WHITE PAPER

REACHING ZERO: Strategies and Tools Utilized to Eliminate Preventable Bloodstream Infections

Lee Steere, RN, CRNI

Joyce Sauvé, RN, CIC

Table of Contents

About the Author:

Lee Steere, RN, CRNI, is a unit manager at Hartford Hospital of a medical infectious disease unit and of the IV Therapy Services Department.

Joyce Sauvé, RN, CIC, works for the Infection Control Department of Hartford Hospital as a Epidemiology Clinician.

BACKGROUND

Septicemia, an illness caused by bacterial blood infections, was the single most expensive condition treated in U.S. hospitals at nearly $15.4 billion in 2009. The number of septicemia-related hospital admissions more than doubled between 2000 and 2009, reaching nearly 840,000 stays. The in-hospital death rate for septicemia was 16 percent in 2009 — more than eight times as high as for all other hospital stays (AHRQ. Statistical Brief #122: "Septicemia in U.S. Hospitals," 2009).

One-quarter of a million bloodstream infections occur in U.S. hospitals each year (Klevens, Edwards, et al., *Public Health Reports, 2007*). Complications resulting from a device, implant, or graft were the most common reasons for these hospitalizations, representing one of every five septicemia-related stays. Catheter-related bloodstream infections (CRBSIs) in particular are the fourth most common hospital-acquired infections. Approximately 90 percent of CRBSIs occur with central-line catheter placements. Roughly 80,000 central-line associated bloodstream infections (CLABSIs) occur in U.S. intensive-care units every year, and these infections are fatal in up to 25 percent of cases, claiming up to 20,000 lives annually and adding $296 million to $2.3 billion to the cost of patient care (Mermel. *Ann Intern Med.* Mar 7, 2000).

Historically, a small number of CLABSIs were considered an acceptable risk of placing central lines. However, the work by Dr. Peter Pronovost at Johns Hopkins Hospital, The Institute for Healthcare Improvement (IHI), and others has challenged that premise. Today, hospitals across the country are leveraging a wide range of clinical-best practices and implementing new tools to demonstrate that achieving the goal of zero hospital-acquired bloodstream infections should be the standard of care. This paper describes the journey of one such inner city medical center, Hartford Hospital (Hartford, CT) in chasing zero.

DEFINING THE PROBLEM

In the simplest definition, a bloodstream infection (BSI) exists when there is a presence of a recognized pathogen in one or more blood cultures drawn from a patient and if the organisms cultured from the blood are not related to a patient infection at another site, for example, a surgical wound. A BSI is more narrowly defined as a CLABSI if a central line was in use during the 48-hour period before development of the BSI ("Centers for Disease Control (CDC) Guidelines for Prevention of Intravascular Catheter-Related Infections," 2011). Even more granular is the designation of an infection as a catheter-related BSI. According to the CDC, a CRBSI is defined as "bacteremia/fungemia in a patient with an intravascular catheter with at least one positive blood culture obtained from a peripheral vein, clinical manifestations of infections, and no apparent source for the BSI except the catheter." As the confirmation of a CRBSI requires the line to be pulled and cultured, CLABSI is the more common definition used for surveillance and reporting of hospital acquired blood stream infections.

CRBSI SOURCE OF PATHOGENS

There are four recognized routes for contamination of catheters. The two most common sources are (1) the patient's own skin at the procedure site due to inadequate skin preparation, lack of sterile techniques and/or appropriate procedure draping and (2) contamination of the catheter hub. Less common but possible is (3) the introduction of a pathogen from hematogenous colonization of the catheter from an infection from somewhere else in the body or from (4) contaminated infusate.

The protector of the vascular access device intraluminal fluid pathway is the IV connector. Clinical practice depends on swabbing and flushing the connector and catheter to provide protection. Yet, this essential nursing practice may not be performed consistently. The external and internal surface of the hub of the catheter or stopcock is the immediate portal of entry to the intraluminal surface of the catheter. Biofilm forming within the catheter hub migrates within the lumen and disperses cells that are flushed into the bloodstream. The hub becomes contaminated during catheter manipulation, e.g., tubing or connector changes, bolus injections, or blood sampling. Additionally, intraluminal contamination can also result from the misuse of the numerous components of the vascular access system, such as needleless connectors, injection ports, and stopcocks.

To address this risk, access site and hub disinfection is recognized as a key prevention strategy, but current practices suffer from nurse compliance issues. The 2012 Joint Commission's National Patient Safety Goals require both access site and hub disinfection in all hospital-care settings including hospitals, critical access hospitals, and long-term care facilities (The Joint Commission, 2012). The SHEA/IDSA recommendations not only include access and disinfection procedures but also recommend monitoring for compliance (Marschall. *Infect Control Hosp Epidemiol*, 2008).

CONTRIBUTING FACTORS TO CRBSI

Insertion and Maintenance

In a prospective observational study assessing catheters placed by a critical-care medicine department in a university teaching hospital, the site of insertion did not alter the risk of infection. The authors concluded that the site of insertion was not a risk factor for infection when experienced physicians insert the catheters, a strict sterile technique is used, and trained intensive-care unit nursing staff perform catheter care (Deshpande, Hatem, Ulrich, et al. *Critical Care Medicine*, 2005). However, other studies have shown that in less-controlled environments, the site of insertion is a risk factor for infection.

The use of the jugular insertion site over the subclavian site is a particular contributor to higher rates of infection (Mermel, McCormick, Springman, Maki. *American Journal of Medicine*, 1991). Likewise, the femoral site is also associated with a greater risk of infection in adults (Parienti, Thirion, Mégarbane, et al. *Journal of the American Medical Association*, 2008).

The duration of use of central venous catheters remains controversial, and the length of time such devices can safely be left in place has not been fully and objectively addressed in the critically ill patient. However, it stands to reason that the longer the catheter dwelling time, the greater the opportunity for introduction of microorganisms from repeated catheter manipulation and the increased risk of biofilm formation.

DEVICE SELECTION

Intravascular catheters are indispensable in modern-day medical practice. Yet, vascular access devices can put patients at risk of local and systemic infections. Catheter design features have been shown to correlate with higher rates of infection. Careful selection of devices is important to reduce this risk. Some considerations worth noting:

The first reported concerns regarding needleless injection port technology use and increased rates of primary BSI surfaced in the mid-1990s (Danzig, Short, Collins, et al. *JAMA*, 1995). These devices, also referred to as needleless connectors, were introduced in an effort to reduce the potential for IV-access related needle-stick injuries. Their design has evolved from blunt cannula systems, typically split septum, to luer-activated valves with a variety of internal mechanisms (Ryder. *New Dev Vascular Dis.*, 2001). More than twenty needleless connectors are currently available in the U.S. market. Proper antisepsis of needleless connectors is essential, and flushing techniques are dependent on the design of the septums and the type of fluid pathways used (Macklin. *Journal of the Association for Vascular Access*, 2010).

Multi-lumen devices have also been associated with higher risk for infections. With more than one channel, multi-lumen catheters can provide vascular access for multiple purposes: for instance, administration of medications and blood draws, TPN, etc. Multiple uses of the catheter, i.e., using the TPN lumen to draw blood or give other fluids) can increase the risk of infection.

Likewise, studies indicate that the stopcock is a main source for bacterial contamination (Koff and Loftus. *Anesthesiology*, May 2009). As a result, stopcock manufacturers have developed antimicrobial technology based on silver ions incorporated into the stopcock's body. Additionally, new stopcocks include closed swabbable designs that enable needle-free connections, aseptic fluid administration, and sampling, while keeping the IV line closed to the atmosphere, preventing contamination of the IV line due to contact with operator hands and bed linen.

Contaminated IV tubing may also contribute to infection risk. It is recommended that sterile-end caps be placed on unused tubing. When disconnecting a primary or secondary IV line, place a new sterile dead- end cap on the open end of the tubing to maintain sterility. When in place, these "tips" provide an easy means to audit line safety.

HEIGHTENED AWARENESS ON CRBSI PREVENTION

Focus on Quality and Patient Safety

According to the Centers for Disease Control and Prevention (CDC), common medical errors total more than $4.5 billion in additional health spending a year. However, hospitals only bear a small percentage of the total costs associated with preventable medical errors. Prompted by the landmark study by the Institute of Medicine titled, "To Err Is Human: Building a Safer Health System," the National Quality Forum (NQF) created a list of 28 Never Events. Never events are defined as incidents of medical care that are of concern to both the public and healthcare professionals and providers, clearly identifiable and measurable, and of a nature such that the risk of occurrence is significantly influenced by the policies and procedures of the healthcare organization.

FINANCIAL INCENTIVES AND MANDATORY REPORTING

On October 1, 2008, CMS halted payments to hospitals for care necessitated by the incidence of "reasonably preventable" errors. Taking guidance from the NQF list, CMS established a list of Hospital Acquired Conditions (HAC) for which it ceased payment. Among the conditions CMS choose to target was "vascular catheter-associated infection." Soon after, private companies, including HealthPartners, Cigna, Blue Cross, Aetna, and WellPoint, adopted similar policies. CMS has urged states to also develop programs that place the financial burden of clinical never events back on the healthcare provider.

As awareness of the extent of these events in the U.S. grew, mandates for public reporting of hospital-acquired infections (HAI) data has expanded. As of January 2011, the federal government, 32 states, and the District of Columbia have passed laws pertaining to HAI prevention and reporting. Reporting initiatives have been bolstered by pay-for-performance programs that strengthen the business case for quality improvement. The rigorous analysis of data required to meet reporting mandates and receive financial incentives for quality improvement has resulted in an ongoing reduction of infection rates. For example, the Patient Protection and Affordable Care Act of 2010 posed a national mandate for public reporting of select infections. Of the 28 conditions listed as "never events" by the NQF, the first to warrant mandatory reporting with a financial penalty was CLABSIs in intensive-care units and high-risk nurseries. Reporting via CDC's National Healthcare Safety Network (NHSN) became a requirement for hospitals to receive their full payment update from CMS. As of September 2011, those that do not submit data are subject to a 2 percent reduction in their Medicare inpatient annual payment. As a next hurdle, hospitals are faced with 2013 pay-for-performance goals that will tie provider payments to 2011 CLABSI benchmark data reported from September 2011 through August 2012. As a testament to the power of financial incentives, upwards of 95 percent of acute-care facilities are participating in this program. Commencing in 2014, Medicare payments will be reduced by 1 percent for those hospitals experiencing the highest rates of adverse hospital-acquired conditions (HR 3590, Title III, Subtitle A, Sec. 3008).

The good news is that there is substantial federal funding available for reducing adverse events and improving patient safety. The Center for Medicare and Medicaid Innovation (CMI) announced it will provide $500 million in funding to selected local and statewide entities to coordinate the implementation of projects under the Partnership for Patients initiative. Likewise, hospitals that achieve the Meaningful Use criteria established in the 2009 American Recovery and Reinvestment Act stand to earn substantial financial incentives to offset investments in patient-safety improvement.

The Hartford Hospital Experience

Hartford Hospital, the 867-bed major teaching hospital affiliated with the University of Connecticut Medical School, serves the New England region. As the only Level 1 Trauma Center in the region operating the state's only LIFE STAR air-ambulance system, Hartford Hospital is recognized for its ability to provide complex and innovative care. To this end, Hartford's leadership has developed an efficient and effective program utilizing a metric-based Balanced Scorecard (see appendix A), which evaluates quality, service, and people goals alongside financial-performance objectives. The Balanced Scorecard approach has created an atmosphere of awareness and accountability while encouraging consistency and transparency in how the organization defines and measures performance.

Leveraging the guidance and mandates of state and federal regulators and quality organizations, Hartford identifies core initiatives that support their organizational pillars: service excellence, quality, people, growth, financial strength, and academic excellence. Among the quality initiatives identified by Hartford in its inaugural Balanced Scorecard in 2010 was the aim to achieve best practices in preventing hospital-acquired infections. The hospital administration set a goal to reduce the mean number of CLABSI/1000 catheter days to 1.2 BSI/1000 catheter days by September 30, 2010. This goal represented a 40 percent reduction in the hospital's 2009 BSI rate.

To achieve its CLABSI reduction goals, hospital leaders knew they would need to motivate caregivers to promote successful infection-prevention practices. Total organization support and focus would be required to adequately impart the importance of meeting the initiative. Three key aspects of the program included the establishment of a BSI Steering Committee, building hospital-wide awareness of the clinical, financial, and regulatory impact of CLABSI, and the incorporation of several clinical best practices known to reduce CLABSIs.

BSI STEERING COMMITTEE

As a result of the Balanced Scorecard effort, Hartford Hospital created a BSI Steering Committee. It was the task of this committee to design a plan to meet the target. The team, composed of multidisciplinary members from the IV team, infection control, upper administration (VP and nursing director), physician leadership, and information systems personnel, met biweekly.

The first goal of the steering committee members was to standardize processes and protocols based on The Joint Commission National Patient Safety Guidelines (NPSGs) and CDC guidelines according to the requirements set forth by the Centers for Medicare and Medicaid Services (CMS) (see table 1). The team also designed a plan for continuous CLABSI education of staff encompassing yearly, mandatory nursing education for new and seasoned staff. The group put a premium on using education to

empower bedside caregivers. Additionally, the team established a priority and process to review new products used in CLABSI prevention and to implement technologies with proven results. Continuous quality Improvement would be achieved by identifying cases of CLABSI and understanding the causes of each. Therefore, the team committed to review every incidence of CLABSI and to audit and monitor compliance with best practices by rounding on the units. Finally, the team set up a process to evaluate outcomes and make necessary changes as needed. The team was dedicated to creating and maintaining a permanent culture change toward zero tolerance for preventable bloodstream infections.

TABLE 1: Recommendations Regarding CRBSI and/or CLABSIs

Institutions can use the guidance of these organizations to justify the resources and products required to achieve BSI rate-reduction goals.

CDC Recommendations: highly enforceable The CDC uses a ranking scheme for evidence-based guidelines: category 1A indicates the highest strength of recommendation, while a category 11 initiative is merely suggested for implementation.	**Guidelines for the Prevention of Intravascular Catheter-Related Infections 2011** 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. 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 > 0.5 percent chlorhexidine skin preparation with alcohol for antisepsis; (4) avoiding routine replacement of CVCs as a strategy to prevent infection; and (5) using antiseptic/antibiotic impregnated short-term CVCs and chlorhexidine impregnated sponge dressings if the rate of infection is not decreasing despite adherence to other strategies (i.e., education and training, maximal sterile barrier precautions, and >0.5 percent chlorhexidine preparations with alcohol for skin antisepsis). These guidelines also emphasize performance improvement by implementing bundled strategies and documenting and reporting rates of compliance with all components of the bundle as benchmarks for quality assurance and performance improvement.
The Joint Commission Recommendations	**National Patient Safety Goals 2012** Conduct periodic risk assessments for central line-associated bloodstream infections, monitor compliance with evidence-based practices, and evaluate the effectiveness of prevention efforts. The risk assessments are conducted in time frames defined by the hospital, and this infection-surveillance activity is hospital-wide, not targeted. The Joint Commission offers 13 EPs (elements of performance) that addresses practices related to the insertion and maintenance of CVCs.
CMS law and recommendations: highly enforceable.	**Defers to state law and organizations, such as the CDC and APIC** 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, such as CDC, APIC, SHEA, and AORN. The U.S. Occupational Health and Safety Administration (OSHA) also issues federal regulations applicable to infection-control practices.

Recommendations/ Mandates

- NPSG EP 2: Educate patients and families before inserting CVC's about CRBSI's
- NPSG EP 1: Educate staff and practitioners involved in procedures – must be done on orientation and annually
- CDC: 3 recommendations under Education and Training, all 1A

HOSPITAL-WIDE AWARENESS

Nontechnological approaches to CLABSI prevention can be highly successful. These strategies include rigorous measurements, achievable interventions, and modifications of organizational culture to embrace safety and staff empowerment (Pronovost P. *Am J Infect Control*, 2008). In fact, these strategies are fundamental to creating a generalizable, sustainable, large-scale implementation of CLABSI reduction methods.

Hartford Hospital initiated a campaign to inform all staff members of the Balanced Scorecard initiative toward reduced bloodstream infections. With education, the committee sought to standardize processes for central venous catheter care and maintenance, including dressing changes and flushing protocol. To continually reinforce the message, caregivers were encouraged to evaluate every line, every day. The hospital instituted a "scrub the hub" campaign as well.

The "Stop BSI" campaign included the use of communication tools for staff, patients, and families of patients, such as "Stop BSI" buttons and a FAQ sheet that encouraged patients and family members to insist on caregiver adherence with protocol for CVC insertion. Observers were empowered to stop practitioners from proceeding if a step was missed (see appendix B).

BEST PRACTICES

CENTRAL LINE BUNDLE

A clinical practice bundle is a grouping of evidence-based best practices that individually improve care, but when applied together, they result in substantially greater improvements. As a rule, the science behind the bundle elements is well established as the standard of care. Bundle-element compliance can be easily measured in a checklist fashion as "yes/no" on five core components:

1. Hand hygiene. Healthcare workers need to adequately disinfect their hands before they insert central lines.
2. The use of maximal barrier precautions that refer to strict clinician compliance with hand washing and wearing proper sterile clothing, cap, mask, and gloves. For the patient, maximal barrier precautions means covering the patient from head to toe with a sterile drape with a small opening for the site of insertion.
3. The use of chlorhexidine (CHG), a topical disinfectant for insertion-site preparation to prevent the central line from getting infected.
4. Optimal catheter-site selection. The preferred site is the subclavian area. The femoral site should be avoided.
5. Daily review of the necessity of the central line with prompt removal of unnecessary lines.

Recommendations/ Mandates

- NPSG EP 6: Use catheter checklist and standard protocol for insertion
- CDC: Multiple guidelines addressed, all with high ranking recommendations

CENTRAL LINE INSERTION CHECKLIST

Johns Hopkins Hospital has published remarkable results in the *New England Journal of Medicine* related to the efficacy of these basic but revolutionary checklists. They ensure fundamental hygiene practices like hand washing and sterilization precautions like draping and wearing masks and gloves. Basic but revolutionary, the humble document slashed central intravenous line infection rate in the State of Michigan by 66 percent and quarterly infection rate to zero. Just three months after they started using it, Michigan's infection rates fell so low that its average ICU outperformed 90 percent of others in the country. After 18 months, it had saved 1,500 lives and roughly $175 million in care costs (Pronovost, et al. *N Engl J Med*, 2006).

Hartford Hospital implemented a central line checklist for use at the time of insertion to help ensure that all processes — before, during, and after central line placement — are executed for each line placement, thereby creating a reliable process (see appendix C). Nurses should be empowered to supervise the preparations, using the checklist prior to line insertion and to stop the process if necessary. Additionally, Hartford developed a Central Line Insertion Procedure Note to further help document compliance with insertion practices (see appendix D).

Recommendations/ Mandates

- NPSG EP 7, 8, 10, 11 and 13
- NPSG 07.04.01 hospitals must have "a STANDARDIZED protocol for disinfection of needleless connectors…"
- All 5 best practices addresses multiple EP's and CDC recommendations around insertion of CVC's

COMMUNICATING PROGRESS TO STAFF

To continually motivate the staff to be mindful of BSI prevention, Hartford Hospital promoted each nursing unit's success by posting the duration of time since the last reported BSI. As teams achieved multiple months without a BSI, the hospital rewarded their efforts with lunch parties and other treats. The BSI committee also used these recognition opportunities to speak with the staff and elicit feedback from them.

Recommendations/ Mandates

- NPSG EP 5: Report CRBSI rates and trends to staff and leaders

LEADERSHIP ROUNDING

Critical to the success of any hospital-wide quality improvement initiative is the demonstrated support of senior management. At Hartford each week, senior executives round on the units following a randomized schedule using a standardized reporting tool to gather information relevant to BSI reduction by asking the following questions.

"How many patients on the unit have central lines?"
"How many have high-risk central lines?"
"What is your plan for removing them?"

The rounding leader also performs a spot check on nursing documentation. In this way, leadership rounding both allows the leadership to reinforce the organization's dedication to the balanced scorecard measures and provides an opportunity for the staff to speak openly and routinely about their successes and challenges related to BSI prevention.

TOOLS

ALL INCLUSIVE CVC KIT AND DRESSING-CHANGE KITS

During its evaluation of current clinical practices, Hartford's BSI Steering Committee identified inadequacies in the central venous catheter (CVC) dressing-change kits in use throughout the hospital.

According to CDC guidelines, caregivers are expected to keep their eyes on the sterile field throughout the dressing-change process. However, the CVC kit in use forced the caregivers into a less than ideal workflow. When caregivers opened the kits, they put on the masks and regular gloves to remove the old dressings and Statlocks®, if being used. After discarding the dressings and gloves, the caregivers then had to leave the sterile field to wash their hands. Returning to the patients, the caregivers then put on the sterile gloves provided and completed the dressing procedure.

To rectify this flawed work flow, Hartford created custom-built CVC dressing-change kits that now include antiseptic gel packs for the purpose of sanitizing hands after handling the old dressings while still keeping their eyes on the sterile fields. Furthermore, the hospital created two separate kits that include different sized CHG Impregnated patches — one specifically for use with dialysis catheters and one for regular CVCs and PICCs. The kits are easily distinguishable by color.

Healthcare Technology Central Line Dressing Kit with Hand Sanitizer
Complys with CDC guidelines on maintaining a sterile field.

Multi-Lumen CVC Kit
All-inclusive central-line dressing kit

CHG IMPREGNATED PATCH

When used in conjunction with central-line insertions and maintenance bundles and the CDC guidelines for dressing changes, chlorhexidine gluconate (CHG) impregnated patches have proven efficacious in reducing central venous catheter infections (Jarog. *The Journal for Advanced Nursing Practice*, July/August 2009). A CHG impregnated patch is an evidence-based protective disk that releases CHG, an antimicrobial agent over seven days at the catheter-insertion site, providing constant antisepsis.

Recommendations/ Mandates

- CDC: Use a chlorhexidine-impregnated sponge dressing for temporary short-term catheters in patients older than 2 months of age if the CRBSI rate is not decreasing despite adherence to basic prevention measures

The CDC draft guidelines for 2011 indicate that patients should be treated with "a chlorhexidine-impregnated sponge dressing for temporary short-term catheters in patients older than 2 months of age, if the CLABSI rate is not decreasing despite adherence to basic prevention measures, including education and training, appropriate use of chlorhexidine for skin antisepsis, and MSB [maximal sterile barrier precautions]."The CDC classifies this innovation as a category 1B recommendation supported by experimental, clinical, or epidemiologic studies and a strong theoretical rationale. Not surprisingly, the BioPatch® CHG-impregnated sponge dressing is currently being used in most hospitals nationwide.

PORT PROTECTORS

When the Hartford healthcare technology team first brought the new innovation of passive disinfection port protectors to the attention of the BSI steering committee, the team found the idea daunting because it required an admission that the gold standard — relying on busy clinicians to scrub the hub with 70 percent isopropyl alcohol (IPA) or a CHG solution with each venous access — is ineffective. Time and friction have been the long-held components of successful disinfection. Although the optimal time interval is unknown, most hospitals require a minimum of 15 to 30 seconds. Studies demonstrate that the efficacy of disinfecting agents improves dramatically with an increasing time of exposure, even in the absence of friction. However, compliance with scrubbing protocols is difficult to monitor and is inconsistently followed.

Recommendations/ Mandates

- NPSG EP 12: Use a standardized protocol to disinfect catheter hubs and injection ports before accessing the ports
- CDC: Minimize contamination risk by scrubbing the access port with an appropriate antiseptic (CHG, povidone iodine, an iodophor, or 70% alcohol) and accessing the port only with sterile devices, 1A

The literature shows that 60 percent of CRBSI originate in skin bacteria (Safdar and Maki. *Intensive Care Medicine*, Jan 2004). As a result, current prevention bundles focus primarily on the prevention of extraluminal colonization. This contributes to the success achieved in ICUs where catheters are used over a short four-day mean length of stay. However, bundled interventions do not adequately address the intraluminal sources of infection, the origin of most CRBSIs in longer-dwelling catheters required in neonatal, pediatric, TPN, antibiotic, hemodialysis, oncology, hematology, and non-ICU adult patient populations.

Microbial biofilms on the intraluminal surfaces of the devices originate from microorganisms transported through contaminated needleless connectors, stopcocks, and catheter hubs. When the number of bacteria released from the biofilm overwhelms the immune system, bloodstream infection occurs. Hub colonization due to frequent access to and manipulation of intravenous systems is the cause of 29 to 38 percent of catheter infections and 60 percent of CRBSI in the ICUs (Bouza et al. *Journal of Hospital Infection*, 2003).

In 2010 when Hartford had successfully reduced BSI rates, the team began to look for ways to address the few cases that were still occurring. Port protectors were seen as a final step. Hartford Hospital selected luer-lock activated disposable disinfection caps (Curos® Disinfecting Port Protectors, manufactured by Ivera Medical Corporation located in Carlsbad, CA). The Curos disinfection cap meets the 2011 Infusion Nurses Society Guidelines that specify "add-on devices are to be of luer-lock design to ensure a secure junction" (*Infusion Nurses Society*, 2011). These disinfection caps are designed to disinfect all commercially available needleless connectors to persistently guard against microorganisms. The green plastic caps contain foam saturated with 70 percent isopropyl alcohol that continually bathes the needleless connector septums and threads. Once applied, the caps maintains efficacy for seven days or until the next venous access. A new cap is applied after every access.

Passive disinfection caps rely on time and 70 percent IPA to reach disinfection efficacy levels not previously seen with traditional friction- and-alcohol swab practices. Once in place, the caps provide persistent disinfection without requiring caregivers to manually scrub. The Curos cap has demonstrated significant reductions in bacterial counts, achieving ~5 log reduction in bacterial and fungal counts within 3 minutes (Ivera Medical Corporation, 2011).

A secondary benefit of disinfection cap usage is the ability of these devices to aid in the immediate ongoing auditing of port disinfection. The brightly colored green caps are easily visible from a distance, confirming compliance levels and clean needleless connectors at a glance.

Hartford initiated a three-month trial in five ICUs accounting for 78 patient beds. The team conducted daily auditing for compliance. During the trial, two BSIs were confirmed although neither were attributed to contaminated needleless valves.

In February 2011, Hartford began using Curos throughout the facility on all lines. In the first eight months of Curos use (February to September 2011), the hospital's average CLABSI rate dropped to 1.03/1000 line days — down from 1.73/1000 line days in the same time period the previous year, representing an average reduction in CLABSI of 40%.

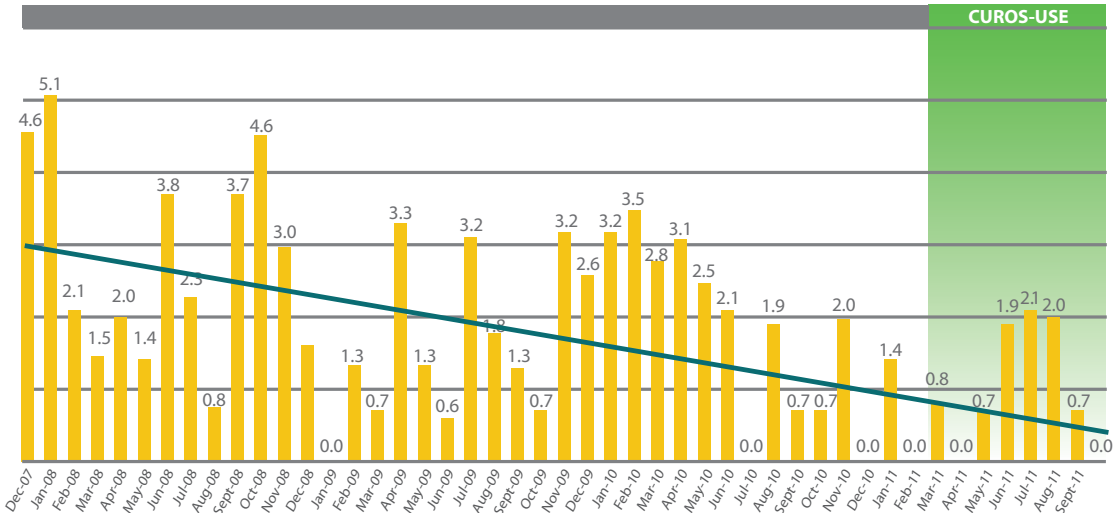
The bright green Curos caps provided Hartford with the capability to audit compliance in a manner that did not exist previously — allowing auditors to quickly assess visually the disinfection of each needleless port. Chart 1 illustrates month-by-month CLABSI rates in all ICU units over more than three and a half years, with the most recent eight months reflecting the use of disinfecting port protectors. Hartford quickly identified an inverse relationship between a decline in Curos use compliance and increasing CLABSI rates. A lull in compliance following initial implementation of Curos is reflected in the May-July 2011 CLABSI rates as compared to the low rates achieved in the first three months of use (February – April 2011.) This finding led Hartford to refocus its efforts on maintaining high compliance with constant auditing and practice promotion.

CLABSI RATE REDUCTION

Since the inception of the BSI Steering Committee in 2009, Hartford Hospital reduced the CLABSI rate from 39 to 17 over a 24-month period by employing the combined interventions outlined in this paper. Using published estimates of costs attributed to CLABSI, this 57 percent reduction in infection rates accounts for approximately $801,700 in savings annually (E. N. Perencevich, P. W. Stone, S. B. Wright, Y. Carmeli, D. N. Fisman, S. E. Cosgrove. *Infect Control Hosp Epidemiol* 28(10) (Oct. 2007):1121-33., $18,432/BSI; R. R. Roberts, R. D. Scott II, R. Cordell, S. L. Solomon, L. Steele, L. M. Kampe, W. E. Trick, R. A. Weinstein. *Clin Infect Dis*. 36(11) (June 1, 2003): 1424-32, $36,441/BSI).

Total catheter days were reduced by 1,506 days as compared to the previous year.

Chart 1 • Overall CLABSI Rate — All ICUs



CONCLUSION

In 2011, Hartford Hospital removed the BSI reduction goal from their balanced scorecard. Its removal was a testament to the excellent progress made across the organization in the previous two years. Yet, the BSI Steering Committee, which continues to meet biweekly, has not seen it as a change in the organization's focus to continue its pursuit of zero BSIs. The hospital administration is demonstrating leadership in this cause, setting BSI goals for physician groups, supporting BSI huddles, leadership rounds, and the steering committee. Additionally, the hospital has funded a new resource for further reductions in BSI rates: The Center for Education Simulation Innovation, a state-of-the-art simulation lab in which caregivers can train on proper line-insertion techniques and greater information systems involvement in designing and implanting electronic tools to more easily identify high-CVCs and assist with compliance auditing.

The multiyear efforts at Hartford Hospital is evidence that significant and long-term BSI rate reduction is possible when there is a pervasive in organizational culture that begins at the top and empowers people at all levels — administrators, caregivers, families, and patients.

APPENDIX A | Hartford Hospital Balance Scorecard | 2010

Pillars	Initiatives	Measure	Target	Accountability
Service Excellence Using service excellence to drive customer loyalty	Improve Staff Responsiveness to Patient Concerns	HCAHPS Survey composite score for two questions related to responsiveness of hospital staff	Increase Top Box Score by 5% by 8/31/2010 ('09=54.3)	L. Spivack
	Improve Patient Throughput	Seen by Provider <30 minutes. Time from arrival in ED to placement in inpatient bed	85% by 9/30/10 ('09=~50%) 6 hrs by 9/30/10 ('09=~8-9 hrs)	L. Spivack
	Hartford Hospital 2020: Phase I	Phase I Facilities Improvement Plan: Improve major infrastructure, clinical capability, patient areas, and access points & Initiate facilities' master planning for new Patient Tower & Garage.	100% completion by 9/30/10	B. Patel
Quality Ensuring that an infrastructure is in place to drive clinical and service excellence	Achieve Best Practice in Preventing Hospital Acquired Infections	Mean Number of Catheter-related Bloodstream Infections (BSI)/1000 catheter days	1.2 BSIs/1000 catheter days by 9/30/10 (37 BSIs in '09 with 40% drop to 23 BSI/yr	J. Roche
	Redesign HH Hospitalist Coverage	Implementation of Hospitalist Program with average of 1:18 patient:hospitalist ratio and 24/7 coverage	Completed by 9/30/10	J. Klimek
	Provide timely and comprehensive information to optimize management of key organizational processes	Implement model providing timely & comprehensive electronic information to optimize management of key organizational processes (patient throughput)	Functional by 7/1/10	S. O'Neill, J. Roche
People Ensuring that we have the right people with the right knowledge and skills to drive the continual improvement of our quality	Create a High Performance Organization (H3W)	Percent of workgroups of Waves 1,2 & 3 reviewing monthly dashboards based on 5 pillars	100% by 9/30/10 ('09 <10%)	J. Flaks
	Establish Leadership and Staff Development Program	Leadership and Professional Development Curriculum Implemented	9/30/2010	P. Besson
	Develop HH Physician Staffing Plan	Plan Complete	2/28/2010	J. Blazar
Growth Staying current in addressing community health needs and education and research opportunities	Implement CV Surgery Redesign Project	Implement CV Redesign Initiative Plan	9/30/2010	B. Boatman
	Increase regional referral base of Transplant Center	Number of New Listed Patients	Increased by 10% by 9/30/10 ('09=131)	B. Boatman
	Strengthen market position as regional destination program and NCI community cancer center	Number of new cases in cancer registry	Increase of 80 cases by 9/30/10 ('09=2403 cases)	D. Handley
	Enhance PCP Physician Base	Develop & Implement Comprehensive Strategic Plan	Develop Plan by 3/31/10 Implement Phase I by 9/30/10	J. Klimek
Financial Strength The financial objectives that will drive all other aspects of our strategy	Enhance understanding of billing, coding and documentation	Error Rate in Documentation	2% error rate by 3/31/10 ('09=14.6%)	T. Marchozzi
	Reduce LOS	11 AM Patient Discharge	Increase to 35% by 9/30/10 ('09 = 9%)	L. Spivack J. Klimek
	Establish Ambulatory Radiology Program	Comprehensive plan developed and pilot site in Enfield occupied	9/30/2010	J. Blazar, B. Patel
Academic Excellence Enhancing Hartford Hospital educational and research strengths, to complement the innovative and complex care we employ in caring for our patients	Establish Center for Education, Simulation, and Innovation (CESI	Site developed and occupied	9/30/2010	N. Yeston, B. Patel
	Enhance HH Research Enterprise	Develop Strategic Plan for Research	7/1/2010	L. Bow

CITATIONS

Bouza, E., et al. "A Needleless Closed System Device (CLAVE) Protects from Intravascular Catheter Tip and Hub Colonization: A Prospective Randomized Study." *J Hosp Infect*. 54(4) (2003):279-87.

Danzig, L. E., L. J. Short, K. Collins, M. Mahoney, S. Sepe, L. Bland, W. R. Jarvis. "Bloodstream Infections Associated with a Needleless Intravenous Infusion System in Patients Receiving Home Infusion Therapy." *JAMA* 273(23) (June 21, 1995):1862-4.

Deshpande, K. S., C. Hatem, H. L. Ulrich, et al. "The Incidence of Infectious Complications of Central Venous Catheters at the Subclavian, Internal Jugular, and Femoral Sites in an Intensive Care Unit Population." *Crit Care Med*. 33(1) (Jan. 2005):13-20; discussion 234-5.

Elixhauser, A. (Agency for Healthcare Research and Quality), B. Friedman (Agency for Healthcare Research and Quality), and E. Stranges (Thomson Reuters). "Septicemia in U. S. Hospitals," 2009. *HCUP Statistical Brief* #122, October 2011. Agency for Healthcare Research and Quality, Rockville, MD. http://www.hcup-us.ahrq.gov/reports/statbriefs/sb122.pdf.

Infusion Nurses Society. "Infusion Nursing Standards of Practice." *J Infusion Nurs.* (2006): 29 (1S).

Jarog, D. "Implementation of Guidelines, Including the Use of a Chlorhexidine Impregnated Patch to Reduce Catheter-Related Bloodstream Infections in Critical Care Patients." *Clinical Nurse Specialist: The Journal for Advanced Nursing Practice* 23(4) (2009):226.

The Joint Commission. *National Patient Safety Goals* (2012). Oakbrook Terrace, IL. Available at: http://www.jointcommission.org/standards_information/npsgs.aspx

Klevens, R. M., J. R. Edwards, C. L. Richards, et al. "Estimating Healthcare-Associated Infections and Deaths in U. S. Hospitals." *Public Health Rep*. 122 (2002, 2007):160-6.

Koff, M. D., R. W. Loftus, C. C. Burchman, et al. "Reduction in Intraoperative Bacterial Contamination of Peripheral Intravenous Tubing Through the use of a Novel Device." *Anesthesiology* 110(5) (2009): 978-85.

Macklin, D. "The Impact of IV Connectors on Clinical Practice and Patient Outcomes." *Journal of the Association for Vascular Access* 3 (2010): 126-134.

Marschall, J., L. A. Mermel, D. Classen, et al. "Strategies to Prevent Central Line-Associated Bloodstream Infections in Acute Care Hospitals." *Infect Control Hosp Epidemiol* 29 (Oct. 2008), Suppl 1: S22-30.

Mermel, L. A., R. D. McCormick, S. R. Springman, D. G. Maki. "The Pathogenesis and Epidemiology of Catheter-Related Infection with Pulmonary Artery Swan-Ganz Catheters: A Prospective Study Utilizing Molecular Subtyping." *Am J Med*. 91(3B) (Sept. 16, 1991): 197S-205S.

Mermel, L. A. "Prevention of Intravascular Catheter-Related Infections." Erratum: Ann Intern Med 133 (2000): 395. *Ann Intern Med* 132 (2000): 391–402.

O'Grady, N. P., M. Alexander, L. A. Burns, et al. "Guidelines for the Prevention of Intravascular Catheter-Related Infections." (2011). Access from http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html.

Parienti, J. J., M. Thirion, B. Mégarbane, et al. "Femoral vs. Jugular Venous Catheterization and Risk of Nosocomial Events in Adults Requiring Acute Renal Replacement Therapy: A Randomized Controlled Trial." *JAMA* 299(20) (May 28, 2008): 2413-22.

Perencevich, E. N, P. W. Stone, S. B. Wright, Y. Carmeli, D. N. Fisman, S. E. Cosgrove, Society for Healthcare Epidemiology of America. "Raising Standards While Watching the Bottom Line: Making a Business Case for Infection Control." *Infect Control Hosp Epidemiol* 28(10) (Oct. 2007): 1121-33.

Pronovost, P. "Interventions to Decrease Catheter-Related Bloodstream Infections in the ICU: The Keystone Intensive Care Unit Project." *Am J Infect Control* 36(10) (Dec. 2008): S171.e1-5.

Pronovost, P., D. Needham, et al. "An Intervention to Decrease Catheter-Related Bloodstream Infections in the ICU." N *Engl J Med*. 355(26) (Dec. 28, 2006): 2725-32. Erratum in *N Engl J Med.* 356(25) (June 21, 2007): 2660.

Roberts, R. R., R. D. Scott II, R. Cordell, S. L. Solomon, L. Steele, L. M. Kampe, W. E. Trick, R. A. Weinstein. "The Use of Economic Modeling to Determine the Hospital Costs Associated with Nosocomial Infections." *Clin Infect Dis.* 36(11) (June 1, 2003): 1424-32.

Ryder, M. "The Role of Biofilm in Vascular Catheter-Related Infections." *New Dev Vascular Dis*. 2 (2001): 15-25.

Safdar, N., D. G. Maki. "The Pathogenesis of Catheter-Related Bloodstream Infections with Non-Cuffed Short-Term Central Venous Catheters." *Intensive Care Med* 30(1) (2004): 62-7.