

GETTING TO ZERO

REDUCING RATES OF CLABSI IN COMMUNITY HOSPITALS

A REPORT BY



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The Leapfrog Group (www.leapfroggroup.org) is a Washington, DC-based not-for-profit organization founded a decade ago by public and private purchasers of employee health benefits to work for improvements in health care safety, quality, and affordability.

EXECUTIVE SUMMARY

Central-line associated bloodstream infections, commonly referred to by the acronym CLABSI, are serious and all-too often lead to long-term illness or even death. CLABSIs are also expensive, costing as much as \$40,000 per incident. Today many hospitals across the country have begun to target CLABSIs, especially in their ICU's, as an important problem that they can tackle successfully. Many have adopted the checklist and approach used by the team from Johns Hopkins University, led by Peter Pronovost, in what is widely known as the Keystone Project.

To begin understanding how hospitals achieved outstanding results in eliminating CLABSI, we conducted a small study of four typical community hospitals, all of which had achieved zero or very low CLABSI rates in their ICUs. Hospital staff members, including ICU staff (physicians and nurses), quality control, infection control, materials management, and administration, were interviewed using an open-ended interview guide during visits to the four hospitals.

Results showed that all four hospitals used a checklist and guidelines promulgated by AHRQ and CDC:

1. Hand hygiene
2. Maximal sterile barrier precautions
3. Chlorhexidine skin antisepsis
4. Appropriate insertion site selection
5. Prompt removal of unnecessary catheters

One of the important questions addressed in this study was the role of organized and/or evidence-based approaches to the reduction of central-line associated infections, and how hospitals tailored those organized approaches. The approaches to reducing infections varied in formality and sophistication. One of the hospitals used CLABSI reduction as one of their first attempts to employ Six Sigma methodology for quality improvement. Another participated in the Keystone project. The third hospital was prompted by their corporate parent to address CLABSI. Hospital leaders adapted materials that were handed down from the system to fit their institution. The fourth hospital did not have a manufacturing-driven or statewide initiative that promoted its success, but it developed a successful infection control program that started with the CDC guidelines and was driven by teamwork.

This study identified three primary content domains associated with the achievement of zero or very low CLABSI rates: (1) use and application of evidence-based procedures for central line insertion and maintenance, (2) culture and environment, and (3) maintenance efforts at each hospital.

All four hospitals in this study adopted and followed the AHRQ and CDC guidelines, but significant efforts were needed to encourage adherence to the measures and to monitor staff performance. Although clinical staff members were aware of the literature, process changes did not take effect until hospital policy was rewritten. It was important that all members of the care team had input into the process. Each of the hospitals developed specific methods for educating staff and measuring results with performance data. All four hospitals now use an insertion checklist, and the checklists document the procedure. Tracking the CLABSI data to document improvement helped to achieve necessary changes in culture, as did support from the hospital's medical leadership.

To complement the insertion checklist, each of the hospitals analyzed the organization of supplies and devices required for insertion. All had purchased or developed central line kits or carts to hold all the required supplies. The kits ensure that the supplies are easily portable and comprehensive, and contribute to the standardization of the insertion process. The central line kits or carts all contained similar supplies: protective provider barriers (cap, gloves, gown), protective patient barrier, chlorhexidine, catheters, and other devices and tools, including IV medication delivery antimicrobial technology (all employing silver as the antimicrobial agent). We also found consistency in who places central lines and a commitment by all of the hospitals' physicians to follow best practices for placing lines.

Respondents commented on the importance of the hospital's internal and external community relationships and the obligation to the patients who place their trust in the hospital's care. All the hospitals used a culture of safety survey or questionnaire to gain a better understanding of their successes and areas of improvement opportunity. The involvement of all levels of staff, especially senior administrative and clinical leadership, is critical to a successful initiative roll-out. All of the hospitals integrated clinical and administrative staff into the improvement process. Staff indicated that buy-in goes hand-in-hand with staff ownership—if the staff participates in the development and execution of the initiative, then they are more apt to follow the guidelines and produce positive results. This buy-in relates directly to a common theme found across all four hospitals—ownership of the process, patient, and outcomes.

Interview subjects at every hospital spoke about the culture of communication and collaboration. All four hospitals emphasized the value and judgment of the clinical nursing staffs and their relationship with the ICU physician staffs. Over time, the dynamic between nurses and physicians focused on increased collaboration and mutual respect. All the hospitals reported that the overall dynamic improved as a result of the hospitals' ability to celebrate successes.

Respondents at all four hospitals emphasized the importance of not only initial education but also on-going training. All four had implemented continuous education beyond a standard orientation for both clinical staff and physicians. In all four hospitals, comprehensive, multidisciplinary rounds were conducted for every ICU patient; although this was time-intensive, physicians and ICU nurses at the hospitals said that consistent, comprehensive care contributed to better patient outcomes, and it also enabled open communications across staff members.

Respondents at all four sites stated that it is a constant challenge to keep infections at bay. Some established additional practices to help ensure proper line insertion and line maintenance, such as minimizing the number of central lines placed. Others re-examined and adjusted their care processes after having an infection following months of being infection-free. To date, these hospitals have tried a variety of maintenance practices on their own because the published literature focuses more on insertion processes and sterility practices rather than on-going central line maintenance. To ensure proper maintenance, some hospitals have adapted the concept of the insertion kit to central-line dressing changes.

This was a small study of community hospitals and should not be generalized beyond that context. Additional research examining other types of hospitals is needed, as is further study of how hospitals maintain lines once inserted. Nevertheless, our findings do support the idea that local hospitals can and do undertake successful quality improvement efforts and can and do provide high-quality care to their families, friends, and neighbors.

AN URGENT NEED

Enter the phrase “central line bloodstream infections” into Google, and you get more than 66,000 results. Why this proliferation of information? These infections have been targeted by the health care industry—doctors, hospital quality control staff, the government’s Agency for Healthcare Research and Quality (AHRQ), the Centers for Medicare and Medicaid Services (CMS)—and rightfully so. Central-line associated bloodstream infections, commonly referred to by the acronym CLABSI, are serious and all-too often lead to long-term illness or even death. CLABSIs are also expensive, costing as much as \$40,000 per incident. CLABSIs were once thought to be inevitable—not that every patient with a catheter inserted to allow easy administration of drugs would develop an infection, but that some number would, and that it was not preventable.

But then one hospital—Johns Hopkins in Baltimore—did a study in its Intensive Care Unit (where most patients with central lines are cared for), and was able to reduce the number of CLABSIs. The Hopkins researchers, led by Dr. Peter Pronovost, took their process to the Michigan Keystone Center for Patient Safety & Quality, to see if their results could be replicated more widely. The Keystone ICU Project, as it came to be known, had impressive results. It helped decrease CLABSI rates significantly in 103 Intensive Care Units across the state of Michigan. After 18 months, the rate of CLABSI infections decreased by 66%.¹ The most recent study shows that the Keystone ICU Project “was associated with a significant decrease in hospital mortality [of patients aged 65 or older] compared with the surrounding area.”²

Today many hospitals across the country have begun to target CLABSIs, especially in their ICU’s, as an important problem that they can tackle successfully. Many have adopted the checklist and approach used by Pronovost’s team. As a result, we see the 66,000 Google entries.

But what we don’t see is the stories behind the studies. What were the inner workings of the hospitals in the CLABSI studies? And what about those hospitals that were not part of a study and have taken up the goal of reducing CLABSI on their own? How did the hospitals effect change? We know that it’s not enough

¹ “Johns Hopkins Safety Team Works to Eliminate Bloodstream Infections in the Nation and the World.” February 25, 2009. http://www.hopkinsmedicine.org/news/media/releases/Johns_Hopkins_Safety_Team_Works_to_Eliminate_Bloodstream_Infections_in_the_Nation_and_the_World

² Lipitz-Snyderman, Allison, Steinwachs, Donald, Needham, Dale M., Colantuoni, Elizabeth, Morlock, Laura L., and Pronovost, Peter J, “Impact of a statewide intensive care unit quality improvement initiative on hospital mortality and length of stay: Retrospective comparative analysis,” *BMJ* 2011;342:d219 doi:10.1136/bmj.d219

to just tell people—especially professionals with a long history and investment in “the way we do things around here”—to change. What are the ingredients that allow some hospitals to adopt new processes, new tools, and new relationships among colleagues?

As Dr. Pronovost has said (speaking of comparative effectiveness research in general), "What we need to also do is say, 'How can I be sure that this therapy is also going to work when I try it in a community hospital or outside of the study?' "³ Arnold Milstein, M.D., a national quality expert, concurs, noting the value of “comparing different treatment application methods... . That's where you get into the question of now that you've figured out the right treatment, how do you make sure it's implemented effectively, safely, patient-pleasingly and without wasting resources?”⁴ In other words, it is not enough to determine a “best practice” in health care; the hard part is successfully implementing that best practice in a large number of hospitals.

As a first step toward finding out just how hospitals achieved outstanding results in eliminating CLABSI, we conducted a small study of four typical hospitals—the kind you find in most American communities, the kind where most of us will be treated should we need hospital care. Community hospitals are the heart and soul of American medicine, and it is critical that they be able to continue to provide first-class care to their patients—our families and neighbors. We are hopeful that lessons learned from these hospitals that have been successful in reducing their rates of CLABSI will help provide guidance in their efforts to tackle other patient safety initiatives.

This report summarizes the results of this preliminary study. We begin with background on the history of interest in CLABSI, including the work of Pronovost and his team. We then describe what we did and how we did it. The heart of the report is the results of what we found in four extraordinary yet very ordinary American community hospitals. We conclude with some next steps that we might take.

³ Quoted in Aston, Geri, “Comparative Effectiveness (Why Does It Matter to You?),” *H&HN Online*, accessed 2/22/2011.

⁴ Aston, G., cited above.

BACKGROUND

In 2000, the prestigious Institute of Medicine released a groundbreaking report, *To Err Is Human: Building a Safer Health System*, which forced the health care industry to acknowledge the problem of patient safety.⁵ This report was the first widespread publication of two shocking numbers: studies had indicated that at least 44,000 Americans die each year as a result of preventable medical errors, and the number may be as high as 98,000. Since then, hospitals and other health care providers have increasingly identified and attacked specific quality-of-care issues, with varying degrees of success. A further concern: many hospitals tackle problems on their own, "reinventing the wheel," with little or no sharing of results across systems or institutions, or sometimes even across departments within a single hospital.

Over the decade following *To Err Is Human* and its sequel, *Crossing the Quality Chasm*⁶, concern about improving quality of health care and reducing the related costs of poor care was picked up by the public, particularly patient advocacy groups and the payor community. In 2008, the Centers for Medicare and Medicaid Services (CMS) announced that it would no longer pay for adverse events that a hospital can prevent by following evidence-based guidelines. CMS focused on the reduction of 10 adverse events that are widespread and high-cost—medical errors such as the retention of foreign objects after surgery and infections such as vascular catheter-associated infections, which includes central-line associated bloodstream infections (CLABSI).⁷ Many private-sector health plans have followed suit by implementing payment policies designed to incentivize providers to reduce errors and infections and improve outcomes.⁸

One particular set of problems that has received significant attention from providers and payors of health care, including the government, is hospital-acquired infections, including central-line associated bloodstream infections (CLABSI). Reducing the incidence of CLABSI has both economic and human implications for all health care stakeholders. Approximately 48% of all patients admitted to an Intensive Care Unit (ICU)—by definition, the sickest, most vulnerable patients—have a central line inserted to

⁵ Institute of Medicine, *To Err Is Human: Building a Safer Health System*, L.T. Kohn, J.M. Corrigan, and M.S. Donaldson, eds. Washington, DC, 2000.

⁶ Institute of Medicine, *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC. 2001.

⁷ Center for Medicare and Medicaid Services (CMS). Accessed October 14, 2010.
http://www.cms.gov/HospitalAcqCond/06_Hospital-Acquired_Conditions.asp#TopOfPage

⁸ The Commonwealth Fund. "A Conversation with Dana Gelb Safran About Getting the Incentives Right: The Blue Cross Blue Shield of Massachusetts Alternative Quality Contract." *Quality Matters Newsletter*. June/July 2010.
<http://www.commonwealthfund.org/Content/Newsletters/Quality-Matters/2010/June-July-2010/A-Conversation-with-Dana-Safran.aspx>

administer medications and obtain blood draws on a regular basis. Inserting a central line exposes the skin and body to the outside world and can provide easy access for bacteria to enter the bloodstream. Proper insertion and maintenance techniques are critical for successful outcomes. On average, there are 5.3 central line infections per 1,000 catheter days as a result of many factors: prolonged hospitalization before catheterization, prolonged catheterization, microbial colonization at the insertion site, microbial colonization of the catheter hub, and insertion site location, among others.⁹

When a patient does develop a central-line associated bloodstream infection, the consequences are serious and expensive. The patient will require treatment with antibiotics and prolonged hospitalization, usually for an average of seven days.¹⁰ One study found that the average cost of care in the ICU ranges from \$2,000 to \$3,000 per day,¹¹ in addition to antibiotic treatment and additional care, which amounts to an average additional cost of \$45,000 per patient for a CLABSI.¹² Unfortunately, antibiotic treatment does not always lead to a successful outcome for patients. Data indicates a mortality rate of 18% for patients who develop CLABSI.¹³

As would be hoped, the field has developed and tested guidelines for preventing CLABSI. Specific guidelines have been set by the Agency for Healthcare Research and Quality (AHRQ), the Centers for Disease Control and Prevention (CDC), the Institute for Healthcare Improvement (IHI), and other organizations to help hospitals improve quality care for patients with central-lines.¹⁴ In addition to guidelines, CDC developed the National Healthcare Safety Network (NHSN) in 2005 as an internet-based surveillance system to collect patient safety data voluntarily reported by hospitals across the country. AHRQ provides educational resources and supports continued research on effective techniques to reduce

⁹ Marschall, Jonas MD et al. "Strategies to Prevent Central Line-Associated Bloodstream Infections in Acute Care Hospitals." *Infection Control and Hospital Epidemiology*. October 2008; 29: S22-S30.
<http://www.journals.uchicago.edu/doi/abs/10.1086/591059>.

¹⁰ IHI Toolkit

¹¹ Luce, John M. and Gordon D. Rubenfeld. "Can Health Care Costs Be Reduced by Limiting Intensive Care at the End of Life?" *American Journal of Respiratory and Critical Care Medicine*. March 2002, Vol. 165: 750-754.
<http://ajrccm.atsjournals.org/cgi/content/full/165/6/750#B8>.

¹² Kass, Nancy Sc.D. et al. "Controversy and Quality Improvement: Lingering Questions." *The Joint Commission Journal on Quality and Patient Safety*. June 2008: Vol 34, No 6. <http://psnet.ahrq.gov/public/7329-JCJQPS.pdf>.

¹³ IHI Toolkit. <http://www.premierinc.com/safety/topics/bundling/downloads/01-central-lines-how-to-guide.pdf>

¹⁴ AHRQ guidelines can be found at http://www.ahrq.gov/about/annualconf10/hines_milne/hines.HTM. CDC Guidelines can be found at <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5110a1.htm>. IHI guidelines can be found at "Prevention of Central Line-Associated Bloodstream Infection." <http://www.ihl.org/NR/rdonlyres/01E7F0ED-EEDE-41BA-ABB0-982405602158/0/cli.pdf>

rates of CLABSI and other hospital-acquired infections. A notable national AHRQ-funded initiative, “On the Cusp,” focuses on unit-based educational training and tools to reduce CLABSI in ICUs. AHRQ and the CDC recommend the following quality measures to prevent CLABSI:¹⁵

1. Hand hygiene
2. Maximal sterile barrier precautions
3. Chlorhexidine skin antisepsis
4. Appropriate insertion site selection
5. Prompt removal of unnecessary catheters

IHI created the 100,000 Lives Campaign in 2005, with subsequent guides for focusing on specific quality improvements to reduce errors, infections, and poor outcomes using the concept of “bundles” of measures. IHI’s How-To Guide for the Prevention of Central Line Infections uses the same five measures recommended by the CDC.¹⁶

These guidelines were shown to be effective in research led by a team from Johns Hopkins and then in the Keystone ICU Project, which took the five quality processes of the guidelines and used a culture- and safety-based educational training approach, called the Comprehensive Unit-Based Safety Program (CUSP), with all health care providers in the ICUs in hospitals throughout the state. The program enables staff members to identify the cause of a problem and possible solutions for successful completion of the five measures. In some cases, providers identified materials management or effective communication as elements for improvement. Most notably, the program focused on the use of a checklist to ensure caregivers consistently complied with practice guidelines for every central line insertion procedure.

Results from the Keystone study showed that this safety-focused and evidence-based intervention helped CLABSI rates decrease significantly in 103 Intensive Care Units across the state of Michigan. As noted above, after 18 months, the rate of CLABSI infections decreased by 66%.¹⁷

¹⁵ Agency for Healthcare Research and Quality. “Health Care-Associated Infections.” <http://Psnet.ahrq.gov/primer.aspx?primerID=7>. Accessed October 15, 2010.

¹⁶ IHI Toolkit. <http://www.premierinc.com/safety/topics/bundling/downloads/01-central-lines-how-to-guide.pdf>

¹⁷ “Johns Hopkins Safety Team Works to Eliminate Bloodstream Infections in the Nation and the World.” February 25, 2009. http://www.hopkinsmedicine.org/news/media/releases/Johns_Hopkins_Safety_Team_Works_to_Eliminate_Bloodstream_Infections_in_the_Nation_and_the_World

In 2009 the U.S. Department of Health and Human Services allocated \$8 million to expand the Michigan Keystone project to all 50 states, Puerto Rico, and the District of Columbia.¹⁸ Additional funding will support the expansion of this intervention to other types of hospital-acquired infections. At the state level, some states have passed legislation that requires hospitals to report hospital-acquired infections such as CLABSI, and others have instituted public-reporting initiatives to educate consumers about hospital-acquired infections:

- **Pennsylvania Health Care Cost Containment Council (PHC4)** - PHC4 provides hospital cost and outcomes information for consumers through its online database, www.phc4.org. The interactive website allows consumers to search by hospital, by type of hospital-acquired infection, or by peer group to examine data results from 2005, 2006, and 2007. The data results include the number of cases, infection rate per 1,000 cases, mortality number and percentage, average length of stay, and the average charges.
- **Maryland Health Care Commission (MHCC)** - MHCC began publicly reporting several hospital-acquired infection measures to consumers in 2006. In 2010, the organization began reporting data for central-line association bloodstream infections. MHCC collects CLABSI outcomes data and publishes it in the Maryland Hospital Performance Evaluation Guide (<http://mhcc.maryland.gov/consumerinfo/hospitalguide/index.htm>).
- **South Carolina Department of Health and Environmental Control (DHEC)** - The DHEC passed the Hospital Infections Disclosure Act (HIDA) in 2008 to provide information about hospital-acquired infections through accessible reports to educate consumers in South Carolina. The individual hospital reports include the number of infections, the number of central line days, and the infection rate per 1,000 central line days for each ICU on its website (<http://www.scdhec.gov/health/disease/hai/individual.htm>).

In tandem with federal and state policy and regulations, individual hospitals and health care systems have implemented a variety of initiatives to reduce hospital-acquired infections, many of them specifically focused on CLABSI. Some hospitals have utilized the toolkits and guidelines set forth by the CDC, AHRQ, and IHI; others have added their own customized approach to successfully implementing the guidelines using educational programs, team-building exercises and tools, lean manufacturing principles, Six Sigma, and more.

¹⁸ <http://www.ahrq.gov/news/press/pr2009/haifund.htm>

RESEARCH GOALS

As noted above, the research work and recommended guidelines from CDC, AHRQ, IHI, and others give hospitals a path to follow to prevent the occurrence of central-line associated bloodstream infections. Although much progress has been made in recent years,¹⁹ the problem persists in too many hospitals across the country. One reason for the persistence of the problem of CLABSIs is that hospitals don't know

About the Leapfrog Group

The Leapfrog Group, a coalition of health care purchasers, focuses on efforts to improve quality and patient safety in hospitals across the United States and on providing information to purchasers and consumers about the status of patient safety in their local hospitals. A major tool of Leapfrog's work is its hospital survey. Hospitals that participate in the Leapfrog Hospital Survey represent institutions that are willing to be publicly accountable for improving performance and outcomes.¹ Approximately 1,200 hospitals report to the Leapfrog Hospital Survey each year, representing about a quarter of hospitals and of hospital beds in the country.

where to start or how to adapt published guidelines and approaches to their own situation. To begin to answer this question, the Leapfrog Group undertook a qualitative study of exactly what took place in a small group of community hospitals that had achieved exemplary CLABSI rates.

The Leapfrog Hospital Survey first included data on hospital-acquired conditions in 2008 (hospital injuries and pressure ulcers), and added CLABSI data in 2009. Health care purchasers, including health plans and employers, are concerned about the impact of hospital-acquired infections for the commercial population due to morbidity and mortality rates and increased costs. Like the Keystone research, the survey results demonstrate that hospitals can achieve

exemplary results in preventing CLABSI. In 2009, 33.0% of hospitals reporting CLABSI rates to the Leapfrog Hospital Survey from their Medical/Surgical ICUs reported a rate of zero CLABSI; in 2010, 34% reported a rate of zero.

The majority of the hospitals in the United States are community hospitals. These hospitals may have limited resources and research expertise compared to academic medical centers, but nonetheless they are committed to providing high quality care for their patients. Understanding how hospitals can "get to zero" for their CLABSI rates, and how these lessons can be applied throughout the hospital community, was the goal of this project.

¹⁹ CDC, "Protecting Patients with Central Lines," accessed at www.cdc.gov/Features/Vitalsigns/HAI, March 9, 2011.

Study Methodology

The study was conducted by Leapfrog staff, with support from Shoshanna Sofaer, DrPH, of Baruch College. The team developed a survey tool based on a literature review. Domains studied included leadership structure, organizational culture, teamwork, physical environment, staffing, set-up and process, staff education and training, technology, data collection and reporting, and quality improvement.

Four hospitals were invited to participate in the study. The first criterion used to select the hospitals was a low central-line associated bloodstream infection rate as reported to Leapfrog in the 2009 Leapfrog Hospital Survey. Other criteria used to select the hospitals included, but were not limited to, the number of staffed beds, the number of ICU beds, their status as a teaching hospital, and whether they participated in the Michigan Keystone Project. Two of the hospitals chosen are located in Michigan, one is located in New Jersey, and one is located in South Carolina.

The interviews were conducted by Leapfrog staff and held during the months of June and July of 2010. The number of people interviewed at each hospital depended on the size and structure of the CLABSI reduction effort at the hospital. Interviewees were selected by a hospital representative, usually the quality improvement director, acting as on-site coordinator and working with Leapfrog project staff. At the smallest hospital, 5 people were interviewed; at the largest, 10 people were interviewed. A diverse group of infection control, quality improvement, and other hospital representatives participated in the interviews.

Those that participated included quality improvement directors, directors of infection control, chief nursing officers, hospital CEOs, medical directors, front-line nurses, and directors of materials management, among others. Interviews were scheduled in advance. The coordinators at each hospital were given a general explanation of the project which was then communicated to all interviewees prior to the interviews, but the actual survey questions were not distributed in advance. The majority of interviews were conducted on site, with a few requiring phone follow-up.

All interviews were recorded and transcribed. Each transcript was reviewed by at least two Leapfrog researchers and analyzed for specific themes related to the domains of the study. Finally, meetings were held to identify and resolve any discrepancies in the analyses.

RESULTS

One of the important questions addressed in this study was the role of organized and/or evidence-based approaches to the process of reducing central-line associated infections, and how hospitals tailored those organized approaches to fit the needs of their institution. While all of the hospitals were successful at reaching and maintaining zero or very low rates of CLABSI, their approaches to reducing infections varied in formality and sophistication. One of the hospitals used CLABSI reduction as one of their first attempts to employ Six Sigma methodology for quality improvement. The ICU Clinical Coordinator, the Six Sigma Project Coordinator, and the Infection Control Coordinator nominated CLABSI reduction in the ICU as a target that was accepted for and rolled out as one of the first projects using the methodology. The Project Coordinator and ICU staff noted that it was important to have a Six Sigma consultant as a participant to provide feedback and help. The focus on quantifying and documenting process adherence and results was an important ingredient in fostering success. According to the Performance Improvement Director, the physicians responded quickly “once they could see the numbers.” The same director noted that they linked specific behaviors, like hand-washing or wearing a protective cap, to outcomes, and were able to show that the physicians who were not meeting their process targets had higher rates of infections.

Six Sigma

Made famous by large manufacturers in the late 1980’s, Six Sigma is a multidisciplinary team-based approach to quality improvement that seeks to identify the errors in a given process in order to reduce the variability of that process, and, in turn, in its outcome. Businesses apply Six Sigma to increase profitability, but, many in health care, including the staff at one study hospital, use it to improve clinical outcomes. The Six Sigma methodology is grounded in rapid measurement and performance feedback to front-line employees; in health care, that means physicians, nurses, techs, and other caregivers.

Another hospital was part of the Keystone Project in Michigan. The hospital already targeted bloodstream infections as a priority, but the Keystone project gave them an organized and team-based approach to reduce infections. Keystone helped empower their nurses to hold their physicians accountable: one of the physicians described the shift from a physician-centric culture to a team-centric culture as “challenging,” but since the project started, that shift has been successful. Keystone also promoted a bundling technique that gave caregivers what they needed when they needed it and gave hospital quality staff access to expertise and coaching throughout the initiative.

The third hospital was prompted by their corporate parent to address CLABSI. Hospital leaders adapted materials that were handed down from the system to fit their institution: They developed a unique daily goals worksheet to be used during rounds and ensured that all protocols were in line with CDC guidelines. Leadership also created a strong educational framework, assigning “unit educators” to each division of the hospital. The Director for Performance Improvement credits the “education task force” with helping to disseminate changes in clinical practice and reinforce those changes hospital-wide.

The fourth hospital did not have a manufacturing-driven or statewide initiative that promoted its success, but it developed a successful infection control program that started with the CDC guidelines and was driven by teamwork.

In addition to looking at approaches to process improvement, this study identified three primary content domains associated with the achievement of zero or very low CLABSI rates in these four community hospitals. First, we evaluated the hospitals’

use and application of evidence-based procedures for central line insertion and maintenance, including the local application of nationally vetted procedures and determining effective ways to encourage and monitor adherence by ICU staff. That is, did the hospitals use the national guidelines? How did they keep track of their CLABSI rates and changes in those rates? How did they monitor changes in the behavior of caregivers when changes were made to the protocol?

Second, we explored the culture and environment at each hospital related to safety integration, leadership participation, staff collaboration, and education and training. If the hospital had a more-or-less formal project to reduce CLABSI rates, were there a single leader and/or a team? Who was involved? Were there any naysayers along the way? How were new procedures introduced and taught?

Third, we examined the maintenance efforts at each hospital; once they had reduced their CLABSI rates to very low or zero incidence, how did they maintain that success over time? All three of these elements were deemed critical success factors by the hospitals, as detailed in the following results.

Addressing Hand Hygiene

An ICU nurse had an idea that “Wash in / out” signs, placed above hand-washing stations, could improve hand-washing compliance. She constructed bright yellow “STOP” signs at home and brought them into the ICU, posting them outside each patient room. In a short time, hand-washing compliance jumped, and rates of bacterial infections dropped. The hospital immediately rolled out the signs institution-wide. While the signs themselves are an important hand hygiene reminder, they speak to a larger cultural phenomenon in this hospital: staff are encouraged to take ownership over problems and supported in rolling out innovative solutions.

Insertion Processes for Placing Central Lines

As noted above, the CDC recommends five evidence-based guidelines for proper insertion of central lines to reduce the likelihood of a bloodstream infection:

1. Hand washing
2. Use of full barrier precautions prior to catheter insertion
3. Skin preparation with chlorhexidine
4. Avoidance of the femoral site
5. Removal of unnecessary catheters

All four hospitals in this study adopted and followed these guidelines, but significant efforts were needed to encourage adherence to the measures and to monitor staff performance. Although physicians and nurses were aware of the literature and measures for reducing CLABSI, hospital management noted that process changes did not take effect until the policy was re-written to include these specifications. At one hospital, management recalled that they updated their policy “because practice has to be consistent with policy.” Hospital administrators, management, physicians, and front-line clinical staff all collaborated to update the policy accurately; it was important that all members of the care team had input in to the process.

Some of the hospitals needed to update their medical devices and supplies in order to fully comply with the evidence-based guidelines. Before taking on the challenge of reducing CLABSI, all four hospitals had used either povidone iodine or betadine solution instead of chlorhexidine to clean and prepare insertion sites. Within the preceding few years, clinical staff at each of the hospitals discussed with its administrators the recommendation to switch to chlorhexidine and worked with materials management to coordinate the supplies transition.

To monitor consistent adherence to the guidelines, each of the hospitals developed specific methods for educating staff and measuring results with performance data. All four hospitals participate in the National Healthcare Safety Network (NHSN) developed by the CDC. The NHSN allows the hospitals to monitor patient safety and performance data, particularly in the module for infections including CLABSI, and it also encourages hospitals to network with one another for best practices and lessons learned. In addition, two of the four hospitals participate in a statewide initiative to reduce CLABSI, one as an On the Cusp project and another as a sepsis bundle project.

To provide performance results to physicians and clinical staff, three of the hospitals developed specific reports to improve performance in adhering to the measure set. As one hospital medical director said, “Variation is not acceptable... [Hospitals should] find a way to inspire the members of the medical staff.” By focusing on compliance with evidence-based care measures, “It’s not a matter of changing the way you deliver medical care—it’s a matter of being organized.”

All four hospitals now use an insertion checklist prior to inserting a central line catheter, and the checklists serve as documentation of the procedure. Most of the elements on the hospitals’ checklists focus on the five process measures to provide reminders to staff and maintain consistency in care delivery. If the checklist is not completed prior to an insertion, staff instituted a “stop procedure.” For example, if the patient is not fully prepped and if the patient and the health care providers are not fully gowned, anyone can stop the procedure at any time and start the process over again. In one of the hospitals, implementing the stop procedure required overcoming a culture in which doctors expected deference from nurses and other clinical staff. It took some time for the doctors to accept the input of the ICU nurses. Tracking the CLABSI data to document improvement helped to achieve the necessary change in culture, as did support from the hospital’s medical leadership.

Besides tracking CLABSI rates, some of the hospitals collected other data elements such as the number of catheters inserted or removed and blood culture data on a daily basis and reported this information to the infection control staff to maintain real-time data for analysis and preemptive action.

To complement the central line insertion checklist, each of the four hospitals conducted an internal analysis to evaluate the organization of supplies and devices required for insertion. Some of the hospitals observed staff behavior prior to and during the insertion process, noting that supplies were scattered throughout the ICU instead of located in a central area, so the staff worked with the materials management department to re-organize the materials more efficiently. Over the preceding few years, all of the hospitals had purchased or developed central line kits or carts to hold all the required supplies. The kits ensure that the supplies are easily portable and comprehensive, and contribute to the standardization of the insertion process. In addition, the kits or carts are helpful in emergency situations. The central line kits or carts all contained similar supplies: protective provider barriers (cap, gloves, gown), protective patient barrier, chlorhexidine, catheters, and other devices and tools, such as catheter connectors. In all 4 hospitals, kits and carts included IV medication delivery antimicrobial technology (all employing silver as an antimicrobial agent). The hospital staff identified the use of a consistent set of effective supplies as an important component of their ability to achieve consistent results.

Some hospitals have enacted processes to evaluate the necessity of a central line prior to insertion, with the aim of inserting fewer lines altogether. According to one physician, “Minimizing the number of central lines that we place is important—we emphasize [to staff] that they only get put in when absolutely indicated.”

We also found consistency in who places central lines and a commitment by all of the hospitals’ physicians to follow best practices for placing lines. Two of the hospitals had created de facto policies limiting who could insert lines: in one hospital only three physicians placed lines; in another, only five. One physician explained that when he was first hired by the hospital, family practice residents were placing lines, which he thought was unacceptable. There were too many residents, and each one wasn’t able to insert enough lines to become proficient. “If you’re not [placing lines] regularly you’re going to have all kinds of complications... The thing is, in order to become a pro at doing something like that ... you really got to do a lot. You ... practice your foul shot, you practice your golf swing, [so] practice your central lines.”

ICU Newsletter

One hospital created an internal newsletter, called “The Critical Beat,” for its ICU staff members. The newsletter is electronically distributed among the ICU team to provide updates, education, information on new evidence-based guidelines, and relevant articles and publications. The ICU Clinical Coordinator works with the Director of Patient Safety and Risk Management, Infection Prevention Nurse Epidemiologist, and the ICU Nurse Director to develop the content of the newsletter.

Consistent Elements in the Culture of the Hospitals

One repeated theme in the interviews conducted at these four community hospitals was the importance of the relationship of the hospital to its community. Many ICU nurses, as well as other interview subjects, noted that their physicians and clinical staff frequently care for family members, friends, or someone who knows someone else in the community. Repeatedly throughout the staff interviews, respondents commented on the importance of the hospital’s internal and external community relationships, and the obligation to the patients who place their trust in the hospital's care.

At the onset of the CLABSI prevention initiatives and throughout the evaluation process, staff at each hospital received support and guidance from the administrative leadership. All of the hospitals used a culture of safety survey or questionnaire to gain a better understanding of their successes and areas of opportunity. The involvement of all levels of staff, especially senior administrative and clinical leadership, is critical to a successful initiative roll-out because it shows personal commitment and investment in the common goal to improve patient safety. For example, one Chief Nursing Officer said she is “heavily

involved” in patient safety and quality improvement initiatives because “if the leaders aren’t involved, then you don’t draw an example for the staff.”

In order to become invested in these initiatives, staff members needed to believe in the value of adopting the guidelines and new procedures. All of the hospitals integrated clinical and administrative staff into the improvement process: multidisciplinary rounds were designed to help coordinate patient care; front-line caregivers were polled on how to improve the design of daily goals worksheets; and when infections did happen, everyone was involved in redesigning the process. Staff at one hospital said that buy-in goes hand-in-hand with staff ownership—if the staff participates in the development and execution of the initiative, then they are more apt to follow the guidelines and produce positive results. At another hospital, the ICU nurse director noted that buy-in is critical to the adoption of the improvement processes so that the nurses “understand we are doing all of these things for the patients and [we] acknowledge [the nurses] and they take pride in it.” This buy-in relates directly to a common theme found across all four hospitals—ownership of the process, patient, and outcomes. At the end of a shift, nurses communicated with one another to hand-off each patient’s care plan and followed up with the next nurse to see if the plan was enacted, instilling a sense of accountability and responsibility for each and every patient.

A second important part of the safety culture around preventing CLABSIs is communication, and interview subjects at every hospital spoke about the culture of communication and collaboration. Staff at one hospital noted that they use the aviation model of cockpit communication, emphasizing the effort of the team for the benefit of the patient and improving the relationship between physicians and nurse staff. The medical director of another hospital’s ICU asserted that the “[nurses’] input is massive—none of this can happen without the collaborative effort [because] you need a healthy team model.” Throughout the educational training for their CLABSI reduction initiatives, all four hospitals emphasized the value and judgment of the clinical nursing staffs and their relationship with the ICU physician staffs.

The nursing staff at all four hospitals have been empowered to speak up if there is a deviation in adhering to the process measures prior to inserting a central line. At one hospital, this focused on the ability to exercise the stop procedure. At other hospitals, it involved a verbal cue or action to obtain a new central line kit and re-start the process due to accidental contamination or nonadherence to the checklist. Over time, the dynamic between nurses and physicians focused on increased collaboration and mutual respect. For example, at one hospital a well-respected physician was slow to make a habit of always donning a sterile cap when inserting a central line. There was good-natured teasing about his concern about his hairstyle, but the ICU nurses were persistent. In time, he put on his cap without being reminded to do so. In

turn, all the hospitals reported that the overall dynamic improved as a result of the hospitals' ability to celebrate successes, which stemmed from all departments and levels within the hospital. One administrative staff member believed that positive recognition efforts "inspire[s staff] to try harder—it is important to let them know they are responsible for the success and make a big deal over it." Some of the hospitals have themed recognition bulletin boards where staff can post congratulatory comments about one another, while other hospitals host pizza parties and other recognition events.

These hospitals used the occurrence of an infection to re-examine their process and address culture gaps in care. After an infection (their first in two years), one hospital conducted a root cause analysis (RCA). It revealed that the insertion checklist had been followed. However, some days later a nurse had documented the probable need to change a line, but an emergency occurred, and the line did not get checked and changed. The next day the message was lost in the hand-off between shifts, and the line was once again left unchecked and unchanged. According to the infection control coordinator, "[This] brought up the whole issue of patient etiquette: Where does the responsibility of the nurse end? To document it and tell the doc, or to make sure it gets done?" The RCA team identified that "at the end of the day," no one was responsible for making sure the line change had been completed—a process issue—and that the nurses did not feel it was their role to tell the physicians or someone "higher up" that the line still needed to be checked and changed—a culture issue.

The RCA team addressed both problems. First, it identified the medical director of the ICU as the person responsible to ensure that the line is checked if the nurse questions it and, if needed, that it is changed. If he is not able to change the line himself, he must find someone else to do it. The team also understood that physicians, especially those who work in the ICU, have schedules that ebb and flow. Thus, they wanted to ensure that even if the medical director were unable to change the line himself or forgot to have someone else do it, the nurses felt empowered to speak up. Hospital administration sent out a "chain of command letter" clearly stating that nurses could speak to someone if they have patient safety (e.g., infection) concerns. The goal, according to the director of patient safety and quality, was to make sure "nurses felt the power of the support of the administration."

Respondents at all four hospitals emphasized the importance of not only initial education but also on-going training. All four hospitals had implemented continuous education beyond a standard orientation (typically 12 weeks long) for both clinical staff and physicians. In one hospital, the educational process includes administrative leadership conducting rounds on each floor “to be transparent and learn from any mistakes” and an on-line educational program for clinical staff and physicians to reiterate important patient care and

Bulletin Boards

Two of the four hospitals used bulletin boards to update and educate ICU staff. The hospitals got creative: one used a hot-air balloons theme – the surrounding community is known for its hot-air balloon festival – and another used a “Peanuts Comics” theme – a staff favorite. The bulletin boards illustrated key statistics, such as the number of days since the last CLABSI infection, and important reminders, such as hand hygiene practices, and staff quickly began to watch the boards to see how they were doing. Additional articles and publications were posted to the bulletin board by the Clinical Improvement Managers, ICU Directors, and the Infection Prevention Managers.

maintenance concepts. At another hospital, the infection control staff worked with ICU administrative staff to create educational poster boards, five-minute discussion forums, and hand-outs for clinical staff to initiate a two-way dialogue. At a third hospital, educational sessions were followed by observations and competency checks to ensure the educational material was effective in communicating key concepts. Every hospital has appointed a staff educator, either as a separate position or part of an existing position, to conduct on-going training for proper central line insertion and maintenance. One hospital’s staff educator focuses on a different topic each month, such as central line dressing changes or appropriate hand hygiene, as a “refresher.”

In all four hospitals, comprehensive, multidisciplinary rounds were conducted for every ICU patient; although this was time-intensive, physicians and ICU nurses at the hospitals said that

consistent, comprehensive care contributed to better patient outcomes, and it also enabled open communications across staff members. “The daily rounding ... indicates a 9:00 a.m. begin time without fail. It doesn’t matter if we have two patients in ICU or 13 patients in the ICU—we are rounding. It’s nursing-led, collaborative, and multidisciplinary... where you have every care provider together in the rounds,” according to the director of patient care services at one hospital. During rounds, clinical staff members at each hospital complete the “Daily Goals Worksheet,” which helps guide maintenance efforts with dressing changes, fluids, and other care regimens. The Daily Goals Worksheet serves as a working document that can be modified as needed over time to incorporate various elements of care or particular initiatives in place, and it also serves as part of the performance documentation efforts by hospitals. There are numerous examples of Daily Goals Worksheets, including a sample developed for the On the Cusp project.

Variation in Line Maintenance Processes

Although these four hospitals have achieved a very low or zero rate of CLABSIs, respondents at all four stated that it is a constant challenge to keep infections at bay. Some hospitals established additional practices to help ensure proper line insertion and line maintenance, such as minimizing the number of central lines placed. Other hospitals re-examined and adjusted their care processes after having an infection after months of being infection-free. To date, these hospitals have had to try a variety of maintenance practices on their own because the published literature focuses more on insertion processes and sterility practices rather than on-going central line maintenance.

The core maintenance activity that occurs when caring for patients with central lines is changing dressings. The CDC recommends that transparent dressing be changed at least once every seven days.²⁰ ICU nurses monitor the dressings on a daily basis and sometimes determine that more frequent dressing changes are necessary. One of the hospitals had two infections after more than two years with no infections at all. The ICU staff described themselves as devastated by the new infections. An in-depth staff discussion about their processes showed that the clinical staff members were following the published guidelines, but suggested that the frequency of dressing changes represented an area of opportunity for improvement. The staff posited that they were waiting too long to change dressings, even though all central lines were assessed daily. The clinical staff decided to try changing every patient's dressing three times a week—on Mondays, Wednesdays, and Fridays—so as to create a “routine” that would be easier to follow than depending on individual judgment and remembering that a week had passed since the initial placement or previous dressing change. They also decided to change the tubes and claves, and several months later there had been no additional infections.

To ensure proper maintenance, some hospitals have adapted the concept of the insertion kit and applied this concept to central-line dressing changes. One of the hospitals created a central-line dressing-change kit with all of the necessary supplies and devices for clinical staff. Administrative staff believes that the comprehensiveness of the kit facilitates consistency with maintenance practices. Other hospitals continue to explore this concept for dressing changes because they have had positive outcomes as a result of creating central-line insertion kits.

²⁰CDC. <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5110a1.htm>.

RECOMMENDATIONS AND NEXT STEPS

Although the rate of CLABSIs in ICUS has been reduced by 58% since 2001,²¹ there remains much work to be done. Our study looked at four community hospitals that have been successful in reducing their ICU CLABSI rates. The hospitals all followed appropriate evidence-based care measures for central line insertions. We were also able to observe other additional factors that contributed to their success.

- Proper preparation (including *organization and logistics of supplies, including supplies such as antimicrobial IV access devices that have proven effective in reducing infection*) and technique for insertion are critical to positive health outcomes for ICU patients.
- Consistency with these best practices remains the goal of each hospital, and *limiting the number of medical staff authorized to insert central lines* is one method to promote that consistency.
- *Documenting adherence* to the process and *monitoring infection rates* was also critical in holding the care-giving staff accountable and contributed to their on-going success.
- *A robust culture of safety and collaboration* plays a role in mutual accountability and ownership of the care processes and patients' outcomes.
- *Hospital staff members* from all levels and departments of these organizations *were actively involved* in their respective plan or initiative to reduce the rate of CLABSI to zero in their ICU. Even when making small adjustments to supporting materials, front-line caregivers were included in the effort.
- *Nurses* in every ICU felt they *had permission to speak up* if a protocol had been breached.
- This foundation set the stage for on-going multidisciplinary collaboration, hands-on education, staff empowerment, and motivational leadership, which created an *internal system of checks and balances* with regard to patient care processes and maintenance.
- Each hospital *tailored its change initiative* to its own staff and circumstances. Two used formal programs; two did not. They followed the clinical guidelines to the letter, but adapted the operational arrangements, materials, initial and on-going training schedules, and other factors based on their own experience.
- These hospitals monitored their progress and *used that feedback to adapt* on an on-going basis.

However, we did observe variation in practices related to the maintenance of central lines, and this is an area for further development and dissemination of best practices. The lack of consistency across the four

²¹ CDC, "Making Healthcare Safer: Reducing Bloodstream Infections in Patients with Central Lines," accessed at <http://www.cdc.gov/Features/Vitalsigns/HAI>, March 11, 2011.

hospitals in central line maintenance practices is not surprising, given the lack of specificity for maintenance practices in the published literature and best practices of other hospitals. Most hospitals follow the CDC's care measure to change central-line dressings every seven or fewer days, but some hospitals have found better outcomes when dressings are changed more often.

- We recommend that *additional research* be conducted to better define and disseminate *optimal maintenance practices*.

This preliminary study was necessarily limited; we visited only four hospitals, all community hospitals with limited to no academic affiliation. The conclusions, therefore, should not be generalized to all hospitals, or even all community hospitals.

- We recommend *repeating the study with hospitals of different sizes and types*, as well as additional small community hospitals.

Nevertheless, our findings do support the idea that local hospitals can and do undertake successful quality improvement efforts and can and do provide high-quality care to their families, friends, and neighbors.

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