Possible contaminant in blood cultures

As per part 1, diagnosis of a BSI.

Incidents closely related in time

If IV antimicrobials are stopped for less than 21 days and then restarted, this is NOT considered a new incident. However, if IV antimicrobials are stopped for 21 days or more and then restarted, this is considered a new incident.

Use of “Off-label” in “Scrub the Hub” Recommendations

In the U.S., antiseptic skin preparations must meet the criteria of the FDA Tentative Final Monograph (TFM). Any company wishing to bring a product containing CHG to market for skin disinfection must file a New Drug

Application (NDA) and submit their findings in order to demonstrate the product is safe and effective. If the outcome is positive, the FDA will give approval.

Skin disinfectants and surface disinfectants should not be assumed to be interchangeable in their use. This Elimination Guide recognizes the catheter hub as the hard piece of plastic permanently attached to the catheter. In their recent guidance, IDSA and SHEA recommend that “before accessing catheter hubs or injection ports, clean them with an alcoholic CHG preparation or 70% alcohol to reduce contamination.”⁸ Authors of this Elimination Guide believe that one of the British studies cited to support the use of an alcoholic CHG solution to clean the hub recommends use of a product licensed in the U.S. for skin, for use on the catheter hub.⁵⁵ In the U.S. this is an “off-label” use of alcoholic CHG solution and, although various concentrations of CHG have been studied for this purpose, it would seem reasonable that it requires consideration of all possible risks and benefits. In the case of CHG, the issues that should be considered include:

1. What is the safety and efficacy of this product for the intended use?
2. What comparative data is available regarding the effect of CHG on plastic or hubs made of other polymers?
3. Does CHG use contribute to or result in any form of plastic degradation such as cracking or softening?
4. Have any formal studies of hubs examined this effect?
5. Is CHG more effective than alcohol?
6. What types of outcomes measurements were included in available studies? Is bacteremia one of the measured outcomes?
7. If we support the use of skin disinfectants on surfaces rather than skin are there any concerns?
8. Will this lead other clinicians to believe that surface disinfectants can safely be used on skin?

U.S. Regulatory and Public Policy Issues Relating to CRBSI Reduction

In 2009 TJC expanded its Infection Control chapter.² While no substantive changes to the Infection Control chapter have been made, the TJC has designated three of the NPSGs to specifically address initiatives in infection control. TJC's action indicates their priorities and perception of infection prevention as a major patient safety initiative.

One of TJC's NPSGs is the reduction of central line infections which is understandable given the reduced quality of patient outcome associated with the acquisition of a CRBSI. TJC is phasing in this goal with hospitals expected to have achieved full implementation in 2010. National Patient Safety Goal 07.04.01 stipulates requirements for evidence-based practice in relation to short- and long term CVCs and PICC lines. The CMS has also addressed this initiative in its Inpatient Prospective Payment System Reforms in the U.S., where central line infections acquired in hospitals no longer qualify for a higher payment rate.

The most recent public policy initiative relating to CRBSI prevention is included in HHS' *HHS Action Plan to Prevent Healthcare-Associated Infections*. In this Plan, HHS proposed four national 5-year prevention targets and metrics for CLABSI.¹²

The proposed CLABSI targets and metrics are Metric 1, an outcome metric, and Metric 2, a process metric.

1. [Metric 1] CLABSI 1: CLABSIs per 1000 device days by ICU and other locations. [Target 1] CLABSIs per 1000 device days by ICU and other locations below present NHSN 25th percentile by location type (75% reduction in Stratified Infection Ratio).
2. [Metric 2] CLABSI 4: Central line bundle compliance (nonemergent insertions). [Target 2] 100% compliance with central line bundle (nonemergent insertions).

The following table provides succinct descriptions of the key roles of these leading U.S. agencies. It also attempts to compare and contrast their CRBSI reduction strategies and recommendations.

Table 10-1. Crosswalk of Key Roles of these Leading U.S. Agencies Influencing CRBSI Prevention

Key Issues	CDC	TJC	CMS
<p>Initiatives, core business, and mission</p>	<p>The CDC serves as the national focus for developing and applying disease prevention and control, environmental health, and health promotion and health education activities designed to improve the health of the people of the U.S. The Agency has a federal mandate in the U.S. only. The CDC has no regulatory function but, rather, is recognized globally as a leading public health agency. Its Division of Healthcare Quality Promotion (DHQP) is respected and trusted source of state-of-the-art clinical practice guidance and HAI surveillance methodology, much of which is either voluntarily applied or modified for use in international settings.</p>	<p>TJC evaluates and accredits more than 15,000 healthcare organizations and programs in the U.S. An independent, not-for-profit organization, TJC is the nation's predominant standards setting and accrediting body in healthcare. Since 1951, TJC has maintained state-of-the-art standards that focus on improving the quality and safety of care provided by healthcare organizations. TJC's comprehensive process evaluates an organization's compliance with these standards and other accreditation or certification requirements. TJC accreditation and certification is recognized nationwide as a symbol of quality that reflects an organization's commitment to meeting certain performance standards. To earn and maintain TJC's Gold Seal of Approval™, an organization must undergo an onsite survey by a TJC survey team at least every 3 years. (Laboratories must be surveyed every 2 years.)</p>	<p>CMS is the U.S. federal agency responsible for administering the Medicare, Medicaid, SCHIP (State Children's Health Insurance), HIPAA (Health Insurance Portability and Accountability Act), CLIA (Clinical Laboratory Improvement Amendments), and several other health-related programs.</p>
<p>Recommendations regarding CRBSI and/or CLABSIs</p>	<p>Guidelines for the Prevention of Intravascular Catheter-Related Infections 2002</p> <p>These guidelines have been developed for practitioners who insert catheters and for persons responsible for surveillance and control of infections in hospital, outpatient, and home healthcare settings. This report was prepared by a working group comprising members from professional organizations representing the disciplines of critical care medicine, infectious diseases, healthcare infection control, surgery, anesthesiology, interventional radiology, pulmonary medicine, pediatric medicine, and nursing. The working group was led by the Society of Critical Care Medicine</p>	<p>National Patient Safety Goals (Chapter) 2009</p> <p>Infection surveillance must be performed on all central lines; these lines carry significant risk of morbidity and mortality regardless of circumstances. Limiting surveillance to certain types of lines, patient care units, or service lines is not allowable under NPSG.07.04.01.</p>	<p>Defers to state law and organizations such as the CDC and APIC</p> <p>The hospital's program for prevention, control, and investigation of infections and communicable diseases should be conducted in accordance with nationally recognized infection control practices or guidelines, as well as applicable regulations of other federal or state agencies. Examples of organizations that promulgate nationally recognized infection and communicable disease</p>

Key Issues	CDC	TJC	CMS
<p>Recommendations regarding CRBSI and/or CLABSIs (continued)</p>	<p>(SCCM), in collaboration with IDSA, SHEA, Surgical Infection Society (SIS), American College of Chest Physicians (ACCP), American Thoracic Society (ATS), American Society of Critical Care Anesthesiologists (ASCCA), APIC, Infusion Nurses Society (INS), Oncology Nursing Society (ONS), Society of Cardiovascular and Interventional Radiology (SCVIR), American Academy of Pediatrics (AAP), and the Healthcare Infection Control Practices Advisory Committee (HICPAC) of the CDC and is intended to replace the Guideline for Prevention of Intravascular Device-Related Infections published in 1996. These guidelines are intended to provide evidence-based recommendations for preventing CRBSIs. Major areas of emphasis include (1) educating and training healthcare providers who insert and maintain catheters; (2) using maximal sterile barrier precautions during CVC insertion; (3) using a 2% CHG preparation for skin antisepsis; (4) avoiding routine replacement of CVCs as a strategy to prevent infection; and (5) using antiseptic/antibiotic impregnated short-term CVCs if the rate of infection is high despite adherence to other strategies (i.e., education and training, maximal sterile barrier precautions, and 2% CHG for skin antisepsis). These guidelines also identify performance indicators that can be used locally by healthcare institutions or organizations to monitor their success in implementing these evidence-based recommendations.</p>		<p>control guidelines and/or recommendations include: CDC, APIC, SHEA, and the Association of preoperative Registered Nurses (AORN. The U.S. Occupational Health and Safety Administration (OSHA) also issues federal regulations applicable to infection control practices.</p>
<p>Law vs. Recommendations (U.S. only)</p>	<p>Recommendations, but highly enforceable.</p>	<p>Recommendations</p>	<p>Law and recommendations which are highly enforceable.</p>

Key Issues	CDC	TJC	CMS
Activities infection preventionists perform as a result of these initiatives	Surveillance Education (staff and families) Monitoring Public reporting (NHSN) for certain states Periodic evaluation		
Benefits and Difficulties	Benefits Reduction in catheter-associated infections Saves healthcare costs Better outcome to patients Increased satisfaction to patients Difficulties Consistency Resources Competing priorities		
Recommendations impact the others	Highly Influential, Gold Standard	Highly Influential (TJC determination can impact approval for CMS funding)	Highly Influential (Law), federal funding is at stake
How can APIC members meet the recommendations?	Education Training		
Benefits for patients	Reduction in catheter-associated infections Saves healthcare costs Better outcome to patients Increased satisfaction to patients		
Negative outcomes if those recommendations are not met?	Higher mortality and morbidity for patients Increased length of stay Increase costs to the healthcare organization Decreased patient satisfaction Increased legal liability		
Additional high level agency input?	Efforts to consolidate the recommendations should be made across the board allowing for one consistent approach that is recognized across the U.S. and internationally as an appropriate model to follow.		

Public Reporting of CRBSIs and Pay-for-Performance

Strategies to improve the quality of healthcare have been employed throughout the U.S. In 1997, a project started by business leaders in southwestern Pennsylvania (PA) to create new jobs and improve the quality of life in the region focused on a major local industry: healthcare. Economic pressures on the healthcare sector were resulting in hospitals suffering operating losses, bankruptcies, consolidations, and a high rate of employee turnover.

The Pittsburgh Regional Health Initiative (PRHI), a nonprofit community consortium, adapted industrial improvement methods to healthcare settings. One of the first problems addressed by approximately 40 healthcare facilities, 4 major insurers, 32 major employers, civic and corporate leaders, organized labor, and local public health authorities was CLABSIs. There was no financial incentive for participation in the project and individual hospital information was never shared. Standardized definitions based on the CDC's National Nosocomial Infections Surveillance System (NNIS) criteria were used to determine infections. Participating hospitals had an intense desire to show continuing decreases in the number of infections identified and strongly supported the infection prevention activities. By the time the Institute of Medicine (IOM) called for the application of engineering principles to the daily work of healthcare in 2005, hospitals participating in the program had reduced aggregate CLABSI rates from 4.3 to 1.6 infections per 1000 central line days—a 63% decrease.

One of the basic concepts used by the group was entitled “Perfecting Patient Care.” By using industrial improvement models to design work flow processes, potential for error was minimized. Most hospitals worked with manufacturers and clinicians to design custom barrier kits including gloves, gowns, caps, large drapes, and masks. When the physician was provided with all elements necessary for central line insertion, including CHG skin prep and a data collection form to document the process, it became rare that the process was not performed perfectly. The Toyota Production Model was used to examine mishaps immediately and implement preventive measures. Other elements of the collaboration include staff training about infection control measures, checklists, and hospital unit feedback on infection rates and compliance with appropriate preventive practices.

Because of the area's success, business leaders throughout the state learned that these quality improvement initiatives offered a great opportunity for cost-containment as the price tag for providing healthcare insurance was increasing. Because of the continuing escalation of healthcare costs, an increasing number of citizens became uninsured, affecting the economy of the state. Pennsylvania's Health Care Cost Containment Council (PHC4) announced that effective January 1, 2004, hospitals were required to submit all HAI data to their agency. This independent agency had been authorized in 1986 to receive patient-specific data on various conditions, outcomes, and charges; however, this was the first time they had collected infection information. Hospital-specific data was analyzed by the group and publicly reported on their website, in the news media, and in booklet form. In 2008, this requirement became a part of the state's “Act 52” which included reporting infection data through NHSN for all available modules. This patient-specific infection data is now available to PHC4, the State Health Department, and the PA Patient Safety Authority. Although public reporting and pay-for-performance initiatives are intended to accelerate improvements in hospital care, it is still unclear about the true benefits of these methods. Public reporting is designed to provide information to consumers and force hospitals to improve processes or risk being perceived as providing substandard care. CLABSI rates in PA have been difficult to compare though because PHC4 reported the number of actual CLABSIs and used patient days as a denominator for rate calculation. Smaller facilities that have fewer patients with central lines in place could have very low numbers of infections and low rates while university-based medical centers could be perceived as poor performers.

Pay-for-performance initiatives have also been implemented in the area providing financial incentives for improving care. Highmark Inc., an independent licensee of the Highmark Blue Cross and Blue Shield Association, was part of the original PRHI consortium. The program aligns with national organizations and incorporates industry standards and guidelines that support the HHS' Four Cornerstones of Value Driven Healthcare. Hospitals can enroll in specific improvement modules then their performance is evaluated utilizing defined, standardized performance metrics. Data is compared across indicators, quality measures, and participants. Highmark has hired some of the area's top infection preventionists, quality improvement specialists, physicians, data analysts, nurses, and others to create an expert department that collaborates with the participating facilities and closely monitors performance.

For hospitals participating at a higher level (more initiatives) that have greater than 3 CRBSIs per year and/or a rate of greater than or equal to 0.5 CRBSIs per 1000 central line days, participation in this indicator is mandatory. A standardized data collection tool must be completed monthly, including the number of device days, CRBSIs, and a calculated rate. Formal presentations are given by each institution twice during the program year including a critical analysis of actions taken to improve results (planning, implementation, education, and training efforts, etc.). To evaluate performance, reduction of CRBSI infections is compared to the hospitals' infection rate for the previous year. Reduction of device utilization rates is also reviewed.

While public reporting has increased physician and leadership awareness of infection prevention activities, pay-for-performance programs have served to strengthen the business case for quality improvement. In this area, public reporting has served as an additional catalyst to continue the efforts of CRBSI reduction, but the rigorous analysis of data required to receive a financial incentive for quality and competitive motivation has resulted in an ongoing reduction of infection rates. The most important message to share from this process is that team effort is needed to be successful and that real focus on each individual infection provides the most critical analysis of areas for improvement. Physician champions may come from various departments and not be part of the normal infection control committee. Physicians from interventional radiology place many PICCs and anesthesiologists place many central lines in the perioperative setting but may never hear about CRBSI data under normal situations. Both groups are essential in ensuring that the insertion process is performed according to your policy. In teaching hospitals, engagement of the house staff is also critical. Focused training on central line insertion practices is necessary and feedback of infection data can help support the success of your program in the future.

Definitions Used in CRBSI Prevention

Clinical Definitions

Aseptic technique	Mechanisms employed to reduce potential contamination.
Exit site infection	Microbiological: Exudate at catheter exit site yields a microorganism with or without concomitant bloodstream infection. Clinical: Erythema, induration, and/or tenderness within 2 cm of catheter exit site; may be associated with other signs and symptoms of infection, such as fever, pus, or other purulent drainage.
Infusion	The introduction of a solution through a blood vessel via a catheter lumen. This may include continuous infusions such as nutritional fluids or medications, or it may include intermittent infusions such as flushes or IV antimicrobial administration, or blood, in the case of transfusion or hemodialysis.
Phlebitis	Induration or erythema, warmth, and pain or tenderness around catheter exit site.
Sterile	Free from living organisms.
Tunnel infection	Tenderness, erythema, and/or induration >2 cm from the catheter exit site, along the subcutaneous tract of a tunneled catheter (e.g., Hickman or Broviac catheter), with or without concomitant bloodstream infection.

Device Definitions

CVC or central vascular access device (CVAD)	Catheter inserted into a centrally located vein with the tip residing in the vena cava; permits intermittent or continuous infusion and/or access into the venous system.
Midline catheter	The midline catheter is a peripherally inserted 6- to 8-inch catheter that may be used in patients requiring intermediate duration (i.e., several weeks) of physiologically compatible IV therapy. Unlike conventional short peripheral IV catheters, the midline catheter does not require changes every 48–72 hours. The tip of the midline catheter should rest in the upper extremity of the insertion arm, and does not extend to the great vessels. A midline is NOT a central line.
PICC	A CVAD inserted into an extremity and advanced until the tip is positioned in the vena cava.
Umbilical catheter	A CVAD inserted through the umbilical artery or vein in a neonate.

Laboratory Definitions

Catheter colonization	Growth of organisms from a catheter segment by either semi-quantitative or quantitative culture. In the semi-quantitative culture technique, the catheter is rolled on a culture plate, which is observed for colony formation. The growth of ≥ 15 CFU defines colonization. In the quantitative technique, the catheter segment is processed in broth and sonicated, and the broth is surface-plated onto a culture plate. The growth of 1000 or more CFU defines colonization.
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Surveillance Definitions

CLABSI	<p>A CLABSI is a primary BSI in a patient that had a central line within the 48-hour period before the development of the BSI. If the BSI develops within 48-hours of discharge from a location, it is associated with the discharging location. <i>Note:</i> There is no minimum period of time that the central line must be in place in order for the BSI to be considered central line-associated.</p> <p>* For the purposes of this document reference to CLABSIs include:</p> <ul style="list-style-type: none"> • CLRBSI (central line-related bloodstream infections) • CABSI (catheter-associated bloodstream infections) • CRBSI (catheter-related bloodstream infections) • Primary BSI (bloodstream infections)
Primary bloodstream infections	<p>Primary bloodstream infections are classified either as LCBI or CSEP. CSEP may be used to report only a primary BSI in neonates (≤ 30 days old) and infants (≤ 1 year old).</p>
LCBI	<p>If there is no other recognized cause for positive blood culture and/or signs and symptoms and</p> <ul style="list-style-type: none"> • 1 positive blood culture with recognized pathogen or • Skin organisms: >2 blood cultures drawn on separate occasions positive for the same organism + clinical symptoms or • Infant/neonate: >2 blood cultures drawn on separate occasions positive for the same organism + clinical symptoms
CSEP	<p>Infants and neonates <u>only</u>: Clinical symptoms + no positive blood culture + antimicrobial therapy instituted.</p>
Device days	<p>A count of the number of patients with a specific device in the patient care location. To calculate device days, for each day of the month, at the same time each day, record the number of patients who have the specific device (e.g., central line, ventilator, or indwelling urinary catheter).</p>
Patient days	<p>A count of the number of patients in the patient care location. To calculate patient days, for each day of the month, at the same time each day, record the number of patients on the unit. At the end of the month, the sum of all days is recorded.</p>
Secondary Bloodstream Infection	<p>A culture-confirmed BSI associated with a documented HAI at another site. If the primary infection is cultured, the secondary BSI must yield culture of same organism and exhibit same antibiogram as the primary HAI site. For example, if blood culture is positive in a patient with a nosocomial urinary tract infection (UTI) and organisms and antibiograms of both blood and urine specimens are identical, infection is reported as UTI with secondary BSI. Secondary BSI is not reported separately. If, on the other hand, an organ/space surgical-site infection (SSI) is identified by computed tomography (CT) scan and no culture is used to meet the criteria for SSI-GIT, and a blood culture grows <i>Bacteroides fragilis</i>, then the SSI-gastrointestinal tract is recorded as an SSI with a secondary BSI. The pathogen for the SSI is recorded as <i>Bacteroides fragilis</i>.</p>

Note: For the purposes of CDC NHSN, an introducer is considered an intravascular catheter whereas other organizations consider an introducer as a temporary device designed to get the catheter into the vein. In neonates, the umbilical artery/vein is considered a great vessel.

Neither (the location of) the insertion site nor the type of device may be used to determine if a line qualifies as a central line. The device must terminate in one of these vessels or in or near the heart to qualify as a central line. Pacemaker wires and other nonlumened devices inserted into central blood vessels or the heart are not considered central lines because fluids are not infused, pushed, nor withdrawn through such devices.

NHSN Surveillance Definitions and Methods

This section outlines specific details regarding the definitions used for surveillance purposes by participants in the U.S. of the CDC's NHSN surveillance system. Readers should recognize that these definitions and methodologies are designed for surveillance activity as such may not be useful for clinical diagnosis or treatment purposes.

CDC's NHSN defines a CLABSI as a BSI that was identified in a patient who had a central line at the time of, or within 48 hours before, the onset of the BSI. It should be noted that there is no minimum period of time that the central line must be in place before the BSI is considered central line-associated.

Central line: an intravascular catheter that terminates at or close to the heart or in one of the great vessels which is used for infusion, withdrawal of blood, or hemodynamic monitoring. The following are considered great vessels for the purpose of reporting central line infections and counting central line days in the NHSN system: aorta, pulmonary artery, superior vena cava, inferior vena cava, brachiocephalic veins, IJ veins, subclavian veins, external iliac veins, and common femoral veins.

Notes:

- An introducer is considered an intravascular catheter.
- In neonates, the umbilical artery/vein is considered a great vessel.
- Neither (the location of) the insertion site nor the type of device may be used to determine if a line qualifies as a central line. The device must terminate in one of these vessels or in or near the heart to qualify as a central line.
- Pacemaker wires and other nonlumened devices inserted into central blood vessels or the heart are not considered central lines, because fluids are not infused, pushed, nor withdrawn through such devices.

Infusion: the introduction of a solution through a blood vessel via a catheter lumen. This may include continuous infusions such as nutritional fluids or medications, or it may include intermittent infusions such as flushes or IV antimicrobial administration, or blood, in the case of transfusion or hemodialysis.

Temporary central line: nontunneled catheter

Permanent central line: includes

- Tunneled catheters, including certain dialysis catheters
- Implanted catheters (including ports)

Birth weight: the weight of an infant at the time of birth. This value should not be changed as the infant gains weight. For example, if an infant weighs 1006 grams at birth, but remains in the neonatal intensive care unit (NICU) for 2 months and has a body weight of 1650 grams when it develops a BSI, the recorded birth weight should still be 1006 grams.

BSIs: classified according to the criteria used, either as LCBI or CSEP. CSEP may be used to report only a primary BSI in neonates (≤ 30 days old) and infants (≤ 1 year old).

LCBI

LCBI criteria 1 and 2 may be used for patients of any age, including patients ≤ 1 year of age.

LCBI must meet one of the following three criteria:

Criterion 1: Patient has a recognized pathogen cultured from one or more blood cultures

AND

organism cultured from blood is *not* related to an infection at another site. (See Notes 1 and 2)

Criterion 2: Patient has at least *one* of the following signs or symptoms: fever ($>38^{\circ}\text{C}$), chills, or hypotension

AND

signs and symptoms and positive laboratory results are *not* related to an infection at another site

AND

common skin contaminant (i.e., diphtheroids [*Corynebacterium* spp.], *Bacillus* [not *B. anthracis*] spp., *Propionibacterium* spp., coagulase-negative staphylococci [including *S. epidermidis*], viridans group streptococci, *Aerococcus* spp., *Micrococcus* spp.) is cultured from *two* or more blood cultures drawn on separate occasions.

Criterion 3: Patient ≤ 1 year of age has at least *one* of the following signs or symptoms: fever ($>38^{\circ}\text{C}$ core)

hypothermia ($<36^{\circ}\text{C}$ core), apnea, or bradycardia

AND

signs and symptoms and positive laboratory results are *not* related to an infection at another site

AND

common skin contaminant (i.e., diphtheroids [*Corynebacterium* spp.], *Bacillus* [not *B. anthracis*] spp., *Propionibacterium* spp., coagulase-negative staphylococci [including *S. epidermidis*], viridans group streptococci, *Aerococcus* spp., *Micrococcus* spp.) is cultured from *two* or more blood cultures drawn on separate occasions. (See notes 3–5.)

Notes:

1. In criterion 1, the phrase “one or more blood cultures” means that at least one bottle from a blood draw is reported by the laboratory as having grown organisms (i.e., is a positive blood culture).
2. In criterion 1, the term “recognized pathogen” does *not* include organisms considered common skin contaminants (see criteria 2 and 3 for a list of common skin contaminants). A few of the recognized pathogens are *S. aureus*, *Enterococcus* spp., *E. coli*, *Pseudomonas* spp., *Klebsiella* spp., *Candida* spp., etc.
3. In criteria 2 and 3, the phrase “*two* or more blood cultures drawn on separate occasions” means (1) that blood from at least two blood draws were collected within two days of each other (e.g., blood draws on Monday and Tuesday or Monday and Wednesday would be acceptable for blood cultures drawn on separate occasions, but blood draws on Monday and Thursday would be too far apart in time to meet this criterion), and (2) that at least one bottle from each blood draw is reported by the laboratory as having grown the same common skin contaminant organism (i.e., is a positive blood culture). (See note 4 for determining sameness of organisms.)
 - a. For example, an adult patient has blood drawn at 8 a.m. and again at 8:15 a.m. of the same day. Blood from each blood draw is inoculated into two bottles and incubated (four bottles total). If one bottle from each blood draw set is positive for coagulase-negative staphylococci, this part of the criterion is met.
 - b. For example, a neonate has blood drawn for culture on Tuesday and again on Saturday and both grow the same common skin contaminant. Because the time between these blood cultures exceeds the 2-day period for blood draws stipulated in criteria 2 and 3, this part of the criteria is *not* met.
 - c. A blood culture may consist of a single bottle for a pediatric blood draw due to volume constraints. Therefore, to meet this part of the criterion, each bottle from two or more draws would have to be culture-positive for the same skin contaminant.

Table 13-1. Examples of How to Report Speciated and Unspeciated Common Skin Contaminate Organisms

Culture	Companion Culture	Report as...
<i>S. epidermidis</i>	Coagulase-negative staphylococci	<i>S. epidermidis</i>
<i>Bacillus</i> spp. (not <i>anthracis</i>)	<i>B. cereus</i>	<i>B. cereus</i>
<i>S. salivarius</i>	<i>Strep viridans</i>	<i>S. salivarius</i>

4. There are several issues to consider when determining sameness of organisms.
 - a. If the common skin contaminant is identified to the species level from one culture, and a companion culture is identified with only a descriptive name (i.e., to the genus level), then it is assumed that the organisms are the same. The speciated organism should be reported as the infecting pathogen (see examples in Table 13-1).
 - b. If common skin contaminant organisms from the cultures are speciated but no antibiograms are done or they are done for only one of the isolates, it is assumed that the organisms are the same.
 - c. If the common skin contaminants from the cultures have antibiograms that are different for two or more antimicrobial agents, it is assumed that the organisms are not the same (see Table 13-2).
 - d. For the purpose of NHSN antibiogram reporting, the category interpretation of intermediate (I) should not be used to distinguish whether two organisms are different.

CSEP

CSEP may be used only to report a primary BSI in neonates and infants.

To report a CSEP, the following criterion must be met:

Patient ≤ 1 year of age has at least one of the following clinical signs or symptoms with no other recognized cause: fever ($>38^{\circ}\text{C}$ core), hypothermia ($<36^{\circ}\text{C}$ core), apnea, or bradycardia

AND

blood culture *not* done or *no* organisms detected in blood

AND

no apparent infection at another site

AND

physician institutes treatment for sepsis.

Table 13-2. Examples of How to Interpret the Sameness of Two Skin Contaminate Isolates by Comparing Antimicrobial Susceptibilities

Organism Name	Isolate A	Isolate B	Interpret as...
<i>S. epidermidis</i>	All drugs S	All drugs S	Same
<i>S. epidermidis</i>	OX R GENT R	OX S GENT S	Different
<i>Corynebacterium</i> spp.	PENG R CIPRO S	PENG S CIPRO R	Different
<i>Strep viridans</i>	All drugs S	All drugs S except ERYTH (R)	Same

General Techniques for Monitoring CRBSIs

Surveillance Methodology

The collection of infection data for BSIs and their corresponding denominator data should be performed using active, patient-based, prospective surveillance of the population at risk (i.e., patients who have central lines) and should be overseen by a trained infection preventionist. This means that the infection preventionist shall seek out infections during a patient's stay by screening a variety of data sources, such as microbiology reports, patient records, clinical notes, temperature charts, etc. Others may be trained by the infection preventionist to screen data sources for these infections, but the IP must make the final determination. To minimize the infection preventionist's data collection burden, other staff may be trained to collect the denominator data.

Denominators (Patient Days and Central Line Days)

Patient Days: At the same time every day, the number of patients on the unit is counted. If a patient has not yet been admitted, the patient is not counted. If a patient has been discharged, the patient is not counted. If a patient is off the unit for testing, the patient *is* counted. The sum of these daily counts is recorded at the end of the month.

Central line days: At the same time every day, count the number of patients with *one or more* central lines (e.g., a patient with a subclavian central line and a PICC is counted as *one* central line day). If a patient with a central line has been discharged or transferred to another unit, the central line day is not counted. If a central line is scheduled for insertion, but not yet placed, it is not counted. If a patient with one or more central lines is temporarily off the unit for testing, the central line day *is* counted. The sum of these daily counts is recorded at the end of the month. Specialty care areas (SCA) and NICU locations use additional risk stratification in the collection of denominator data (see "Unit-specific Methodology" later). When denominator data are available from electronic databases (e.g., ventilator days from respiratory therapy), these sources may be used as long as the counts are not substantially different ($\pm 5\%$) from manually collected counts.

Specimen Collection Considerations

Ideally, blood specimens for culture should be obtained from two to four blood draws from separate venipuncture sites (e.g., right and left antecubital veins), not through a vascular catheter. These blood draws should be performed simultaneously or over a short period of time (i.e., within a few hours).^{56,57} If your facility does not currently obtain specimens using this technique, you may still report BSIs using the criteria and notes here, but you should work with appropriate personnel to facilitate better specimen collection practices for blood cultures. See online http://www.cdc.gov/ncidod/dhqp/pdf/nhsn/NHSN_Manual_PatientSafetyProtocol_CURRENT.pdf.

Unit-specific CRBSI Methodology

Surveillance can occur in four different types of inpatient locations:

1. ICU
2. SCA: This location type includes those five inpatient locations where patients are likely to have permanent central lines:
 1. Long-term acute care
 2. Bone marrow transplant
 3. Solid organ transplant

4. Acute inpatient dialysis
5. Hematology/oncology

When collecting denominators, central line days in SCA locations are collected separately for temporary central lines and permanent central lines. If a patient has both a permanent and a temporary central line, only the temporary central line is counted.

3. NICU: When collecting denominators in NICU locations, central line days are stratified by umbilical central lines and nonumbilical central lines (e.g., PICC). If a patient has both an umbilical line and a nonumbilical central, only the umbilical line is counted. In NICU locations, patients are further stratified into the following birth weight categories:
 - ≤750 grams
 - 751–1000 grams
 - 1001–1500 grams
 - 1501–2500 grams
 - >2500 grams
4. Other inpatient locations where denominator data can be collected (e.g., surgical ward or orthopedic ward). BSIs in patients with central lines are not collected in areas such as emergency departments or operating rooms.

Data Analysis

The *BSI rate* in patients with central lines is calculated using the following formula, stratified by each location monitored:

$$\frac{\# \text{ BSIs in patients with central lines}}{\# \text{ central line days}} \times 1000$$

In SCA locations, both numerator and denominator are further stratified by temporary and permanent lines.

In NICU locations, both numerator and denominator are further stratified by birth weight category and by umbilical versus nonumbilical central lines.

The *device utilization (DU) ratio* is a measure of patient days in which central lines were used. The formula for calculating the DU ratio is:

$$\frac{\# \text{ central line days}}{\# \text{ patient days}}$$

A multiplier is not used for the DU ratio.

Suggested Reporting Mechanisms and Recipients

One of the most important mechanisms of process improvement is to provide actionable data. Retrospective surveillance has some definite advantages for an infection preventionist but, when trying to identify problems in a timely manner, BSIs should be addressed as soon as culture results become available. While most facilities have traditionally disseminated infection data to hospital-wide committees and administration, it is essential to also share this information with the people who can actually make a difference—the direct care providers. Involving physicians who place the central lines provides valuable feedback on potential technique issues.

Managers of individual units may not provide much detail to their nursing staff, and if results only appear as infection rates, the effect may be minimal. Timely feedback is important, especially with device-associated infections such as BSIs. Including direct care staff members in a root cause analysis (RCA) discussion provides a great opportunity to gain greater insight into issues that may not otherwise be identified. For example, learning that the flush syringes are difficult to attach to a positive pressure valve may provide information that would not be known to the unit manager. Providing comparative data within the organization can have a broad impact also. A little competition between ICUs can be a good thing, particularly when the area with the most improved results cares for a higher risk patient population.

Infection data can be of less interest to administrators when it is simply provided as a rate or raw numbers. Using the business case model to highlight the cost of these infections provides much more memorable data for administrators. As your efforts to reduce infections are successful, providing cost avoidance data provides valuable information to get further buy-in for infection prevention efforts. Cost benefit analysis may enable you to better argue for custom kits or coated catheters if needed.

How to do an Historic Comparison

Very few hospitals have long-term detailed infection data on BSIs outside the ICU setting. PICC usage has increased to the point where there are more CVCs on non-ICU settings than ICU settings. This may not have originally been part of the facility's surveillance plan. In order to develop comparative data, it is strongly recommended that data be collected in all healthcare settings.

Generating infection rates based on device days is the most stable calculation for internal and external comparative purposes. However, it has not been an easy task at many facilities to be able to capture device utilization information so central line days may not be available to start your historical comparison. When beginning an initiative to reduce BSIs, it is acceptable to continue to tally infection data as it has been done in the past but start to include more descriptive data. In this manner, you can compare your historical data with current data, but eventually you will be able to develop device-associated infection rates more comparable with published benchmarks. Spreadsheet programs, such as Excel, are easily adaptable for these efforts. Graphs can be created using both historical calculations and newer formats. Graphics are an easy way to disseminate infection rates to various customers in your organization and can be customized for the recipients. For example, a graph highlighting declining trends can be placed on patient units for public viewing while the same information can also be used in a more detailed manner for infection and quality committees.

Examples of Process and Outcomes Measures

Successful capture of both process and outcomes measures helps to demonstrate the effects of various changes throughout the initiative. Process measures might include the use of barrier precautions, skin antisepsis, selection of appropriate insertion sites, number of attempts to insert the catheter, adherence to dressing change protocols, and evaluation of catheter necessity on a daily basis. Some examples of catheter insertion process documentation and information about how to conduct a point prevalence study of central line dressing observations are included in the Tools and Resources section of this Guide.

Outcomes measures should improve as process measures are implemented successfully. For example, the number of BSIs should decrease when the devices are placed and utilized appropriately. Outcomes measures may also include data on other adverse patient outcomes, such as thrombophlebitis. Reduction in the duration of catheterization through daily review of catheter necessity can also be calculated as an outcome measure.

External Reporting: How to Meet Your Organization's Obligations

Every organization may have a slightly different mandate on external reporting, based on location, organization structure, and facility interests. Often times, these reports may need to include different data elements. For example, in U.S. states where public reporting laws have mandated data submission, only infection rates may be necessary. Other U.S. states may require patient-specific data be entered into NHSN. Hospitals that are part of a healthcare system may require certain process and/or outcome measures be reported for system comparisons. Because reporting HAI data is in a period of transition, it may be better to be proactive and collect as many data elements as possible in electronic format, such as Excel. The U.S. NHSN data collection forms that are available at www.apic.org/eliminationguides are an easy way to start capturing your data, even if you are not required to utilize that system. The use of standardized data collection forms provides information which could later be useful in case retrospective review is needed. It is generally better from a time management perspective to collect data elements when reviewing patient records rather than trying to go back to find this information at a later time.

Case Studies

APIC members in various clinical settings and locations have reported substantial reductions in their organization's CRBSIs after implementing evidence-based and other interventions²⁸ including:

- Hand hygiene
- Maximal barrier precautions
- CHG skin antisepsis
- Optimal catheter site selection
- Daily review and timely removal of catheters
- Advanced technologies

Many of these organizations also report substantial improvement in their organizational culture including:

- Downward recalibration of the organization's expected CRBSI incidence
- More highly visible support for infection prevention from the organization's leadership
- Increased clinical governance including higher expectations that clinicians will consistently adhere to infection prevention recommendations
- Prompt investigation of CRBSIs and resolution and remediation of contributing risk factors
- Provision of more timely data to front line staff to better convey the need for and impact of improvements⁵⁸

These case studies are included to provide unique insights into the different types of CRBSI improvement projects initiated by APIC members as well as specific strategies that they have used.

Maintaining Safety and Quality in PICC Line Care, The Queen Elizabeth Hospital (QEH), Adelaide, Australia

What is the name of the organization that conducted this project?

The Queen Elizabeth Hospital (QEH), Adelaide, Australia.

Briefly describe this organization including city, state, country, size, and range of clinical activities typically offered.

QEH is a 350-bed general teaching hospital in a major Australian city. It provides medical care and specialist ICU, renal dialysis, transplant, general surgery, oncology, and hematology services.

Briefly describe the organization's infection prevention program capacity including personnel; line reporting; CRBSI goals, education, and policies; participation in an aggregate CRBSI data collection system (e.g., NHS, state-based reporting or other equivalent); and any other relevant issue(s).

QEH's infection prevention program has a capacity of 1.8 full-time infection preventionists and is supported by an infectious diseases (ID) microbiologist and an ID consultant. Every 2 months the program reports data to the hospital's Quality Council. The data is collected using definitions developed by the AICA, these definitions are largely based on NNIS definitions. QEH also submits CRBSI data to the State Health Department for

aggregation. The data is also submitted to Australia's Joint Commission equivalent body, the Australian Council on Healthcare Standards (ACHS), as an accreditation requirement.

Goals: Keeping BSI lower than ACHS level of 1% (hematology and oncology); all others <3%. National levels—ACHS or Productivity Commission.

To provide routine education in Radiology and ICU by using a standardized screensaver about catheter insertion on each computer screen.

To identify education needs of staff relating to PICC and CVC management and to provide workshops on PICC management as needed.

Describe the pre-improvement project CRBSI issue addressed by the project.

Prior to this project, QEHL experienced CRBSI rates in patients with PICCs which were higher than the mean state and national rates. The IPs identified a need for improved education of staff on central line insertion and line maintenance.

Please describe the measurement of CRBSIs before and after this improvement project.

AICA definitions were used and we also looked at line-related BSI rates from October 2004 to January of 2005. Primary hematology and oncology were 2.25% pre-project and were 0.34 per 1000 line days post-project.

What were the primary and secondary goals of this CRBSI improvement project?

The primary goals of this project, as identified by a PICC working party formed in November 2005, were to:

- Decrease BSI rates in the hematology and oncology patient population
- Provide comprehensive education on line insertion and maintenance to clinicians
- Undertake a comprehensive review of the evidence base, underpinning QEHL's line insertion and management policy

A secondary goal was to review the IHI's central line bundle and assess its applicability to QEHL.

Which clinical areas did this improvement project target? Or was it organization-wide?

The project initially targeted hematology and oncology services; however, the benefits were realized across the organization. An example being that, prior to the project, the radiology department was called out to resolve line related issues approximately five times a day on average. Since the project these callouts have decreased to about one call out every 6 months.

Please describe the definition of CRBSIs you used in this project.

The project followed AICA definitions, which are NNIS-like, and described fully in section entitled U.S. Regulatory and Public Policy Issues Relating to CRBSI Reduction.

What types of catheters/lines/devices were included? Why were others excluded?

The project included PICCs, CVCs, and Vas-Cath (dialysis catheter) as these catheters contributed the greatest CRBSI burden.

Please describe the composition of any teams supporting or driving the improvement project.

PICC Working Party

- (Sponsors) Ms. Jan Hooper, Nursing Co-director, Medical and Emergency Services
- (Sponsors) Dr. Peter Bardy, Medical Co-director, Medical and Emergency Services
- Mrs. Marija Juraja, Clinical Service Coordinator, Infection Prevention and Control Unit
- Ms. Karen Daniels, Clinical Educator, Centre of Education
- Ms. Kristen Linke, Clinical Service Coordinator, Haematology/Oncology Unit
- Mr. David Songer, Clinical Service Coordinator, Radiology and Imaging Services
- Mr. Peter Rogers, Clinical Nurse, Radiology and Imaging Services
- Mr. John Black, Clinical Educator, Emergency Department
- Ms. Sheila Lehman, ICLN, Haematology/Oncology Unit
- Ms. Jenny Phillip-Hughes, ICLN, ICU

Which specific CRBSI infection prevention interventions were implemented as part of this improvement project?

- Full barrier precautions with each insertion
- Replacement of povidone-iodine with a 2% CHG and 70% alcohol containing solution for insertion site preparation
- Introduction of an occlusive dressing
- Introduction of a CHG and alcohol swab stick for dressing changes at 7 days
- Use of a mechanical access vascular device (MAVD) on all PICCs and CVCs
- Education

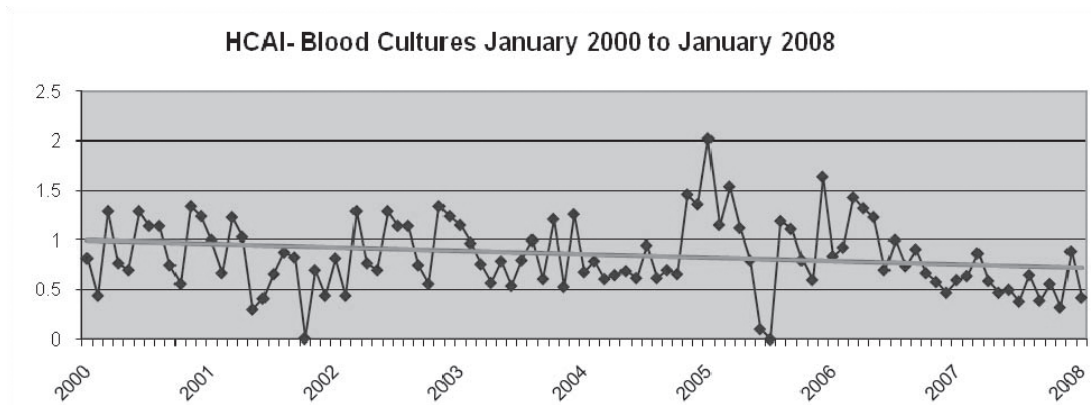
What specific tools were used or quality improvement methodologies employed during the CRBSI improvement project?

- A face-to-face training program was delivered and included a presentation and education kit covering what type of lines used, why, how inserted, risks of line, and points of infection
- Similar training was also made available on all computers in the target units/departments
- Practical hands-on sessions enabled staff to practice blood collection, line dressings, and occlusion management
- New revised policy on PICC line care was introduced
- Changes in knowledge of staff undertaking the education package were measured using a pre-and post-training test

What specific challenges, opportunities, and obstacles presented during the improvement project?

Major challenges included:

- Protracted delays testing and introducing new products into the hospital
- Staff resistance to change to new CHG-containing product due to a preference for the more visible iodine-povidone solution
- Staff were challenged trying to find time to participate in PICC project team meetings and also to undertake the increased work given that there was no additional investment, nor any release from duties



Case Study Figure 1. Eight-year trends in blood cultures processed.

The opportunities associated with the project were unanticipated and included:

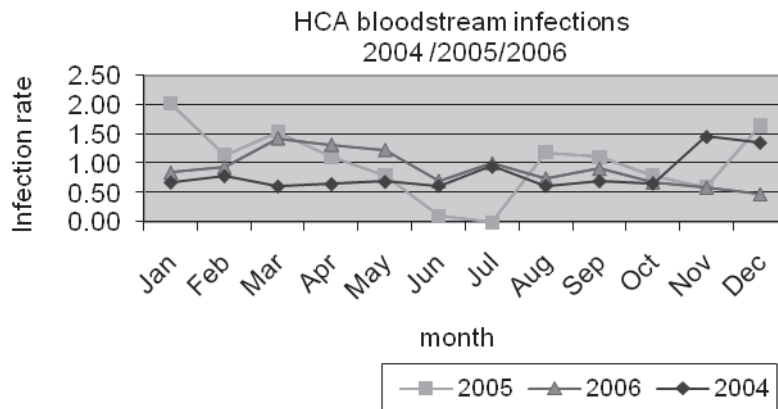
- A peer-generated interest and demand for training based on positive coworker feedback
- Expanded demand for the training from community-based nurses
- A community-based nursing group taking the initiative to develop a checklist tool specific to the management of CVADs in the community

How did you measure the clinical, professional, or financial impact of the project’s interventions on your organization’s CRBSIs? What changes did you notice in these measurements?

Although no QEHS-specific CRBSI cost data was available, administrator support for the project was based on projected cost savings which are most likely to have been met.

Since the project QEHS has experienced a sustained, downward trend in CRBSIs. QEHS’s monitoring system indicates when the 1% threshold is exceeded and it triggers an immediate investigation by the infection prevention team.

QEHS also noticed an ongoing downward trend in the volume of blood cultures processed by their laboratory.



Case Study Figure 2. Hospital-wide healthcare-associated BSIs 2004–2006.

What did the organization learn from the improvement project?

QEH learned that it is possible to decrease BSI and experience associated reduced lengths of patients stays.

What recommendations would you make within the organization as a result of the improvement project?

QEH considers the following to be key recommendations from the project

- Use a CHG and alcohol containing solution for insertion
- Introduce the Biopatch™ to further increase opportunity to reduce CRBSIs
- Embrace each component of the IHI bundle including strict measurement and adhere to these at all times
- Line maintenance, including patient education, are separate to insertion but equally important to be addressed in any similar, comprehensive CRBSI prevention initiative

What specific recommendations would you make to your infection prevention peers who are also interested in undertaking CRBSI improvement projects?

- Recruit champions at organization-wide and unit-specific levels. This project’s champions included senior executive staff from the medical divisions. These champions advocated and supported the project at multiple committee and other decision making levels.
- Provide regular feedback to staff to build ongoing and sustainable relationships.

Please describe any unique infection prevention insights realized by the improvement project.

- Local, national, and international networks provide alternative perspectives and additional valuable information that can add value to the project.
- Infection preventionists require substantial project management skills and resources to design and implement projects of this magnitude.

Please describe any ongoing efforts and investments that are required to sustain these CRBSI improvements.

- This project has not yet formally ended. The PICC committee still exists although meetings have been scaled back to an ad-hoc basis.
- To maintain the lower CRBSI incidence, the infection prevention department maintains a watching brief on the reported rates and rapidly responds once the 1% threshold is breached.
- Some units have demonstrated a tendency for complacency and stubbornness to change to the new skin-prep product. Sustained change was only achieved when the infection preventionists provided clinical evidence of benefit. Also, when introducing any new product, QEH suggest that a 1-month amnesty be adopted after which time all remaining supplies of old product are removed, thus forcing adoption of the new product and sufficient time for staff to become comfortable with and competent in the use of the new product.
- PICC education must be provided through your education center as an ongoing educational opportunity to provide old and new staff with opportunities to refresh or increase their knowledge and expertise.
- Patients must not be forgotten as they must also be given education on care and management of their CVADs and after-hour’s processes/contacts for troubleshooting.

Evidence-based Prevention of CRBSIs: Multicenter Success in Pittsburgh and Pennsylvania

What is the name of the organization that conducted this project?

University of Pittsburgh Medical Center (UPMC) Presbyterian

Briefly describe this organization including city, state, country, size, and range of clinical activities typically offered.

Founded in 1893, UPMC Presbyterian is an 834-bed adult medical/surgical referral hospital and a site of ongoing research and graduate programs in conjunction with the University of Pittsburgh School of Medicine. Located in Pittsburgh, PA, the hospital is a renowned center for organ transplantation and a recognized leader in cardiology and cardiothoracic surgery, critical care medicine and trauma services, and neurosurgery. The hospital is designated as a Level I Regional Resource Trauma Center. It is the largest, most complex facility in the UPMC Health System which includes 50,000 employees, 20 hospitals, and a network of other care sites across western Pennsylvania and throughout the world.

Briefly describe the organization's infection prevention program capacity including personnel; line reporting; CRBSI goals, education, and policies; participation in an aggregate CRBSI data collection system (e.g., NHSN, state-based reporting or other equivalent); and any other relevant issue(s).

The Infection Control and Hospital Epidemiology department includes 8 infection preventionists, Dr. Carlene Muto (Associate Professor, Director of Infection Control and a member of the Infectious Disease Epidemiology Research Unit and an infectious disease physician dedicated to the department), an office manager, and a data specialist. An infection preventionist is also responsible for a large psychiatric care facility (280 beds). As part of an integrated system, many policies are considered to be system policies but an individual hospital can choose to exceed particular standards based on patient population. UPMC Presbyterian had been a NNIS hospital since the late 1980s and recorded all infections attributed to ICU settings plus bloodstream and surgical site infections identified throughout the facility. Dr. Muto was the physician leader for the Pittsburgh Regional Healthcare Initiative (PRHI) Nosocomial Infection Advisory Committee, which began regional process improvement activities related to central line-associated bacteremia in 2001.

Pennsylvania's Health Care Cost Containment Act mandated that all acute care hospitals in the state begin reporting all HAI information to PHC4, effective January 1, 2004. In 2008, this requirement became a part of "Act 52" which included using all NHSN modules and reporting infection data through NHSN.

Please describe the pre-improvement project CRBSI issue addressed by the project.

Many of the original PRHI measures involved improving processes such as skin disinfection using CHG/alcohol (CHG) and physicians using maximum barrier precautions (MBP) for all central line insertions. Most of the hospitals in the region had custom barrier kits created, which often included a documentation sheet to record the specifics of the procedure. As compliance rates increased, CLABSI rates decreased.

At UPMC Presbyterian:

- A pilot study was done to determine baseline rates of MBP and CHG usage (12/01 to 1/02).
- An RCA identified issues preventing the use of MBP and CHG.
- Clinicians often could not readily find all of the necessary components so they were omitted or replaced with alternatives (e.g., povidone iodine [PI], small drape).

- Other clinicians may not have been aware of the efficacy data demonstrating lower CLABSI rates when targeted practices were used.
- A standard procedure note was developed requiring clinicians to check the barriers, catheter type, and antiseptic used.
- A CLABSI mandatory educational module was developed and made electronically available for clinicians who placed CVCs. Continuing medical education credit was provided for completion of the learning module.
- A CVC kit containing a CHG/silver sulfadiazine coated catheter and CHG antiseptic was provided.
- A supplemental kit containing a large drape, sterile gown, mask with face shield, and hat was provided.
- Both kits were conveniently placed in all areas where CVCs were placed.
- Process information was recorded for all CVC insertions and compared to baseline rates.
- Noncompliant clinicians received a letter from administration.

Please describe the measurement of CRBSIs before and after this improvement project.

For PRHI, all hospitals submitted data quarterly, including central line days and the number of CLABSIs identified. PRHI staff performed calculations and sent report cards to all hospital administrators, comparing their results to others in the region. By 2005, a 63% region-wide decline in healthcare-associated BSIs was achieved.

At UPMC-Presbyterian, Actionable CLABSI data and compliance with targeted practice was collected, analyzed, and reviewed monthly and feedback given to the clinicians and administrators, including all of the “C’s” (CEO, COO, CFO). RCA is performed on all potential CLABSIs now.

What were the primary and secondary goals of this CRBSI improvement project?

The goals were affectionately known as “zero tolerance” for HAIs. Hospitals continued to benchmark against their historical data but no target rates were set—only trying to continually reduce rates to provide “perfect patient care.” For PHC4, the goal was to reduce the cost of healthcare to consumers and their approach was to eliminate all HAIs. Annual reports were printed and detailed information was released to the news media with hospital-specific infection, cost, and mortality data. Infections were reported as actual numbers, rather than risk-adjusted numbers or rates.

Which clinical areas did this improvement project target? Or was it organization-wide?

Organization wide

Please describe the definition of CRBSIs you used in this project.

Standard NNIS/NHSN definitions were used.

What types of catheters/lines/devices were included? Why were others excluded?

Standard NNIS/NHSN definitions were used. There was a great deal of controversy in the area concerning femoral lines but the revised NHSN definitions indicate that femoral lines are indeed considered “central lines,” so that issue has been settled.

Please describe the composition of any teams supporting or driving the improvement project.

Multidisciplinary teams included physician champions, unit medical directors, administrators, direct caregivers, IV team members, quality improvement department staff, infection preventionists, and infectious disease physicians.

Which specific CRBSI infection prevention interventions were implemented as part of this improvement project?

Barrier supply kits, insertion documentation forms, CHG products included in the line kit, site-specific dressings (PICC, IJ), and standard clear plastic dressings.

What specific tools were used or quality improvement methodologies employed during the CRBSI improvement project?

Screen savers; online education modules for hand hygiene, scrub the hub, dressing changes, etc.; in-services by manufacturer's technical representatives; education by our nursing education department; and infection preventionists served as a resource for our units. Continuous review of all infection data by our Continuous Quality Improvement Institute (CQII), with hospital comparison data provided dashboards. We are in the process of implementing reports for inpatients with devices in place that would be generated on a daily basis so nurse managers can review device necessity.

What specific challenges, opportunities, and obstacles presented during the improvement project?

- Physicians may not have complied because products were not easily accessible or they were not aware of their benefits. In particular, anesthesiologists that placed lines in preoperative patients had never been informed about any HAIs, so they felt no connection to the process.
- Increasing accessibility to barriers, coated CVCs, and CHG by bundling into kits was imperative.
- Developing kits required RESOURCES.
- Administrative and medical leadership support was crucial in increasing compliance (SUPPORT).
- Administrative feedback to noncompliant clinicians was essential (LEVERAGE).
- Education may have contributed to increase compliance but probably was not as contributory as product accessibility.

How did you measure the clinical, professional, or financial impact of the project's interventions on your organization's CRBSIs? What changes did you notice in these measurements?

As a result of this project, we estimated that annually we have been able to avoid 172 CRBSIs, save 60 lives, and avoid costs in excess of \$5.7 million.

What did the organization learn from improvement project?

It takes a team approach, physician and administration buy-in, and continuous monitoring to sustain infection prevention initiatives.

What recommendations would you make within the organization as a result of the improvement project?

No specific recommendations; it's just part of life at UPMC Presbyterian.

What specific recommendations would you make to your infection prevention peers who are also keen to undertake CRBSI improvement projects?

Engage key physicians, ask for their input on product selections, and definitely get buy-in from anesthesia and interventional radiologists that place PICC lines. PICCs are the forgotten link in most CLABSI reduction protocols.

Please describe any unique infection prevention insights realized by the improvement project.

As the program gets closer to the minimum number of CLABSIs, you will identify more Gram-negative organisms in blood cultures that fit the definition of primary bacteremia with no other identified source. Without

any evidence of infection at another body site, these must be defined as CLABSI— even though they probably have no relationship to catheter-related activities.

Please describe any ongoing efforts and investments that are required to sustain these CRBSI improvements.

We are now really digging into every little thing that might result in a CLABSI—flush syringes that might not be perfectly threaded that result in issues with our lines, etc. It is important to chat frequently with the direct caregivers who will relay this type of information. Nurse managers may not be aware of little issues.

Six Sigma: Barnes-Jewish Hospital, St. Louis, Missouri

What is the name of the organization that conducted this project?

Barnes-Jewish Hospital, St. Louis, Missouri

Briefly describe this organization including city, state, country, size, and range of clinical activities typically offered.

Barnes-Jewish Hospital at Washington University Medical Center is a 1390-bed tertiary care hospital in Missouri. An affiliated teaching hospital of Washington University School of Medicine, Barnes-Jewish Hospital has an 1800-member medical staff, over 9000 employees, and is part of the 13 hospital BJC HealthCare system. The hospital has 40 clinical areas including 6 ICUs. It is a Level One Trauma Center as designated by the American College of Surgeons and has the only comprehensive transplant center in the region. The Siteman Cancer Center at Barnes-Jewish Hospital and Washington University School of medicine is a National Cancer Institute Comprehensive Cancer Center. Recognized for its excellent nursing care, it is also a certified as a magnet hospital by the American Nurses Credentialing Center.

Briefly describe the organization's infection prevention program capacity including personnel; line reporting; CRBSI goals, education, and policies; participation in an aggregate CRBSI data collection system (e.g. NHSN, state-based reporting or other equivalent); and any other relevant issue(s).

The interventional epidemiology and infection prevention department consists of 9 IP Specialists (IPS), an epidemiology technician, a data analyst, and a project coordinator. The IP team is supported by a hospital epidemiologist and 4 other infectious disease physicians. The services provided span Barnes-Jewish Hospital and over 200 outpatient areas affiliated with Washington University School of Medicine.

Education and policies are often created by the Infection Prevention and Epidemiology Consortium at BJC. IPS conduct CRBSI surveillance in 6 ICUs and one post intensive care unit. Line days and data reported electronically via nursing charting system. Culture data are also provided to the department electronically via our "Germ Watcher" informatics system. BSIs reported to state for 3 ICUs (surgical ICU, medical ICU, and coronary care unit).

Please describe the pre-improvement project CRBSI issue addressed by the project.

Since 1998, the BJC Consortium has developed and implemented targeted interventions to decrease CRBSI. These efforts included education modules, policy development, and line insertion/care point prevalence surveys. These efforts decreased infections dramatically and had become the standard of care at the hospital but infections still occurred. In 2005, the hospital set an aggressive goal to strive for zero preventable infections. A gap analysis revealed that our process of placing and caring for central lines differed depending on the location of the patient, the supplies available, and the training of the individual. As a result we set out to redesign the process of placing and caring for lines with a focus on the patient experience.

Please describe the measurement of CRBSIs before and after this improvement project.

Pre- and post-measurement completed by IPS through routine surveillance. Surveillance data are reported upon identification of the CRBSI to the clinical nurse specialist on each area and a questionnaire is used to identify potential risk factors. Standardized infection ratios are used to communicate data on the hospital scorecard, to the infection prevention committee, and the individual ICUs' unit practice committees.

Line insertion observation data was completed by those assisting in the procedure to assess compliance with all CDC guidelines. These data were fed back via the individual ICUs' unit practice committees.

What was/were the primary and secondary goals of this CRBSI improvement project?

- Zero preventable CRBSI by 2010.
- Prevent retained guidewires, pneumothorax, and other patient safety events associated with central lines.

Which clinical areas did this improvement project target? Or was it organization-wide?

Organization wide

Please describe the definition of CRBSIs you used in this project.

- CRBSI measured using NNIS/NHSN definitions in ICUs only.
- Electronic algorithm used to conduct surveillance in 35 other patient care areas based on NHSN definitions.

What types of catheters/lines/devices were included? Why were others excluded?

- All CVCs as defined by NHSN were included in the interventions and surveillance.

Please describe the composition of any teams supporting or driving the improvement project.

- The steering committee for the project consisted of the vice president of Safety and Quality, IP staff, hospital epidemiologist, interventional radiology physician, nursing director and clinical nurse manager, IV therapy manager, Lean/Six Sigma Black Belt, and the chair of the Critical Care Committee.
- Several sub-groups were developed for the value stream analysis and rapid improvement events. These included representatives of the steering committee and various other staff including staff nurses, patient care technicians, hospitalists, anesthesiologists, and media relations personnel.

Which specific CRBSI infection prevention interventions were implemented as part of this improvement project?

- Standardized central line equipment carts and ultrasound
- Standard kits with all items necessary for placing lines
- Standard line insertion checklists
- Decision making tool to assist registered nurses (RNs) in determining type of line necessary
- Standard simulation training for assistants and inserters coupled with online education modules

What specific tools were used or quality improvement methodologies employed during the CRBSI improvement project?

The methodology for the project was Lean Six Sigma. It included a value stream analysis and several subsequent rapid improvement events

Tools included:

- Online training modules for central line insertion
- Pictorial guides placed on central line carts for line insertion, dressing application, and line removal
- Screen savers
- Central line informational website

What specific challenges, opportunities, and obstacles presented during the improvement project?

- This project required many resources and administrative support. The IP staff involved had to incorporate the project and teamwork into their already full schedules. Clinical nurse managers had difficulty finding staff to attend the meetings due to staffing challenges.
- Physician involvement and critical care committee support was paramount to standardize our process. Physicians were invited to team meetings but often did not have time to attend the entire meeting. As a result, a stakeholder luncheon was held during rapid improvement events where they could stop by, be updated on the project, and offer input over lunch.
- Creating the standard central line insertion kit required partnership with the IV products committee. A business case had to be developed to gain the resources for the kit.
- Finding locations to store the procedure carts and kits was a challenge in several areas.
- Identifying personnel to be responsible for the procedure carts required administrative buy-in and support.

How did you measure the clinical, professional, or financial impact of the project’s interventions on your organization’s CRBSIs? What changes did you notice in these measurements?

Interventions implemented first quarter of 2009. No results to share at this time.

- Plan to measure changes in CRBSI Society of Interventional Radiology results of line insertion checklist and cost savings as a result of fewer CRBSI.
- Having the central line carts and ultrasound available in designated areas reduced time gathering equipment. Motion to gather supplies went from 0.7 miles to 283 feet in one area. Time to gather supplies went from 20 minutes to 2 minutes. The number of supplies went from 17 to 2.

What did the organization learn from improvement project?

- Standardization improves efficiency and provides structure for a culture of safety.
- The rapid improvement events gave stakeholders a chance to design a process that works for them and the patients. It gave staff a place to voice concerns and understand others roles.

What recommendations would you make within the organization as a result of the improvement project?

The multidisciplinary approach and front line staff involvement was key to developing a standardized process.

What specific recommendations would you make to your infection prevention peers who are also keen to undertake CRBSI improvement projects?

- Take time to prepare for your team meeting, gather data, and stay on task. An efficiently run team meeting will go a long way with stakeholders and team members. Remember to update your administration when you make even a minor improvement.
- Do not forget to include your renal physicians and nurses in the process who place or care for dialysis lines.

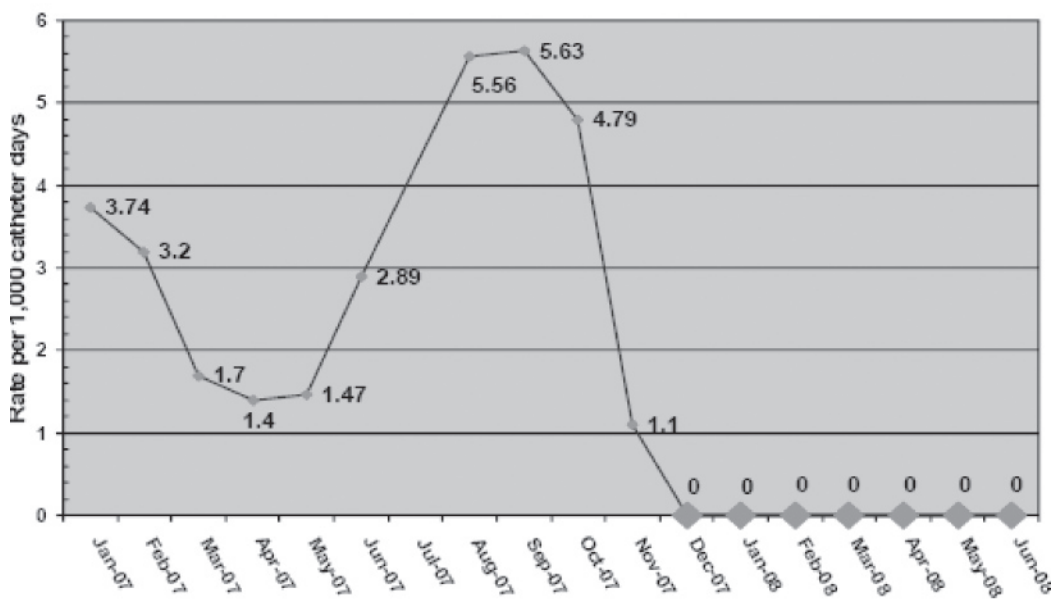
Please describe any unique infection prevention insights realized by the improvement project.

Communicating with the caregivers when a CRBSI is identified has aided in understanding the unique risk factors in each unit. It builds relationships with the staff and allows for discussion around how care can be improved.

The Impact of a Closed Luer Access Split-Septum Device on CRBSI Rates in a Community Hospital Adult Medical/Surgical ICU, Jennie Edmundson Hospital, Council Bluffs, Iowa

Background: Jennie Edmundson Hospital is a 250-bed acute care facility in the mid-western United States. MAVD have been associated with significant CRBSI increases in a variety of clinical settings in at least two countries over the past 5 years. In August 2007, during the use of a positive pressure MAVD, the CRBSI rate in the adult medical/surgical ICU reached a 2007 peak of greater than 5 CRBSIs per 1000 catheter days which was more than twice the pooled mean CRBSI rate of 2.2 per 1000 catheter days reported from more than 100 medical/surgical ICUs contributing data to the CDC’s NHSN in 2006. This peak occurred despite the introduction of multiple CRBSI prevention measures introduced as part of a bundled initiative in 2007. Infection prevention responded to the peak by replacing the MAVD with a closed Luer access split-septum alternate device in December 2007. The purpose of this study was to evaluate the impact of a closed Luer access split-septum device in reducing CRBSIs in the adult medical/surgical ICU population.

Methods: Baseline CRBSI rates were measured at December 2007. Investigators also reviewed 24 consecutive months worth of retrospective CRBSI data and compared rates to 10 consecutive months of CRBSI data collected after the introduction of the closed Luer access split-septum device. Monthly CRBSI rates per 1000 catheter days for each month of pre- and post intervention periods’ intervention were calculated according to the NHSN methodology and pooled for either the pre- or post intervention period. Analysis included more than 23,000 catheter days. No other specific interventions targeting CRBSI reduction were introduced or enhanced during the 10 months after split septum introduction



Case Study Figure 3. CRBSI rates decrease in the Jennie Edmundson Hospital ICU, January 2007 to June 2008.

Results: The mean rate of CRBSI per 1000 catheter days decreased 57% from 4.06 infections per 1000 catheter days at baseline to 1.73 infections per 1000 catheter days 10 months after implementation of split septum device.

Conclusions: Consistent with other recent domestic and international studies, removing the mechanical valve and replacing it with a closed Luer access split-septum device resulted in a dramatic and sustained reduction in CRBSIs in the Jennie Edmundson Hospital adult medical/surgical ICU.

Tools and Resources

Each of these tools is available at <http://www.apic.org/eliminationguides>.

Resources for Additional Information

Comparison table of CDC and SHEA/IDSA Guideline Measures for Prevention of Catheter Related Bloodstream Infections

Resources and Policies for Clinical Practice

The Canberra Hospital Central Venous Catheter Decision Tree

Vascular Access Device Protocol: The Kaiser Permanente Organization

Peripheral Vascular Devices—Guidelines for Insertion and Management: The Queen Elizabeth Hospital

Central Venous Cannulation including PICCs: The Queen Elizabeth Hospital

Resources and Tools for Education

Accessing Central Venous Access Devices—The AAASASH Technique Poster: The Queen Elizabeth Hospital

“Scrub the Hub” poster

Resources and Tools for Surveillance, Monitoring, and Quality Improvement

Guide to Completion of a Point Prevalence Study

CDC NHSN Central Line Insertion Practices Adherence Monitoring Tool

Infection Control Guidelines for Conducting a Root Cause Analysis for Sentinel Events (SE) Involving Bloodstream Infection

Rapid BSI Response Form

Web-based Tools and Resources

The web sites included below have been selected by the authors of this Guide as useful sources of information, resources, and tools for either additional information, clinical practice, or surveillance which may be helpful adjuncts to this Elimination Guide. They are current as at the time of publication. Their inclusion does not indicate APIC or author endorsement.

Web sites for Additional Information

Association for Vascular Access:

<http://www.avainfo.org/website/article.asp?id=4>

Johns Hopkins Hospital Vascular and Interventional Radiology, CVC Patient Information:

<http://www.hopkinsmedicine.org/vascular/procedures/CVAC/>

Journal of Vascular and Interventional Radiology:

<http://www.jvir.org/>

Infusion Nurses Society:

<http://www.ins1.org>

Copies of the 2006 Infusion Nursing Standards of Practice can be purchased from this site.

Society of Interventional Radiology:

<http://www.sirweb.org/>

Society for Parenteral and Enteral Nutrition:

<http://www.nutritioncare.org/>

Web sites for Clinical Practice

Centers for Disease Control and Prevention (CDC):

Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2002

http://www.cdc.gov/ncidod/dhqp/gl_intravascular.html

NHSN Central Line Insertion Practices (CLIP) Training Course 2008:

http://www.cdc.gov/ncidod/dhqp/nhsn_CLIP_training_text.html

Greater Cincinnati: <http://www.gchc.org/CommunityInitiatives/PatientSafety/CentralLineInfectionReduction/tabid/657/Default.aspx>

Institute for Healthcare Improvement:

<http://www.ihl.org/IHI/Programs/Campaign/CentralLineInfection.htm> (includes pediatric and rural prevention interventions)

Kaiser Permanente Hospitals “PLUS” MEASURES TOOLKIT:

<http://nursingpathways.kp.org/national/quality/infectioncontrol/toolkit/index.html>

For external access (outside of Kaiser Permanente) click on “Non-Kaiser Permanente download.”

Multisociety HAI Prevention Compendium 2008:

http://www.cdc.gov/ncidod/dhqp/HAI_shea_idsa.html

Queensland Health, Centre for Healthcare Related Infection Surveillance and Prevention, I-Care Project:

<http://www.health.qld.gov.au/chrisp/icare/about.asp>

Society of Interventional Radiology:

<http://www.sirweb.org/>

Society for Parenteral and Enteral Nutrition:

<http://www.nutritioncare.org/>

Web sites for Surveillance Practice

Australian Infection Control Association Bloodstream Infection including Dialysis Definition:

http://www.aica.org.au/images/PDF_Files/Blood%20Stream%20Infection.doc

Centers for Disease Control and Prevention:

National Healthcare Safety Network (NHSN)

<http://www.cdc.gov/nhsn/>

National Healthcare Safety Network (NHSN) Document Library

<http://www.cdc.gov/nhsn/library.html>

National Healthcare Safety Network (NHSN) Data Collection Forms

<http://www.cdc.gov/nhsn/dataCollectForms.html>

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