Getting Started Kit:

Prevent Central Line Infections

Central Line Associated - Blood Stream Infections (CLA-BSI)

How-to Guide

Safer Healthcare Now!

We invite you to join the *Safer Healthcare Now!* Campaign (SHN) to help improve the safety of the Canadian healthcare system. *Safer Healthcare Now!* is a National campaign supporting Canadian healthcare organizations to improve patient safety by using quality improvements methods to integrate evidence and best practices in patient care delivery. The campaign is supported by the Institute for Healthcare Improvement (IHI) and is patterned after IHI's *100,000 Lives Campaign* (now 5 Million Lives Campaign). To join the SHN! Campaign, obtain further information about resources, contacts, and tools, visit our website http://www.saferhealthcarenow.ca/EN/Pages/default.aspx

Patient safety interventions are organized as bundles and described in Getting Started Kits, based on those originally developed by IHI for its *100,000 Lives Campaign* (now 5 Million Lives Campaign). These kits are designed to engage your teams and clinicians in a dynamic approach for quality improvement, and to provide a thorough basis for *getting started*. **Please note that although the SHN kits and the original kits developed by IHI are similar, there are also key differences in the content of the interventions and corresponding measures for some kits.** These differences are clearly noted in the body of the SHN kits themselves, and on the SHN website.

The "Getting Started" kits are based on the current state of knowledge. Consistent with the dynamic nature of this campaign, which continues to evolve, emerging evidence may influence adaptation of the kits in the future. This kit was reviewed and updated in February 2009. We remain open to working

consultatively on updating the content as together we make healthcare safer in Canada.

The Quebec Campaign: Together, let's improve healthcare safety! works collaboratively with the SHN Campaign. The GSKs for all six targeted interventions used in both campaigns are the same and the leader for the Quebec Campaign is a member of the SHN National Steering Committee.

Acknowledgement

We wish to thank and acknowledge the Institute for Healthcare Improvement (IHI) for their significant support and contributions to the *Safer Healthcare Now!* campaign. The material contained in these Canadian "Getting Started" kits has been modified from the original documents created by the Institute for Healthcare Improvement (IHI) for its *100,000 Lives* Campaign (now 5 million lives campaign) to be better aligned with the Canadian healthcare setting.

In addition, we also wish to thank and acknowledge our Canadian faculty who has contributed significantly to the work of the Central Line Infection teams and the revisions to this kit. In particular, we acknowledge the work of Dr. Peter Skippen and Ms. Tracie Northway.

Canadian ICU Collaborative Faculty

Ms. Paule Bernier, *P.Dt., MSc, Sir MB Davis Jewish General Hospital (McGill University), Montreal*

Dr. Paul Boiteau (Chair), *Department Head, Critical Care Medicine, Calgary Health Region; Professor of Medicine, University of Calgary*

Mr. Mike Cass, *BSc, RN, MScN, Advanced Practice Nurse, Trillium Health Centre*

Ms. Leanne Couves, *Improvement Associates Ltd.*

Ms. Rosmin Esmail, *BSc, MSc*

Mr. Bruce Harries, *Improvement Associates Ltd.*

Dr. Ann Kirby, *Associate Professor, University of Calgary; Chair, Quality and Safety Improvement Council; QI Physician, Department of Critical Care Medicine, Calgary Health Region*

Mr. Gordon Krahn, *BSc, RRT, Quality and Research Coordinator, BC Children's Hospital*

Dr. Denny Laporta, *Assistant Professor of Medicine; Chief Adult Critical Care Division, Sir MB Davis Jewish General Hospital*

Dr. Claudio Martin, *Professor, Schulich School of Medicine and Dentistry, University of Western Ontario; Attending Physician, London Health Sciences Centre*

Ms. Debbie Lynch, *RN, ICP Eastern Heath, St. John's*

Ms. Cathy Mawdsley, *RN, MScN, Clinical Nurse Specialist – Critical Care, London Health Sciences Centre; Adjunct Professor, School of Nursing, University of Western Ontario*

Dr. Sherissa Microys, *Assistant Professor, University of Ottawa; Intensivist, Ottawa Hospital; Major, Canadian Forces*

Dr. John Muscedere, *Assistant Professor of Medicine, Queens University; Intensivist, Kingston General Hospital*

Ms. Tracie Northway, *RN, MScN, BC Children's Hospital*

Ms. Jannell Plouffe, *RN, MScN, Nurse Practitioner PICU, Winnipeg Children's Hospital*

Ms. Kimberly Rafuse, *RN, BScN, DOHN, ICP Annapolis Valley District Health Authority*

Dr. Peter Skippen, *Division Head & Medical Director, Pediatric ICU, BC Children's Hospital, Vancouver*

Table of Contents

Background

Goal

Prevent central line associated blood stream infections (CLA-BSI) by implementing the components of care called the "central line bundles."
A "bundle" is a collection of processes needed to effectively and safely care for patients undergoing particular treatments with inherent risks. Several interventions are "bundled" together and, when combined, significantly improve patient care outcomes. For further information on bundles and how they work access the Institute for Healthcare Improvement's website at http://www.ihi.org/IHI/Topics/CriticalCare/IntensiveCare/ImprovementStories/WhatIsaBundle.htm .

Note: Change of name of CR-BSI to CLA-BSI
The SHN Faculty screened all of the recent literature based upon the varying terminology that has crept into the literature. Based upon the more common usage, we have chosen to adopt the use of CLA-BSI as the preferred terminology for this Starter Kit because of its more descriptive nature.

The Case for Central Line Associated Bloodstream Infections (CLA-BSI)

- Central venous catheters (CVCs) are being used increasingly in the inpatient and outpatient setting to provide long-term venous access. CVCs disrupt the integrity of the skin, making infection with bacteria and/or fungi possible. Infection may spread to the bloodstream and hemodynamic changes and organ dysfunction (severe sepsis) may ensue, possibly leading to death. Approximately 90% of the CLA-BSI's occur with central venous catheters (CVCs).[1]

- Forty-eight percent of intensive care unit (ICU) patients in the U.S. have central venous catheters, accounting for 15 million central-venous-catheter-days per year in U.S.-based ICUs. Studies of catheter-related bloodstream infections that control for the underlying severity of illness suggest that

mortality attributable to these infections is between 4% and 20%. Thus, it is estimated that 500 to 4000 U.S. patients die annually due to bloodstream infections.

- In addition, nosocomial bloodstream infections prolong hospitalization by a mean of 7 days. Estimates of attributable cost per bloodstream infection are between US $3,700 and $29,000. There are no equivalent Canadian figures for burden of illness.[2 3 4]

Central Line Bundles

The central line bundles were developed by grouping individual evidence-based best practice interventions for patients with central venous lines. When the interventions are implemented together as packaged, they should result in better outcomes than when implemented individually.

The IHI's 5 Million Lives Campaign's central line bundle included 5 elements. There has been a slight departure from the IHI bundle in this SHN Starter Kit. One of the insertion items has been reclassified (preferred site) and four new components have been added. The current 8 components are broken into two separate bundles. Each of these bundles, the **insertion bundle** and the **maintenance bundle**, are important aspects of catheter care in preventing CLA-BSI's. The bundles themselves have been demonstrated to reduce CLA-BSI's by the Canadian ICU Collaborative Pediatric teams, examples of which are illustrated in this guide and recently published from other pediatric and adult centres. [5 6 7]

Initial testing of the central line bundles occurred in intensive care units. Many hospitals have since spread the work to other areas of the hospital where central lines are inserted and maintained. E.g. Oncology programs, general medical or surgical services. These bundles should work equally well in any of these hospital settings, if associated with adequate communication and education. The bundles could also be applied to any catheter whose tip lies in a central vein,

including **peripherally inserted central catheter** (PICC) lines, although the data on this particular type of line is insufficient to be conclusive.

The **central line bundle** is broken into an **insertion** and a **maintenance** bundle.

Central Line Insertion Bundle:

1. Hand hygiene
2. Maximal barrier precautions
3. Chlorhexidine skin antisepsis

Changes to the Insertion Bundle:
More recent evidence does not support a single insertion site in either adults or pediatrics. Optimal catheter site selection depends on a multitude of factors including the operators' technical skills and experience, and the patients' anatomical features.

Central line maintenance bundle:

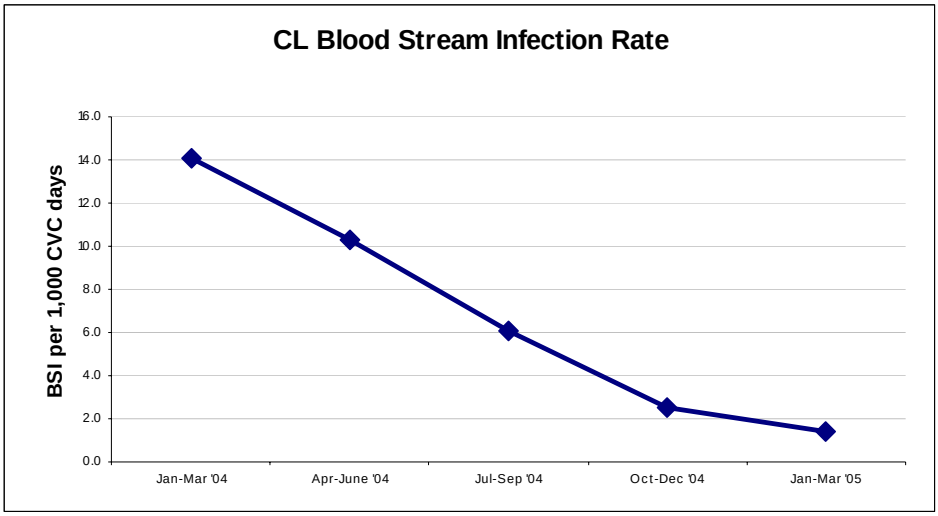
4. Multimodal educational and training programs
5. Accessing the lumens aseptically - scrubbing the hub
6. Checking entry site for inflammation with every change of dressing
7. Daily review of line necessity, with prompt removal of unnecessary lines
8. Dedicated lumen for Total Parenteral Nutrition (TPN)

Compliance with the central line bundles can be measured by simple assessment of the completion of each item. The approach has been most successful when all elements are executed together—an "all or none" strategy—as demonstrated by the Canadian ICU Collaborative Pediatric teams.

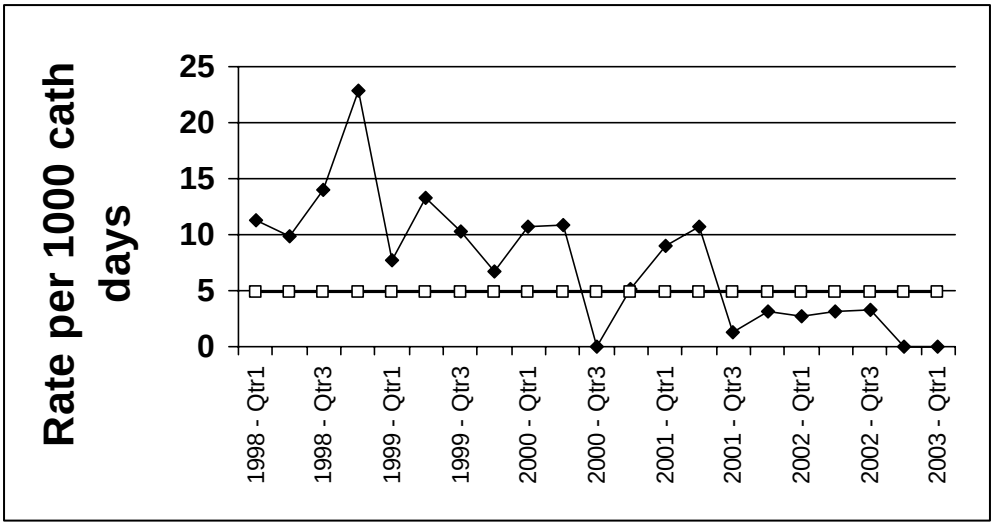
Potential Impact of the Central Line Bundles

The application of SHN's **central line bundles** should at the very least result in similar reductions in the rate of CLA-BSIs as have been associated with other collaborative efforts such as the IHI central line bundle.

Example: Stollery Children's Hospital (Edmonton, AB)



Berenholtz et al. demonstrated that ICU's that have implemented multifaceted interventions similar to the central line bundles have nearly eliminated CLA-BSI's over prolonged periods.



Similar results have been demonstrated in the PICU. [8] [9]

Mortality associated with CLA-BSI's will also likely decline over longer periods. The success of these interventions is perhaps due to a combination of the mindfulness that develops when regularly applying the elements of the bundles, and the particular bundle elements themselves. For example, two studies have shown that the application of maximal barrier precautions substantially reduces the odds of developing a bloodstream infection.

Author/date	Design	Catheter	Odds Ratio for infection without maximal barrier precautions
Mermel 1991	Prospective Cross-sectional	Swan-Ganz	2.2 ($p<0.03$)
Raad 1994	Prospective Randomized	Central	6.3 ($p<0.03$)

Mermel et al. demonstrated that the odds ratio was 2.2 times greater for infection without maximal barrier precautions, while Raad et al. demonstrated a 6.3 times greater likelihood for infection without precautions. [10] [11]

Preventing Central Line Infections: Components of Care

Central Line Insertion Bundle

Hospital teams across the United States and Canada have developed and tested process changes that allowed them to improve performance on hand hygiene. These changes, taken together, support the implementation of the central line insertion bundle.

1. Hand hygiene

The key role of healthcare workers washing their hands in the transmission of pathogens from patient to patient was demonstrated over 150 years ago by Ignaz Semmelweis. This Viennese obstetrician dramatically reduced the mortality related to puerperal fever by implementing systematic hand disinfection in chlorinated lime before examining patients. Since then, routine hand washing before and after patient contact has been espoused as the most important infection control measure in hospitals. The endemic transmission of exogenous staphylococci and other potential pathogens by the hands of healthcare workers has been well documented. [12]

This phenomenon is of particular concern in the ICU where patient care necessitates frequent contact. In fact, one study has shown that on average each ICU patient experiences on average 159 direct and 191 indirect contacts by healthcare workers in a 24-hour period. Much of the previous literature in this field has identified the very poor rates of hand washing by healthcare workers before and after patient contacts (21-66%).[13]

Attention to hand hygiene plays an important role in the prevention of nosocomial infections in the ICU and is likely to be more rewarding since the advent of alcohol-based hand rub solutions.[14]

When caring for central lines, appropriate times for hand hygiene include:

- Before and after palpating catheter insertion sites (Note: palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained.)
- Before and after inserting, replacing, accessing, repairing, or dressing an intravascular catheter
- When hands are obviously soiled or if contamination is suspected
- Before and after invasive procedures
- Between patients, even if only reviewing a patient's chart
- Before donning and after removing gloves
- After using the bathroom
- After eating

» What changes can we make that will result in improvement?

Some of these changes are:

- Empower nursing to enforce use of a central line checklist to be sure all processes related to central line placement, including hand hygiene, are executed for each line placement.
- Include hand hygiene as part of your checklist for central line placement.
- Keep soap/alcohol-based hand hygiene dispensers prominently placed and make universal precautions equipment, such as gloves and masks, readily available
- Post signs at the entry and exits to the patient room as reminders.
- Initiate a campaign using posters including photos of celebrated hospital doctors/employees recommending hand hygiene.

- Create an environment where reminding each other about hand hygiene is encouraged.

2. Maximal barrier precautions

A key change to decrease the likelihood of central line infections is to apply maximal barrier precautions in preparation for line insertion.

For the provider placing the central line and for those assisting in the procedure, maximal barrier precautions means strict compliance with hand hygiene and wearing a cap, mask, sterile gown, and gloves. The cap should cover all hair and the mask should cover the nose and mouth tightly.

For the patient, applying maximal barrier precautions means covering the patient from head to toe with a sterile drape, with a small opening for the site of insertion.

» What changes can we make that will result in improvement?

Some of these changes include:

- Empower nursing to enforce use of a central line checklist to be sure all processes related to central line placement, including maximal barrier precautions, are executed for each line placement.
- Include maximal barrier precautions as part of your checklist for central line placement.
- Keep equipment stocked in a cart for central line placement to avoid the difficulty of finding necessary equipment to institute maximal barrier precautions.

3. Chlorhexidine skin antisepsis

Chlorhexidine skin antisepsis has been proven to provide better skin antisepsis than other antiseptic agents such as povidone-iodine solutions.

The technique for skin preparation with chlorhexidine 2% in 70% isopropyl alcohol is a follows:

- Apply chlorhexidine solution using a back-and-forth friction scrub for at least 30 seconds. Do not wipe or blot.
- Allow antiseptic solution time to dry completely before puncturing the site (~ 2 minutes).[15] [16] [17]

» What changes can we make that will result in improvement?

Some of these changes include:

- Empower nursing to enforce use of a central line checklist to be sure all processes related to central line placement, including chlorhexidine skin antisepsis, are executed for each line placement.
- Include chlorhexidine antisepsis as part of your checklist for central line placement.
- Include only chlorhexidine antisepsis kits/solutions in carts or grab bags storing central line equipment.
- Ensure that solution dries completely before attempting to insert the central line.

Changes to the Insertion Bundle: Optimal catheter site selection

a. Adult patients.

Percutaneously inserted catheters are the most commonly used central catheters. The site of insertion has long been held to be a risk factor for infection. Mermel et al.[18] were able to demonstrate that the great majority of infections develop at the insertion site. Other risk factors included use of the jugular insertion site over the subclavian site. In addition, for use of total parenteral nutrition, McCarthy demonstrated a similar effect.[19]

The subclavian site has been the preferred placement site over the jugular and femoral sites for non-tunnelled catheters in adult patients. This recommendation is based solely on the likelihood of reducing infectious complications. [20] [21] [22] Subclavian placement may have other associated risks. The bundle requirement for *optimal site selection* suggests that other factors (e.g., the potential for mechanical complications, the risk of subclavian vein stenosis, and catheter-operator skill) should be considered when deciding where to place the catheter. In these instances, teams are considered compliant with the bundle element as long as they use a rational construct to choose the site.

More recent publications, with emphasis on full barrier precautions and asepsis during placement have not found a difference in the incidence of catheter related BSI for different site of placement. The conclusions to be drawn from these more recent reports support the consideration of other factors when considering what is the optimal site for placement of a central venous catheter in an individual patient, such as the experience of the operator, and other patient factors such as hyperinflation of the chest, availability of ultrasound guidance etc.[23] [24]

The core aspect of site selection is the risk/benefit analysis by a physician as to whether the subclavian vein is most appropriate for the patient. There will be occasions when the physician determines that the risks of using the subclavian vein outweigh the benefits and a different vessel is selected. For the purposes of bundle compliance, if there is dialogue among the clinical team members as to the selection site and rationale, and there is documentation as to the reasons for selecting a different vessel, this aspect of the bundle should be considered as in compliance. *It is not the intent of the bundle to force a physician to take an action that he or she feels is not clinically appropriate.*

b. Pediatric patients.

Insertion of central venous catheters in children can be more challenging than in adults. When selecting line placement site, patient comfort, patient specific factors (e.g., pre-existing catheters, irregularities in hemostasis, anatomic anomalies), risk of complications (e.g., bleeding risk, pneumothorax), infection

risk, potential for ambulation, and operator experience should all be used to guide selection. The final decision of where to place a central venous catheter in a child requires the physician making decisions based on an individual patient's requirements, and assessing the risk/benefit analysis in each specific clinical situation. Whether a specific site has a lower rate of infection in younger children remains inconclusive. In teenage patients, similar considerations for site selection can be applied as for adult patients.[25] [26]

» What changes can we make that will result in improvement?

Some of these changes include:

- Empower nursing to enforce use of a central line checklist to be sure all processes related to central line placement, including optimal catheter site selection, are executed for each line placement.
- Be more patient specific when selecting the preferred site for catheter placement based upon risk/benefit factors for any given patient, whether they are considered an adult or a pediatric patient e.g., bleeding risks.
- Avoid the use of femoral catheters for Parenteral Nutrition (PN) administration.[27]

Emerging Trends

Antibiotic Impregnated CVCs

It is not recommended to use antibiotic impregnated catheters routinely as a substitute for the other elements of the insertion bundle. Healthcare Infection Control Practices Advisory Committee guidelines advocate the use of AI-CVCs only if strict enforcement of a multiple-facet strategy fails to decrease CLA-BSI rates below benchmark levels. However, there may be situations in some specific patient populations where the use of an antibiotic coated catheter may reduce the risk of CLA-BSI. These would include longer duration, the immunosuppressed patient population.[28]

Ultrasound guided placement of central venous catheters.

In 2001, the Agency for Healthcare Research and Quality performed a review of a vast number of risk reduction strategies to see which ones were unequivocally supported by the evidence. They found 11 such practices. One of them was "Use of real-time ultrasound guidance during central line insertion to prevent complications."[29] [30]

The National Institute for Clinical Excellence in the UK issued guidelines in 2002 recommending the use of two-dimensional ultrasound guidance for elective central venous cannulation in both adults and children and suggested considering its use in all situations, including emergency cannulation. Indeed, there has been a rapid spread of the technique in critical care units and emergency rooms, both adult and pediatric in Canada and the USA over the past few years. Several publications have recently suggested reduced complication rates. A major issue in the future will be that of training and maintenance of competence.[31] [32] [33]

Central Line Maintenance Bundle

4. Multimodal educational and training programs

Many cohort studies now demonstrate that education based preventative programs can reduce CLA-BSI when combined with specific measures. The Canadian Critical Care Collaborative has also demonstrated success with this practice.[34]

5. Accessing the lumens aseptically – Scrubbing the Hub

The hubs on central venous catheters are a common source of bacterial colonization. Although no large studies have been performed to prove that hub cleaning with antiseptic prior to accessing the port reduces infections, the same logic can be applied to the practice of washing hands prior to accessing the

central venous catheter. Most hospital infection control guidelines recommend scrubbing the port for 15-30 seconds with either 70% alcohol or a chlorhexidine/alcohol preparation. Accessing the lumens aseptically has also been shown, through the work of the Canadian ICU Collaborative, to decrease the risk of infection.

» What changes can we make that will result in improvement?

Some of these changes include:

- Rely on hand washing guidelines
- A number of centres have found it helpful to reduce choice and thus reduce possible error by making only chlorhexidine antiseptic swabs available. This includes the practice of using chlorhexidine antiseptic to swab ports.

6. Checking entry site for inflammation with every change of dressing

Checking the entry site for inflammation will prevent unnecessary delays in providing appropriate interventions in care of the patient. On occasion, central line site infections may initially go unnoticed. However, it is clear that the sooner an infection is identified, the more quickly treatment can be initiated.

» What changes can we make that will result in improvement?

Some of these changes include:

- Provide education about checking entry site for signs of inflammation as part of multidisciplinary rounds.
- Include checking insertion site in daily goals or maintenance check sheet.

7. Daily review of central line necessity & prompt removal of unnecessary lines

Daily review of central line necessity will prevent unnecessary delays in removing lines that are no longer clearly needed for the care of the patient. Many times, central lines remain in place simply because they provide reliable access and because personnel have not considered removing them. However, it is clear that the risk of infection increases over time as the line remains in place and that the risk of infection decreases if the line is removed.

The CDC guidelines state "catheter replacement at scheduled time intervals as a method to reduce CLA-BSI has not lowered rates of infection." Additionally, routine replacement is "not necessary for catheters that are functioning and have no evidence of causing local or systemic complications." The guidelines further note "replacement of temporary catheters over a guide wire in the presence of bacteremia is not an acceptable replacement strategy, because the source of infection is usually colonization of the skin tract from the insertion site to the vein." [35] [36]

» What changes can we make that will result in improvement?

Some of these changes include:

- Include daily review of line necessity as part of your multidisciplinary rounds.
- Include assessment for removal of central lines as part of your daily goal sheets.
- Record time and date of line placement for record keeping purposes and evaluation by staff to aid in decision-making.

8. Total Parenteral Nutrition (TPN)

Although the evidence is limited, providing a dedicated lumen for TPN has been recommended to decrease the CLA-BSI by minimizing access to that lumen of the central venous catheter, thereby reducing contamination. The decision to breach this recommendation should be reserved for exceptional situations when the life of a patient is considered to be at risk.[37]

» What changes can we make that will result in improvement?

Some of these changes include:

- Include daily review of dedicated TPN lumens as part of your multidisciplinary rounds. Convert to enteral feeding route as soon as applicable.
- Empower nursing to enforce use of a central line maintenance checklist to be sure all processes related to central line maintenance, including dedicated lumen for TPN, are executed for each patient.[38]

Emerging Trends

Minimizing catheter site skin bioburden

Chlorhexidine-impregnated dressing is effective in reducing vascular bacterial colonization and is also associated with a trend towards reduction in catheter-related bloodstream infections. These dressings could be considered in long term PIC or central venous catheters; although the cost effectiveness of this approach awaits a large RCT.[39] Another well designed study, although small, in a select patient population (adults with long term tunnelled hemodialysis catheters) used Polysporin ointment and followed their patients for 6 months. There was a significant reduction in CLA-BSI in those patients receiving the routine Polysporin dressing, but the 2 groups became dissimilar by the end of the followup, making conclusions as to true effectiveness difficult. [40]

Implementing the Central Line Bundles

Forming the Team

SHN recommends a multidisciplinary team approach to patient care beginning in the in the ICU. Improvement teams should be heterogeneous in make-up, but homogeneous in mindset. The value of bringing diverse personnel together is that all members of the care team are given a stake in the outcome and work to achieve the same goal. In preventing CLA-BSIs, the team must include an intensive care physician and should include:

- Intensive Care Nurses
- Infection Control Practitioners
- Pharmacists
- Nutritionists

All the stakeholders in the process must be included, in order to gain the buy-in and cooperation of all parties. For example, teams without nurses are bound to fail. Teams led by nurses and therapists may be successful, but often lack leverage if physicians are not part of the team.

Some suggestions to attract and retain excellent team members include:

- using data to define and solve the problem;
- utilizing the champions;
- working with those who want to work on the project, rather than trying to convince those who do not;
- schedule meetings in advance with dates/times that are MD friendly;
- ensure that meetings are structured (agenda and minutes);
- ensure meetings are managed effectively (attention to time allocation);

- ensure that there is clarity about task delegation and time lines;
- engage them in the overall goal of the Campaign;
- finding champions within the hospital that are of sufficiently high profile to lend the effort immediate credibility.

The team needs encouragement and commitment from an authority in the intensive care unit. Identifying a champion increases a team's motivation to succeed. When measures are not improving fast enough, the champion re-addresses the problems with staff and helps to keep everybody on track toward the aims and goals.[41]

Eventually, the changes that are introduced become established. At some point, however, changes in the field or other changes will require revisiting the processes that have been developed. Identifying a "process owner," a leader who is responsible for the functioning of the process now and in the future, helps to maintain the long-term integrity of the effort.

Setting Aims

Improvement requires setting aims. An organization will not improve without a clear and firm intention to do so. The aim should be time-specific and measurable; it should also define the specific population of patients that will be affected. Agreeing on the aim is crucial; so is allocating the people and resources necessary to accomplish the aim.

An example of an aim that would be appropriate for reducing CLA-BSI's can be as simple as, "Decrease the rate of CLA-BSI's by 50% within one year."

Teams are more successful when they have unambiguous, focused aims. Setting realistic numerical goals clarifies the aim, helps to create tension for change, directs measurement, and focuses initial changes. Once the aim has been set,

the team needs to be careful not to back away from it deliberately or "drift" away from it unconsciously.

Using the Model for Improvement

In order to move this work forward, SHN and IHI recommend using the Model for Improvement. Developed by Associates in Process Improvement, the Model for Improvement is a simple yet powerful tool for accelerating improvement that has been used successfully by hundreds of health care organizations to improve many different health care processes and outcomes.

The model has two parts:

- Three fundamental questions that guide improvement teams to 1) set clear aims, 2) establish measures that will tell if changes are leading to improvement, and 3) identify changes that are likely to lead to improvement.

- The Plan-Do-Study-Act (PDSA) cycle to conduct small-scale tests of change in real work settings — by planning a test, trying it, observing the results, and acting on what is learned. This is the scientific method, used for action-oriented learning.

Implementation: After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the team can implement the change on a broader scale — for example, test medication reconciliation on admissions first.

Spread: After successful implementation of a change or package of changes for a pilot population or an entire unit, the team can spread the changes to other parts of the organization or to other organizations.

You can learn more about the Model for Improvement on www.IHI.org.

Getting Started

Hospitals will not successfully implement the central line bundle overnight. If you do, chances are that you are doing something sub-optimally. A successful program involves careful planning, testing to determine if the process is successful, making modifications as needed, re-testing, and careful implementation.

- Select the team and the venue. It is often best to start in one ICU. Many hospitals will have only one ICU, making the choice easier.
- The full team has to agree on a definition of central line associated blood stream infection and stick to it.
- Assess where you stand presently with respect to the processes of line placement and maintenance.
- Work with your infectious diseases/infection control department to start collecting data of your unit's baseline catheter-related bloodstream infection rate and how it is determined and reported. In addition, are there requirements for reporting these rates to regulatory agencies within your province?
- Organize an educational program. Teaching the core principles to the ICU staff will open many people's minds to the process of change. Knowing your current reality (e.g., rates and current practices) assists in highlighting strengths and gaps in practices. Post your rates so staff and families can see – be proactive with highlighting efforts at reducing these rates in your unit.
- Introduce the central line bundles to the staff. Start testing changes using the insertion bundle and, as progress is made, add testing of the maintenance bundle. This order is recommended as the insertion bundle is often easier to measure. The maintenance bundle is less straightforward and less predictable to measure due to the nature of the care and environment.

First Test of Change

Once a team has prepared the way for change by studying the current process and educated the affected parties, the next step is to begin testing the central line bundles at your institution.

- Begin using the bundle with one patient from the time of catheter placement.
- Work with each nurse who cares for the patient to be sure they are able to follow the bundle and implement the checklist and daily goals sheet.
- Make sure that the approach can be carried over from shift to shift to eliminate gaps in teaching and utilization.
- Process feedback and incorporate suggestions for improvement.
- Once the bundle has been applied to one patient and subsequent shifts, increase utilization to the remainder of the ICU.
- Engage in additional PDSA cycles to refine the process and make it more reliable.
- After achieving reduction in CLA-BSI in the pilot ICU, spread the changes to other ICUs, and eventually to other places in the hospital where central lines are inserted.

Measurement

Measurement is a way to know whether a change represents an improvement. There are three measures of interest for CLA-BSI.

1. CLA-BSI rate per 1000 central line-days

The first measure is a rate. In this case, for a particular time period, we are interested in the total number of cases of CLA-BSIs. For example, if in February there were 12 cases of CLA-BSIs, the number of cases would be 12 for that month. We want to be able to understand that number as a proportion of the total number of days that patients had central lines. Thus, if 25 patients had

central lines during the month and each, for purposes of example, kept their line for 3 days, the number of catheter days would be 25 x 3 = 75 for February. The CLA-BSI Rate per 1000 catheter days then would be (12/75) x 1000 = 160.

Total no. of CLA-BSI cases ---------- No. of catheter days	X 1000	=	*CLA-BSI rate per 1000 catheter days*

2. Central Line <u>Insertion</u> Bundle Compliance

The second measure is an assessment of how well the team is adhering to the central line insertion bundle. Our experience has been that teams begin to demonstrate improvement in outcomes when they provide all components of a central line bundle. Therefore, we choose to measure the compliance with an entire bundle, not just parts of the bundle.

On a given day, select all the patients who have had a new central line placed and assess them for compliance with the central line insertion bundle. If even one element is missing, the case is not in compliance with the bundle. For example, if central lines were inserted in seven patients on a given day, and 6 have all three bundle elements completed, then 6/7 (86%) is the compliance with the bundle. If all 7 had all elements completed, compliance would be 100%. If all seven were missing even a single item, compliance would be 0%. This measure is always expressed as a percentage.

No. with ALL three elements of central line insertion bundle ---------- No. with CVCs **inserted** on the day of the sample	X 100	=	*Central line **insertion** bundle compliance*

3. Central Line Maintenance Bundle Compliance

The third measure is an assessment of how well the team is adhering to the central line maintenance bundle. On a given day, select all the patients with central lines and assess them for compliance with the central line maintenance bundle, in the same way described above for insertion bundle compliance.

No. with ALL five elements of central line maintenance bundle --- No. with CVCs on the day of the sample	X 100	=	*Central line **maintenance** bundle compliance*

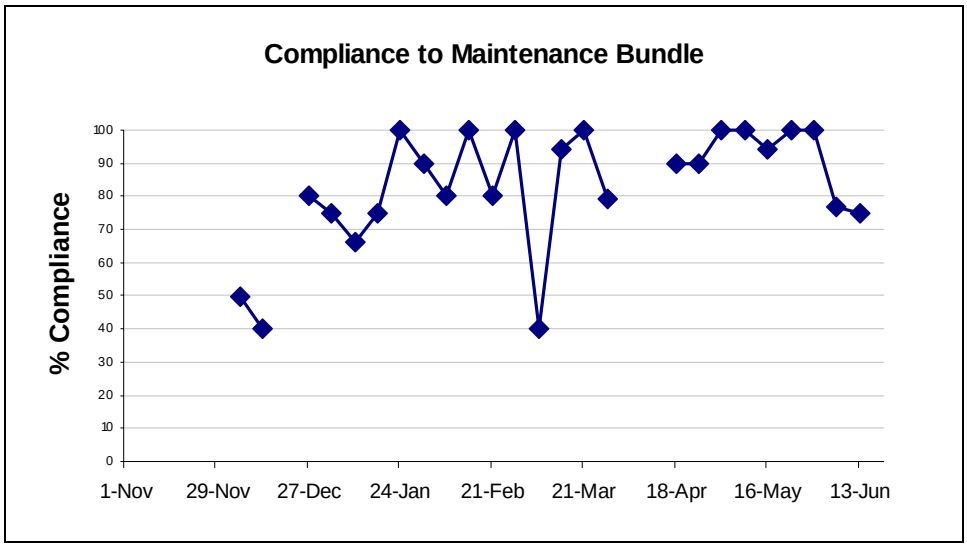
Appendix A contains further details on the technical descriptions of these measures, including definitions of terms, numerators, denominators, exclusions, and collection strategies.

Appendix A also contains a worksheet for each measure. The worksheets provide step-by-step tables for calculating the numerator, denominator, and final calculation for each measure. The worksheets can be used at the baseline stage (before you have started to implement the bundles) or implementation stage. It may be appropriate to collect some or all measures retrospectively, through chart review, but ideally, your data will be collected concurrently. SHN recommends that before your facility, team or unit begins implementing the intervention, you obtain **baseline data**, using the worksheets provided. Baseline data will give you a sense of where you are starting from, and what some of the potential areas of focus are for your facility or unit. We suggest that you take a "snapshot" of three months or more, or whatever is feasible for your organization.

Track Measures over Time

Improvement takes place over time. Determining if improvement has really occurred and if it is a lasting effect requires observing patterns over time. **Run charts** are graphs of data over time and are one of the single most important tools in performance improvement.

<u>Example Run Chart:</u> Winnipeg Children's Hospital (Winnipeg, MB)



Using run charts has a variety of benefits:

- They help improvement teams formulate aims by depicting how well (or poorly) a process is performing.
- They help in determining when changes are truly improvements by displaying a pattern of data that you can observe as you make changes.
- They give direction as you work on improvement and information about the value of particular changes.

Barriers That May be Encountered

- **Fear of change**
  All change is difficult. The antidote to fear is knowledge about the deficiencies of the present process and optimism about the potential benefits of a new process.

- **Communication breakdown**
  Organizations have not been successful when they failed to communicate with staff about the importance of central line care, as

well as when they failed to provide ongoing teaching as new staff become involved in the process.

- **Physician and staff "partial buy-in" (i.e. "Just another flavour of the week?")**
  In order to enlist support and engage staff, it is important to share baseline data on CLA-BSI rates and to share the results of improvement efforts. If the run charts suggest a large decrease in CLA-BSIs compared to baseline, issues surrounding "buy-in" tend to fade. Other centers have cited their "CLA-BSI rates are below" recommended acceptable levels. They struggle with how to motivate staff to move towards best practice. Questioning those who challenge the change is important. Re-focusing on the goal of best practice to prevent infections and consequently decrease risk to the patient is suggested as helpful motivator.

Work To Achieve a High Level of Compliance

The experience of the hospitals that have used the central line bundles thus far has been that the greater the level of compliance with *all* of the items in a bundle, the better the reduction in the CLA-BSI rate.

Of course, compliance is only as good as the element that is least adhered to in the bundle. The Johns Hopkins Hospital's experience with compliance with some elements of central line care analogous to the central line bundle is depicted below.[42]

Intervention:	**Compliance**:
Hand hygiene	62%
Chlorhexidine antiseptic at the procedure site	100%
Draped the entire patient in a sterile fashion	85%
Used a hat, mask, and sterile gown	92%
Used sterile gloves	100%
Sterile dressing applied	100%

Note that, for Johns Hopkins Hospital, bundle compliance cannot be higher than 62%, given the score obtained for hand washing. Aiming for a high level of compliance will improve outcomes and prevent infections.

Tips for Gathering Data

Implementing a central line insertion checklist at the time of insertion will help to ensure a reliable process. Nurses should be empowered to supervise the preparations using the checklist prior to line insertion and to stop the process if necessary. (See Appendix B for a sample checklist.)

Use a form that allows you to record your efforts and track your success. In addition to helping improvement teams create run charts each month, a contemporaneous record documenting line placement and site care can help with prompting early removal.

These strategies are particularly effective if used in conjunction with a Daily Goals assessment sheet. (See Appendix C for a sample.) This form can be completed during daily rounds on the patient. Many organizations implement the central line bundle in tandem with the VAP bundle to improve systematic care to patients in ICUs. (For information on the VAP bundle, see the Getting Started Kit for “Prevent Ventilator-Associated Pneumonia.”)

APPENDIX A: Definition of Terms

1. **Primary Central Line Associated Blood Stream Infection (CLA-BSI)** (CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting) [43] http://www.cdc.gov/ncidod/dhqp/pdf/NNIS/NosInfDefinitions.pdf

   - BSI is considered to be associated with a central line if the line was in use during the 48-hour period before development of the BSI. If the time interval between onset of infection and device use is >48 hours, there should be compelling evidence that the infection is related to the central line (CDC).

   - The major site of infection is a bloodstream infection and the specific site is either laboratory confirmed BSI or clinical sepsis. For example, a patient with leukemia with a vascular catheter has two positive blood cultures with coagulase-negative staphylococci. Even if there are clinical signs and symptoms of localized infection at the vascular access site, but no other infection can be found, the infection is considered a primary bloodstream infection. In addition, when a vascular access device is present and no other infection site is evident, then the BSI is considered a primary catheter associated BSI regardless of whether there are localized signs of infection at the vascular access site (JCAHO).

2. **Central Line:** A vascular access device that terminates at or close to the heart or one of the great vessels. Neither the location of the insertion site nor the type of device may be used solely to determine whether the line qualifies as a "central" line. Only if the location of the tip of the line meets the criteria above does the device qualify as a central line. This includes central venous catheter sheaths through which a transvenous pacing wire might be placed. (CDC: http://www.cdc.gov/mmwr/PDF/rr/rr5110.pdf and JCAHO)

- **For neonates,** an umbilical artery or umbilical vein catheter is considered a central line.

3. **Central Line Day:** Any day that a patient has a central line in place at the time the count is made. A patient with multiple central lines in a particular day should be counted as having only one central line day. Central line days should be counted in a consistent manner (e.g., at the same time each day). Central line days as the denominator include the total number of days of exposure to central lines by all patients in the selected population during the selected time period. (JCAHO)

4. **Great Vessels:** Superior vena and inferior vena cava, brachiocephalic veins, internal jugular veins, and subclavian veins (JCAHO). A catheter inserted into a femoral vein will be considered as located in a great vessel.

5. **Laboratory-Confirmed BSI:** Must meet at least one of the following criteria:
   Criterion 1: Patient has a recognized pathogen cultured from one or more blood cultures, and the pathogen cultured from the blood is not related to an infection at another site.
   Criterion 2: Patient has at least one of the following signs or symptoms: fever (>100.4°F [>38C°]), chills, or hypotension, and these positive findings are not related to an infection at another site, and at least one of the following:

   - Common skin contaminant [e.g., Corynebacterium sp. (formerly diphtheroids), Bacillus sp., Propionibacterium sp., coagulase-negative staphylococci, or micrococci] cultured from two or more blood cultures drawn on separate occasions.

   - Common skin contaminant [e.g. Corynebacterium sp. (formerly diphtheroids), Bacillus sp., Propionibacterium sp., coagulase-negative staphylococci, or micrococci] is cultured from at least one blood culture

from a patient with an intravascular line, and the physician institutes appropriate antimicrobial therapy.

- Positive antigen test on blood (e.g., H. influenzae, S. pneumoniae, N. meningitidis, or Group B streptococcus)

Blood cultures should be drawn if any of the following apply to the patient:

- Hypothermia or hyperthermia
- Increase or decrease WBC
- Other signs of sepsis including unexplained hypotension

6. **Secondary BSI:** A culture-confirmed bloodstream infection related to infection at another site. For example, a patient has pneumonia with Pseudomonas aeruginosa and grows the same pathogen in his blood cultures. The pneumonia is considered the primary infection site and the BSI is secondary to it. Another example is a leukemic patient who appears septic and the blood cultures grow E. coli. The patient has a vascular catheter and also has signs and symptoms of a urinary tract infection, but no urine culture is ordered. The patient's primary infection is a symptomatic UTI complicated by a secondary bloodstream infection. Secondary BSIs are not included in this measure (JCAHO).

7. **Localized Catheter Colonization:** Significant growth of a microorganism from the catheter tip, subcutaneous segment of the catheter, or catheter hub.

8. **Exit Site Infection:** Erythema or induration within 2 cm of the catheter exit site in the absence of concomitant bloodstream infection (BSI) and without concomitant purulence.

Comments: Please see CDC guidelines and JCAHO Core Measure ICU-4 for more specific information.

The rate of all CLA infections (including local infections and systemic infections) is difficult to determine. Although CLA-BSI is an ideal parameter because it represents the most serious form of catheter-associated infection, the rate of such infection depends on how CLA-BSI is defined.

Health-care professionals should recognize the difference between surveillance definitions and clinical definitions. The surveillance definition for catheter-associated BSI includes all BSIs that occur in patients with CVCs, when other sites of infection have been excluded. That is, the surveillance definition overestimates the true incidence of CLA-BSI because not all BSIs originate from a catheter. Some bacteremias are secondary BSIs from undocumented sources (e.g., postoperative surgical sites, intra-abdominal infections, and hospital-associated pneumonia or urinary tract infections). Thus, surveillance definitions are really definitions for central line-***associated*** BSIs.

A more rigorous definition might include only those BSIs for which other sources were excluded by careful examination of the patient record, and where a culture of the catheter tip demonstrated substantial colonies of an organism identical to those found in the bloodstream. Such a clinical definition would focus on CLA-BSI's. Therefore, to accurately compare a health-care facility's infection rate to published data, comparable definitions also should be used.

More important perhaps than the definition used for the advancement of this quality improvement work is ensuring the consistent application of the same definition over time in looking at a system's performance. It is our belief that the surveillance definition is likely easier to use in our respective clinical areas.

APPENDIX B: Technical Descriptions and Worksheets

1. CLA-BSI Rate per 1000 Central Line-Days – Technical Description

Intervention(s): Prevention of CLA-BSI

Definition: The number of CLA-BSI per 1000 central line days is the standard measure for surveillance by the CDC and JCAHO. (The specific surveillance criteria are outlined in the CDC Guideline - MMWR Aug. 9, 2002/51(RR 10) and JCAHO core measures.)

Goal: The rate of CLA-BSI will decrease by 50% in one year using the central line bundle. Once a hospital has gone more than 60 days between CLA-BSI, the goal is for 150 or more days between central line infections.

Matches Existing Measures:

- JCAHO ICU-4
- CDC guidelines

CALCULATION DETAILS:

Calculate as: Number of CLA-BSI / Number of central line-days [x 1,000] = CLA-BSI rate per 1000 central line days

Numerator Definition: Number of CLA-BSI's in ICU patients with a laboratory confirmed BSI who had central line in use anytime during the 48-hour period before development of the BSI. (Please see definitions of additional terms below.)

Numerator Exclusions:

- Secondary bloodstream infections, BSI present or incubating on admission to the ICU, localized catheter colonization, exit site infections

Denominator Definition: Number of central line-days, for patients who have a central line in place and are receiving care in intensive care units, by type of unit.

Denominator Exclusions:

- Patients in non-ICU areas
- Patients who do not have central lines in place while in the ICU

Measurement Period Length: Measure monthly.

COLLECTION STRATEGY:

Data Collection Approach: Report the monthly CLA-BSI rate for the last several months (preferably the last three to six months). This will serve as your baseline. Continue to track the measure monthly. If possible, track the rate in an annotated run chart, with notes reflecting any interventions you made to improve.

If your organization's infection control practitioner reports data quarterly, we recommend that you disaggregate the data and track by month. It is recommended that both the numerator and denominator data elements be collected concurrently.

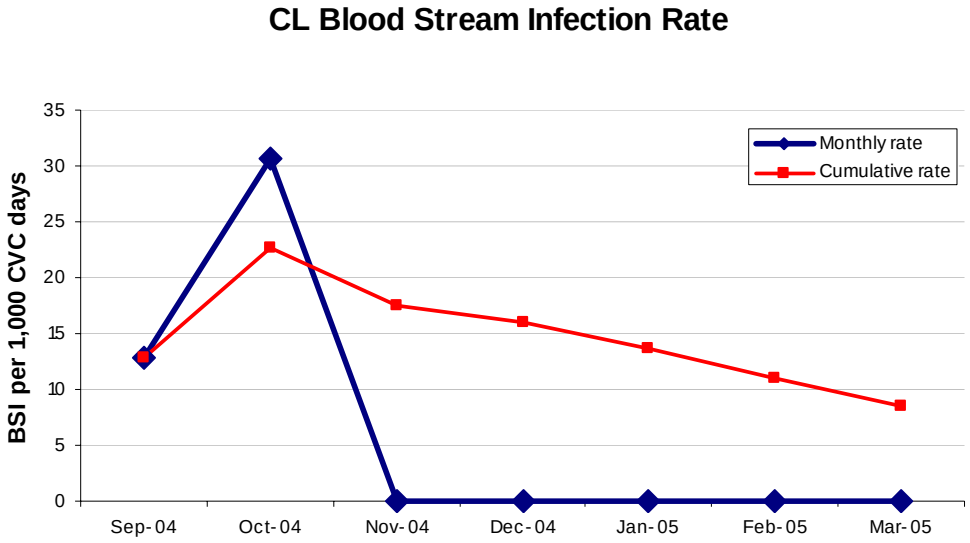
Data Accuracy: Data accuracy is enhanced when all definitions are used without modification and denominator data are collected in a consistent manner (e.g., at the same time each day). It is recommended that an infection control practitioner (ICP) collect the data for this measure, as some interpretation will be required. The patient is followed for evidence of infection for 48 hours after the removal of the central line, whether in the ICU or discharged from the ICU.

Hospitals may wish to implement periodic audits to monitor and ensure data accuracy.

Sampling: No sampling option available for this measure.

SAMPLE GRAPH:

Children's Hospital of Eastern Ontario, Ottawa, Ontario
(CLA-BSI Rate shown is rate per 1000 line days)



1.0 CLA-BSI Rate per 1000 Central Line-Days – Measurement Worksheet

Prevention of CLA-BSI	
Intervention:	Prevention of Central Line-Associated Primary Bloodstream Infections
Definition:	The number of CLA-BSIs per 1000 central line days is the standard measure for surveillance by the CDC and JCAHO. CLA-BSI occur in patients (in ICU or other units) with a laboratory confirmed BSI who had a central line in place within the 48-hour period before the development of the BSI, by unit of attribution.
Goal:	**Primary:** Decrease the rate of CLA-BSI by 50% in one year. **Secondary:** Once a hospital has gone more than 60 days between CLA-BSIs, the goal is for 150 or more days between CLA-BSIs.

Data Collection Details				
Hospital Name:			**Health Region:** ☐ NA or ***Specify Region:***	
Completed By:	**Name:**	**E-mail Address:**	**Phone Number:** ( ) -	**Date of Submission**
Year:	*Indicate the year for which the data was collected:* ☐ 2004 ☐ 2005 ☐ 2006 ☐ 2007 ☐ Other (specify):		**Collection Method:**	☐ Concurrent ☐ Retrospective
Month:	*Indicate the month for which the data was collected:* ☐ Jan. ☐ Feb. ☐ Mar. ☐ Apr. ☐ May ☐ June ☐ July ☐ Aug. ☐ Sept. ☐ Oct. ☐ Nov. ☐ Dec. .			
Implementation Stage:	☐ Baseline Stage *(Pre-intervention)*	☐ Early implementation stage *(Some team members in selected unit(s)have begun implementing CLI bundles)*	☐ Full implementation stage *(All team members on selected unit(s) are consistently implementing CLI bundles)*	
Patient Population: *1 worksheet/pop*	*Describe the source of the patient population e.g. Adult & Paediatric ICU, Intensive Care Unit,, Neuro ICU, Surgical ICU etc.*			
Additional Information	*Describe any other pertinent information here, including Team # if there is more than one CLI team in your hospital* **Team #:** ☐ **N/A**			

Calculation of Denominator		***Formula***	***Answer***	
1.1	What is the total number of patients this month who received care in selected units (ICU or other)?		**1.1** =	
1.2	What is the total number of patients in # **1.1** who did not have central lines in place while in the unit (ICU or other)? *Exclude from patient list for calculating Central Line Rate.*		**1.2** =	
1.3	Subtract the answer to # **1.2** from the answer to # **1.1** and enter here.	**(1.1 - 1.2 =)**	**1.3** =	
1.4	**OPTIONAL:** What is the total number of patients in # **1.3** whose age was less than 18 yrs on admission to the unit (ICU or other)? *Centres have the option to exclude from patient list for calculating CLA-BSI rate. To include pediatric patients in the sample, leave 1.4 blank. Pediatric only patient samples should indicate "pediatric only" in Patient Sample Box above.*		**1.4** =	
1.5	Subtract the total of # **1.4** from the total of # **1.3** and enter here. *This represents the final list of patients eligible for inclusion in the denominator*	**(1.3 - 1.4 =)**	**1.5** =	
1.6	What is the total number of central-line days for <u>all</u> patients in # **1.5**? *This represents the sum of central-line days for the month, to form the denominator*		**1.6** =	
Calculation of Numerator		***Formula***	***Answer***	
1.7	What is the total number of laboratory confirmed bloodstream infections developing after 48 hours of placement and within 48 hours of removal of the central line in patients in # **1.5**? *Count each ICU separately.*		**1.7** =	
Final Calculation		***Formula***	***Answer***	
1.8	Divide # **1.7** by #**1.6**. Multiply by 1000.	**(1.7 / 1.6) x 1000**	**1.8** =	

2. Central Line Insertion Bundle Compliance – Technical Description

Intervention(s): Prevention of CLA-BSI

Definition: The percentage of intensive care patients in the included ICUs with central lines for whom all elements of the **Central Line Insertion Bundle** are documented on the daily goals sheet and/or central line checklists or patient's medical record.

Goal: 95% of all patients with central lines in the included intensive care units receive all elements of a **Central Line Insertion Bundle**. Historically, this level of reliability has been achieved by building an infrastructure using central line insertion checklists, multi-disciplinary rounds, and daily goals.

CALCULATION DETAILS:

Numerator Definition: Number of intensive care patients with central line insertions for whom all elements of the central line insertion bundle are documented and in place. The **Central Line Insertion Bundle** elements are:

- Hand hygiene
- Maximal barrier precautions during insertion
- Chlorhexidine skin antisepsis

NOTE: These are "all or nothing" indicators. If any of the elements are not documented, do not count the patient in the numerator. If a bundle element is contraindicated for a particular patient and this is documented appropriately on the checklist, then the bundle can still be considered compliant with regards to that element.

Numerator Exclusions:

- Same as the denominator

Denominator Definition: Total number of intensive care patients who have had a new central line placed on the day of the week of the sample.

Denominator Exclusions:

- Patients outside the intensive care unit and patients whose lines were not placed in the intensive care unit

Measurement Period Length: Monthly

Definition of Terms: see Appendix A

- **Hand Hygiene:** Recommendations about hand hygiene are found in the CDC guidelines www.cdc.gov/mmwr/PDF/rr/rr5110.pdf
  - When caring for central venous catheters, wash hands or use an alcohol-based waterless hand cleaner:
  - Before and after palpating catheter insertion sites
  - Before and after inserting, replacing, accessing, repairing, or dressing and intravascular catheter
  - Palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained.
  - Wash hands if hands are obviously soiled or if contamination is suspected.
  - Wash hands or use an alcohol-based waterless hand cleaner between patients, after removing gloves and after using the bathroom.

- **Maximal barrier precautions during insertion:** Include all of the following:
  - For the Provider: Hand hygiene, non-sterile cap and mask, all hair under cap, mask covering nose and mouth tightly, and sterile gown and gloves
  - For the Patient: Cover patient's head and body with a large sterile drape

- **Chlorhexidine skin antisepsis:** Includes all of the following:
  - Prepare skin with antiseptic/detergent chlorhexidine 2% in 70% isopropyl alcohol by saturating the pad, pressing it against the skin, and applying chlorhexidine solution using a back-and-forth friction scrub for at least 30 seconds. Do not wipe or blot.
  - Allow antiseptic solution time to dry completely before puncturing the site (~ 2 minutes).

- **Optimal catheter site selection:** there are many factors to consider in any given patient when choosing the optimal site. (e.g., the potential for mechanical complications such as pneumothorax or hemorrhage, risk for subclavian vein stenosis, and catheter-operator skill) should be considered when deciding where to place the catheter.

Calculate as: Number of intensive care patients with central line insertions for whom all elements of the central line insertion bundle are documented and in place / Total number of intensive care patients with central line insertions on day of the week of the sample [x 100 to express as a percentage].

Comments: This measure is an assessment of how well the team is adhering to the central line insertion bundle. IHI's experience has been that teams begin to demonstrate improvement in outcomes when they get the process right more

frequently. Therefore, it is important to measure the compliance with the entire central line insertion bundle, not just parts of the bundle. Incorporating the elements of the central line insertion bundle into a central line insertion checklist and a daily goals form allows for easy review of bundle compliance during weekly survey. This also serves as a reminder during rounds to increase compliance with the bundle elements.

COLLECTION STRATEGY:

Use a central line insertion checklist, daily goal sheet, and/or medical record as data sources. Review for implementation of the central line insertion bundle.

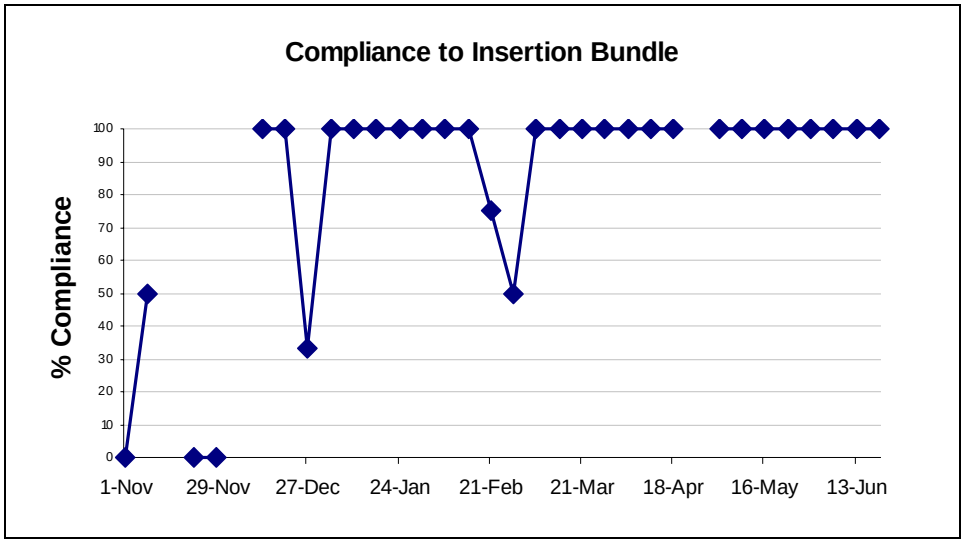
The sample should include all patients with central line insertions in the intensive care unit. Only patients with all aspects of a central line insertion bundle in place are recorded as being in compliance with a central line bundle.

Sampling Plan: Conduct the sample one day per week. This is a weekly compliance measure. Rotate the days of the week and the shifts. On the day of the sample, the medical records (including daily goals sheets and central line checklists) are examined for evidence of bundle compliance in all patients in the ICU for whom central lines were placed in the ICU. The central line checklist and daily goals sheet should be used to confirm compliance with the elements that are specific to the time of initial insertion.

If even one element is missing, the case is not in compliance with the bundle. For example, if there are 7 patients with central line insertions, and 6 have all four bundle elements completed, then 6/7 (86%) is the rate of compliance with the central line insertion bundle. If all 7 patients had all four elements completed, compliance would be 100%. If all 7 patients were missing even a single item, compliance would be 0%. This measure is always expressed as a percentage.

SAMPLE GRAPH:

Winnipeg Children's Hospital (Winnipeg, MB)



2.0 Central Line Insertion Bundle Compliance – Measurement Worksheet

Prevention of CLA-BSI	
Intervention:	Prevention of CLA-BSI
Definition:	The percentage of patients in the selected units (ICU or other) with central line insertions for whom all elements of the Central Line Insertion Bundle are documented on the daily goals sheet and/or central line checklists or patient's medical record.
Goal:	95% of all patients with central lines in the included intensive care units receive all elements of the Central Line Insertion Bundle.

Data Collection Details				
Hospital Name:			**Health Region:** ☐NA or ***Specify Region:***	
Completed by:	**Name:**	**E-mail Address:**	**Phone Number:** ( ) -	**Date of Submission:**
Year:	*Indicate the year for which the data was collected:* ☐ 2004 ☐ 2005 ☐ 2006 ☐ 2007 ☐ Other (specify):		**Collection Method:**	☐ Concurrent ☐ Retrospective
Month:	*Indicate the month for which the data was collected* ☐ Jan. ☐ Feb. ☐ Mar. ☐ Apr. ☐ May ☐ June ☐ July ☐ Aug. ☐ Sept. ☐ Oct. ☐ Nov. ☐ Dec.			
Implementation Stage:	☐ Baseline Stage *(Pre-intervention)*	☐ Early implementation stage *(Some team members in selected unit(s)have begun implementing CLI bundles*	☐ Full implementation stage *(All team members on selected consistently implementing CLI*	
Patient Sample: *1 worksheet/sample*	*Describe the source of the patient population e.g., Intensive Care Unit, Neuro ICU, Surgical ICU etc.*			
Additional Information:	*Describe any other pertinent information here, including Team # if there is more than one CLI team in your hospital*			
	Team #: ☐ **N/A**			

Calculation of Denominator for Each Weekly Sample		***Formula***	***Answer***	
2.1	What is the total number of patients on the day of the weekly sample who received care in the selected units (ICU or other)?		**2.1** =	
2.2	What is the total number of patients in # **2.1** whose age was less than 18 yrs on admission to the unit (ICU or other)? *Exclude from patient list for calculating Weekly Sample.*		**2.2** =	
2.3	Subtract the total of # **2.2** from the total of # **2.1** and enter here.	(**2.1** – **2.2**)	**2.3** =	
2.4	What is the total number of patients in # **2.3** who did not have a central line in place? *Exclude from patient list for calculating Weekly Sample.*		**2.4** =	
2.5	Subtract the total of # **2.4** from the total of # **2.3** and enter here.	(**2.3** – **2.4**)	**2.5** =	
2.6	What is the total number of patients in **2.5** who did not have their central line inserted on the day of the weekly sample?		**2.6** =	
2.7	Subtract the total of # **2.6** from the total of # **2.5** and enter here. *This represents the final list of patients eligible for inclusion in the Weekly Sample (see Technical Description for further details)*	(**2.5** – **2.6**)	**2.7** =	
Calculation of Denominator			***Answer***	
2.8	What is the total number of patients who were actually included in this monthly sample? (i.e. the sum of all weekly samples for the month)		**2.8** =	

Implementation of Bundle Components *(Indicate "Yes" or "No" for questions in this section)*			***Answer***
2.9	Did you implement Central Line Insertion Bundle Element #1 (***Hand hygiene)*** for this month's sample?		☐ Yes ☐ No
2.10	Did you implement Central Line Insertion Bundle Element #2 (***Maximal barrier precautions upon insertion)*** for this month's sample?		☐ Yes ☐ No
2.11	Did you implement Central Line Insertion Bundle Element #3 (***Chlorhexidine skin antisepsis)*** for this month's sample?		☐ Yes ☐ No
2.12	**OPTIONAL:** Did you implement Central Line Insertion Individual Bundle Element (Optimal catheter site selection, with subclavian vein as the preferred site for non-tunneled catheters in patients 18 years and older) for this month's sample?		☐ Yes ☐ No
Calculation of Numerator		***Formula***	***Answer***
2.13	What is the total number of patients in # **2.8** for whom **ALL** of the following elements which have been implemented in your healthcare facility were completed at the time of the survey? (Use Central Line Insertion Checklist) **Central Line Insertion (CLI) Bundle Elements:** 1) Hand hygiene 2) Maximal barrier precautions upon insertion 3) Chlorhexidine skin antisepsis 4) **DO NOT include in bundle calculation beginning May 2009** - Optimal catheter site selection, with subclavian vein as the preferred site for non-tunneled catheters in patients 18 years and older		**2.13** =
Final Calculation		***Formula***	***Answer***
2.14	Divide # **2.13** by #**2.8**. Multiply by 100.	(**2.13** / **2.8**) x 100	**2.14** = **%**

Calculation of Individual Components *(for Teams that are applying some components of the bundle)*				
2.15	What is the total number of patients in # **2.8** that were in compliance with Bundle Element #1 (Hand hygiene)?			
2.16	What is the total number of patients in # **2.8** that were in compliance with Bundle Element #2 (Maximal barrier precautions upon insertion)?			
2.17	What is the total number of patients in # **2.8** that were in compliance with Bundle Element #3 (Chlorhexidine skin antisepsis)?			
2.18	**OPTIONAL:** What is the total number of patients in # **2.8** that were in compliance with Optimal catheter site selection, with subclavian vein as the preferred site for non-tunneled catheters in patients 18 years and older?			
2.19	Compliance Calculation for Bundle Element #1 (Hand hygiene).	(**2.15** / **2.8**) x 100	**2.19=**	**%**
2.20	Compliance Calculation for Bundle Element #2 (Maximal barrier precautions upon insertion).	(**2.16** / **2.8**) x 100	**2.20=**	**%**
2.21	Compliance Calculation for Bundle Element #3 (Chlorhexidine skin antisepsis).	(**2.17** / **2.8**) x 100	**2.21=**	**%**
2.22	**OPTIONAL:** Compliance Calculation for Optimal catheter site selection, with subclavian vein as the preferred site for non-tunneled catheters in patients 18 years and older.	(**2.18** / **2.8**) x 100	**2.22=**	**%**

3. Central Line Maintenance Bundle Compliance – Technical Description

Intervention(s): Prevention of CLA-BSI

Definition: The percentage of intensive care patients in the included ICU's with central lines for whom all elements of the **Central Line Maintenance Bundle** are documented on the daily goals sheet or patient's medical record.

Goal: 95% of all patients with central lines in the included intensive care units receive all elements of the **Central Line Maintenance Bundle**. Historically, this level of reliability has been achieved by building an infrastructure using multi-disciplinary rounds and daily goals.

CALCULATION DETAILS:

Numerator Definition: Number of intensive care patients with central lines for whom all elements of the central line maintenance bundle are documented and in place. The **Central Line Maintenance Bundle** elements are:

- Accessing the lumens aseptically – scrubbing the hub
- Checking entry site for inflammation with every change of dressing
- Daily review of line necessity with prompt removal of unnecessary lines
- Dedicated lumen for Total Parenteral Nutrition (TPN) when possible

NOTE: These are "all or nothing" indicators. If any of the elements are not documented, do not count the patient in the numerator. If a bundle element is contraindicated for a particular patient and this is documented appropriately on the checklist, then the bundle can still be considered compliant with regards to that element.

Numerator Exclusions:

- Same as the denominator

Denominator Definition:

- Total number of intensive care patients with central lines on day of the week of the sample.

Denominator Exclusions:

- Patients outside the intensive care unit

Measurement Period Length:

- Monthly

Definition of Terms: see Appendix A

- **Accessing the lumens aseptically:** Providers should ensure lines are accessed aseptically by following hand washing guidelines and swabbing the port with a chlorhexidine antiseptic swab (for a description of these, see technical description for Central Line Insertion Bundle Compliance).

- **Checking entry site for inflammation with every change of dressing:** For patients with central lines, providers should check for inflammation when changing a dressing.

- **Daily review for necessity and prompt removal of unnecessary lines:** The ICU patient with a central line will be reviewed daily, with a notation on the daily goals sheet or medical record indicating the continued need for the central line. Routine replacement should be avoided, and all lines should be removed as early as possible

- **Dedicated lumen for Total Parenteral Nutrition (TPN):** A separate dedicated lumen should be provided for all patients receiving TPN. This approach has been shown to reduce the overall risk of infection.

Calculate as: Number of intensive care patients with central lines for whom all elements of the central line maintenance bundle are documented and in place / Total number of intensive care patients with central lines on day of the week of the sample [x 100 to express as a percentage].

Comments: This measure is an assessment of how well the team is adhering to the central line maintenance bundle. IHI's experience has been that teams begin to demonstrate improvement in outcomes when they get the process right more frequently. Therefore, it is important to measure the compliance with the entire central line maintenance bundle, not just parts of the bundle. Incorporating the elements of the central line maintenance bundle into a daily goals form, and reviewing lines daily during multidisciplinary rounds, allows for easy review of bundle compliance during weekly survey. This also serves as a reminder during rounds to increase compliance with the bundle elements.

COLLECTION STRATEGY:

Use a daily goal sheet and/or medical record as data sources. Review for implementation of the central line maintenance bundle.

The sample should include all patients with central lines in the intensive care unit. Only patients with all aspects of a central line maintenance bundle in place are recorded as being in compliance with the bundle.

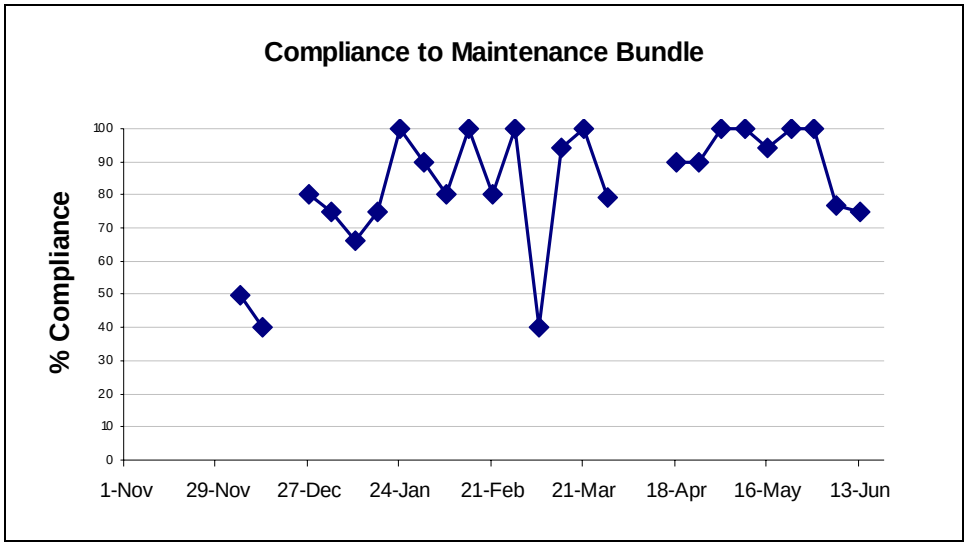
Sampling Plan: Conduct the sample one day per week. This is a weekly compliance measure. Rotate the days of the week and the shifts. On the day of the sample, the medical records (including daily goals sheets) are used to

confirm compliance with the four components of the bundle, for all patients in the ICU for whom central lines were in place. A patient who remains in the ICU with a central line for more than one week may be included in more than one weekly compliance measure, although the compliance with the initial maintenance bundle elements will remain the same.

If even one element is missing, the case is not in compliance with the bundle. For example, if there are 7 patients with central lines, and 6 have all four bundle elements completed, then 6/7 (86%) is the rate of compliance with the central line maintenance bundle. If all 7 patients had all four elements completed, compliance would be 100%. If all 7 patients were missing even a single item, compliance would be 0%. This measure is always expressed as a percentage.

SAMPLE GRAPH:

Winnipeg Children's Hospital (Winnipeg, MB)



3.0 Central Line Maintenance Bundle Compliance – Measurement Worksheet

Prevention of CLA-BSI	
Intervention:	Prevention of CLA-BSI
Definition:	The percentage of intensive care patients in selected units (ICU or other) with central lines for whom all elements of the Central Line Maintenance Bundle are documented on the daily goals sheet and/or central line checklists or patient's medical record.
Goal:	95% of all patients with central lines in the included intensive care units receive all elements of the Central Line Maintenance Bundle.

Data Collection Details				
Hospital Name:			**Health Region:** ☐ NA or ***Specify Region:***	
Completed by:	**Name:**	**E-mail Address:**	**Phone Number:** ( ) -	**Date of Submission:**
Year:	*Indicate the year for which the data was collected:* ☐ 2004 ☐ 2005 ☐ 2006 ☐ 2007 ☐ Other (specify):		**Collection Method:**	☐ Concurrent ☐ Retrospective
Month:	*Indicate the month for which the data was collected:* ☐ Jan. ☐ Feb. ☐ Mar. ☐ Apr. ☐ May ☐ June ☐ July ☐ Aug. ☐ Sept. ☐ Oct. ☐ Nov. ☐ Dec.			
Implementation Stage:	☐ Baseline Stage *(Pre-intervention)*	☐ Early implementation stage *(Some team members in selected unit(s)have begun implementing CLI bundles)*	☐ Full implementation stage *(All team members in selected unit(s) are consistently implementing CLI bundles)*	
Patient Sample: *1 worksheet/sample*	*Describe the source of the patient population e.g., Intensive Care Unit, Neuro ICU, Surgical ICU etc.*			
Additional Information:	*Describe any other pertinent information here, including Team # if there is more than one CLI team in your hospital*			
	Team #: ☐ **N/A**			

Calculation of Denominator for Each Weekly Sample		***Formula***	***Answer***	
3.1	What is the total number of patients on the day of the weekly sample who received care in the selected units (ICU or other)?		**3.1** =	
3.2	What is the total number of patients in # **3.1** whose age was less than 18 yrs on admission to the unit (ICU or other)? *Exclude from patient list for calculating Weekly Sample.*		**3.2** =	
3.3	Subtract the total of # **3.2** from the total of # **3.1** and enter here.	(**3.1** – **3.2**)	**3.3** =	
3.4	What is the total number of patients in # **3.3** who did not have a central line in place? *Exclude from patient list for calculating Weekly Sample.*		**3.4** =	
3.5	Subtract the total of # **3.4** from the total of # **3.3** and enter here.	(**3.3** – **3.4**)	**3.5** =	
3.6	What is the total number of patients in **3.5** who did not have their central line inserted on the day of the weekly sample?		**3.6** =	
3.7	Subtract the total of # **3.6** from the total of # **3.5** and enter here. *This represents the final list of patients eligible for inclusion in the Weekly Sample (see Technical Description for further details).*		**3.7** =	

Calculation of Denominator		***Formula***	***Answer***	
3.8	What is the total number of patients who were actually included in this monthly sample? (i.e. the sum of all weekly samples for the month)		**3.8** =	

Implementation of Bundle Components *(Indicate "Yes" or "No" for questions in this section)*			***Answer***
3.9	Did you implement Central Line Maintenance Bundle Element #1 (***Daily review of line necessity with prompt removal of unnecessary lines)*** for this month's sample?		☐ Yes ☐ No
3.10	Did you implement Central Line Maintenance Bundle Element #2 (***Dedicated lumen for Total Parenteral Nutrition (TPN)***) for this month's sample?		☐ Yes ☐ No

3.11	Did you implement Central Line Maintenance Bundle Element #3 (***Accessing the lumens aseptically)*** for this month's sample?		☐ Yes ☐ No
3.12	Did you implement Central Line Maintenance Bundle Element #4 (***Checking entry site for inflammation with every change of dressing)*** for this month's sample?		☐ Yes ☐ No
Calculation of Numerator		***Formula***	***Answer***
3.13	What is the total number of patients in # **3.8** for whom **ALL** of the following elements which have been implemented in your healthcare facility were completed at the time of the survey? (Use Daily Goals/checklists/medical records) **Central Line Maintenance (CLI) Bundle Elements:** 1) Daily review of line necessity with prompt removal of unnecessary lines 2) Dedicated lumen for Total Parenteral Nutrition (TPN) 3) Accessing the lumens aseptically 4) Checking entry site for inflammation with every change of dressing		**3.13** =
Final Calculation		***Formula***	***Answer***
3.14	Divide # **3.13** by #**3.8**. Multiply by 100.	(**3.13** / **3.8**) x 100	**3.14** = **%**
Calculation of Individual Components ***(for Teams that are applying some components of the bundle)***			
3.15	What is the total number of patients in # **3.8** that were in compliance with Bundle Element #1 (Daily review of line necessity with prompt removal of unnecessary lines)?		**3.15=**
3.16	What is the total number of patients on TPN in # **3.8** that were in compliance with Bundle Element #2 (Dedicated lumen for Total Parenteral Nutrition (TPN))?		**3.16=**
3.17	What is the total number of patients in # **3.8** that were in compliance with Bundle Element #3 (Accessing the lumens aseptically)?		**3.17=**
3.18	What is the total number of patients in # **3.8** that were in compliance with Bundle Element #4 (Checking entry site for inflammation with every change of dressing)?		**3.18=**
3.19	Compliance Calculation for Bundle Element #1 (Daily review of line necessity with prompt removal of unnecessary lines).	(**3.15** / **3.8**) x 100	**3.19=** **%**
3.20	Compliance Calculation for Bundle Element #2 (Dedicated lumen for Total Parenteral Nutrition (TPN)).	(**3.16** / **3.8**) x 100	**3.20=** **%**
3.21	Compliance Calculation for Bundle Element #3 (Accessing the lumens aseptically).	(**3.17** / **3.8**) x 100	**3.21=** **%**
3.22	Compliance Calculation for Bundle Element #4 (Checking entry site for inflammation with every change of dressing).	(**3.18** / **3.8**) x 100	**3.22=** **%**

APPENDIX C: Sample Central Line Insertion Checklist

BC CHILDREN'S HOSPITAL ICU/TCU VASCULAR ACCESS DEVICE INSERTION CHECKLIST

Patient Addressograph

Purpose:	To work as a team to decrease patient harm from catheter-related bloodstream infections
When:	During all central venous line, central line re-wire or PIC insertions
By whom:	Bedside nurse

1. Today's date: _____/_____/_____
Month Day Year

2. Procedure: ❒ PIC line ❒ New central line ❒ Line rewire

3. Is the procedure: ❒ Elective ❒ Urgent

	Before the procedure, did the physician:	Yes	No	Don't Know
	Remove jewellery?	❒	❒	❒
	Apply eye protection?	❒	❒	❒
	Wash hands using 2% chlorhexidine soap (pump soap at sinks in ICU/TCU)	❒	❒	❒
	Use hat, mask and sterile gown?	❒	❒	❒
	Use sterile gloves?	❒	❒	❒
	Disinfect procedure site using 2% chlorhexidine with 70% alcohol.	❒	❒	❒
	Drape entire patient in a sterile fashion.	❒	❒	❒
5.	Did the physician maintain a sterile field during the procedure?	❒	❒	❒
6.	Was a sterile dressing applied to the site?	❒	❒	❒
7.	Was the procedure documented in the chart?	❒	❒	❒
8.	Was the procedure aborted and restarted for break in technique?	❒	❒	❒
9.	Was ultrasound used to visualize the vessel?	❒	❒	❒

10. How many line attempts were made? _____

11. Line site (e.g., R fem vein) _____

PLEASE RETURN COMPLETED SHEET TO CVC BINDER ON LINE CART

[For information purposes only.]

APPENDIX D: Sample Daily Goals Template

ICU Daily Goals

Patient Name _____

Room Number _____ Date____/____/_____

---Initial as goals are reviewed ----

GOAL	NOTES	0700 - 1500	1500 - 2300	2300 - 0700
What needs to be done for the patient to be discharged from the ICU?				
What is this patient's greatest safety risk?				
Central line insertion bundle				
• Hand hygiene				
• Maximal barrier precautions				
• Chlorhexidine skin antisepsis				
• Optimal catheter site selection				
Central line maintenance bundle				
• Daily review of line necessity				
• Dedicated lumen for TPN				
• Accessing the lumens aseptically				
• Checking entry site for inflammation				
Cardiac Rhythm, Hemodynamics				
Volume Status, net goal for next 8 - 12 hrs				
Neuro: Pain Mgt/Sedation				
GI: Nutrition /Bowel Regimen				
Mobilization / Out of Bed / Stroll				
ID: Cultures, Drug levels				
Medication changes (can any be stopped?)				
Tests/Procedures				
Review scheduled labs. Can any be D/C?				

Morning labs, CXR				
Any catheters/tubes be D/C?				
Skin Care Addressed?				
Consultations				
Referring Physician updated?				
Family Updated?				
Social issues to address?				
Emotional/spiritual issues?				
Code Status Addressed?				
Advanced Directive in place?				
Parameters for calling MD				

*Adapted from the Johns Hopkins University Quality & Safety Research Group Tool Kit

[For information purposes only.]

APPENDIX E: Tips and Tricks

Tips and Tricks: Central Line Infection

Many hospitals across Canada and the US have been working to reduce Central Line Infections. Here are some of the "tips and tricks" for successful testing and implementing of each intervention.

- ***Customize the program***.

Making this initiative fit into the patterns and habits at your institution is essential. Teams will be most effective if they engage doctors, nurses, and other staff to work with them to develop key aspects of implementation. For example, it is critical that teams make the review of daily necessity a part of the daily goal sheets. In order to know if a line is truly necessary, the best-performing teams will develop their own standard criteria and work to apply this routinely to all cases in their institution. Once this has been established, all stakeholders will share a common understanding of exactly when a line is truly necessary or simply a convenience. Similar arrangements and customizations can be made for other aspects of the bundle, such as criteria for optimal site selection.

- ***Measure, but do not become pre-occupied with measurement***.

Working on preventing central line infections (or any clinical performance program) requires measurement, but measurement should not become the pre-occupation of the teams engaging in the work. While feedback on performance and compliance may drive further efforts forward, if teams become too focused on measurement details it can hinder the overall program. It is best to design rules that assist your team in making your plans work; for example, assign credit for completion of bundle elements in cases where your team has determined there are true contraindications to bundle elements. Undue attention to unusual cases or special circumstances will impede success. Plan for the majority.

- ***Decide early about the method of data collection you will use***.

Some teams have preferred to use a sampling approach to assess compliance with the central line bundle; for example, some teams use spot checks of compliance three times per week, whereas other teams have chosen daily assessments of compliance at designated times. Regardless of the method, be sure to maintain the standard over time for accurate results.

- ***Emphasize compliance with all elements of the bundle***.

Approach this work with the knowledge that "picking and choosing" bundle elements will not work. Discourage the tendency to select interventions that seem easy at the expense of more difficult options also included in the bundle. Your aim is 100% compliance with every bundle element for every patient – partial compliance is the equivalent of non-compliance.

- ***Post updates to results regularly and prominently***.

Enthusiasm for the project will wane over time if clinical staff perceive that the leadership's enthusiasm has diminished. It is essential to update all involved staff on the work on the monthly level of compliance and the monthly change in central line infection rates. Not only will this show dedication to the project, but when momentum becomes apparent, clinical staff will be aware of the progress.

- ***Apply the bundle elements in a way that makes sense.***

The goal of the bundle is not to force a clinician to do anything that may be clinically inappropriate or cause harm in a unique situation. The elements apply to most patients, but there will always be exceptions. Deal with these in a way that makes sense. For example, if a patient is claustrophobic and panics about being under drapes, then modify the placement of drapes so that the patient is at ease and the site is protected; it's not beneficial to the patient to induce a panic attack. When exceptional situations arise, the key is for the team to discuss the elements, devise a sensible plan, and document it accordingly. Give credit for meeting the bundle element in such cases.

APPENDIX F: Frequently Asked Questions

Frequently Asked Questions: Central Line Infection

Can I implement most of the central line bundle but exclude some items?

While this is possible, it is not recommended. In fact, the goal of bundling therapies together aims to create a linkage between practices that makes the overall process more effective. Certainly, in terms of monitoring compliance with the ventilator bundle, "picking and choosing" items would be unwise.

The definition of a primary central line infection is confusing. What is the standard definition?

The definition used in the rate measure is well described in the Technical Description and Measurement Worksheets included in this document. The key to the numerator is to track *primary catheter-associated bloodstream infections*. Bloodstream infections are considered to be associated with a central catheter if the line was in use during the 48-hour period before development of the bloodstream infection. These catheter-associated bloodstream infections must be *either* laboratory confirmed *or* the patient must meet criteria for clinical sepsis. Clinical sepsis can be defined as a site of suspected infection and two or more generalized signs and symptoms of infection (formerly known as SIRS criteria). Clinical sepsis can be distinguished from the syndrome "severe sepsis," which adds organ dysfunction, such as hypotension or onset of renal failure. In general, the threshold to establish clinical sepsis is lower than that for severe sepsis.

For more specific definitions of clinical sepsis, see: Levy MM, Fink MP, Marshall JC, Abraham E, Angus D, Cook D, Cohen J, Opal SM, Vincent JL, Ramsay G;. SCCM/ESICM/ACCP/ATS/SIS. 2001 SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference. *Crit Care Med*. 2003 Apr; 31(4):1250-1256.

What is a central line?

Typically, most experts and improvement teams have relied upon the definitions provided by the National Nosocomial Infections Surveillance System (NNIS) devised by the Centers for Disease Control (CDC). This program has been replaced recently by a new initiative, the National Healthcare Safety Network (NHSN). NHSN has defined a central line as a catheter whose tip terminates in a great vessel. The great vessels include the aorta, pulmonary artery, superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac veins, and common femoral veins. Neither the type of line alone nor the site of insertion can determine if a line is a central line. If the line terminates in a great vessel, it is a central line.

Are femoral lines central lines? Are they included in the bundle?

Yes. Femoral lines qualify as central lines because they terminate in a great vessel as defined by NHSN. Their placement should be guided by the parameters of the central line bundle. See above.

Are PICC lines central lines? Are they included in the bundle?

Yes. Peripherally inserted central catheters (PICC) lines terminate in a great vessel. Because neither the site of insertion nor the type of line alone can determine whether a catheter is a central line, the peripheral site of insertion does not exempt the line from the central line bundle.

Why are subclavian lines preferred over PICC lines if the standard Is lowest infection risk?

Data is still lacking on infection rates for PICC lines in acute care settings as opposed to chronic or home care settings. The most recent evidence suggests that infection rates rival those of subclavian or internal jugular catheters placed in the acute care setting. No head-to-head comparison has yet been done to make a definitive conclusion. In addition, PICCs are more vulnerable to thrombosis and dislodgment, and are less useful for drawing blood specimens. Moreover, PICCs are not advisable in patients with renal failure and impending need for dialysis, in whom preservation of upper-extremity veins is needed for fistula or graft implantation given a possibly greater risk of subclavian vein stenosis.

Safdar N, Maki DG. Risk of catheter-related bloodstream infection with peripherally inserted central venous catheters used in hospitalized patients. *Chest*. 2005 Aug;128(2):489-495.

Gonsalves CF, Eschelman DJ, Sullivan KL, DuBois N, Bonn J. Incidence of central vein stenosis and occlusion following upper extremity PICC and port placement. *Cardiovasc Intervent Radiol*. 2003 Mar-Apr;26(2):123-127. Epub 2003 Mar 6.

Does everyone in the room need to gown and glove when a central line is placed, or just the nurse assisting the procedure directly and dropping items onto the sterile field?

The best advice is that the placement of a central line should be considered analogous to a surgical procedure. In the operating room, anyone who comes into contact with the sterile field wears maximal barrier precautions. This includes any assistants in direct contact with the field and most certainly the scrub nurse directly assisting in the procedure. To that end, any assistant in direct contact with or dropping items onto the field should be similarly gowned, gloved, etc., as in a surgical situation.

Why is a full-size drape essential for maximal barrier precautions?

Studies that demonstrate the effectiveness of maximal barrier precautions have employed a full-size drape. These studies show dramatic reductions in risk when maximal barrier precautions are used. It is not possible to clearly parse out the effect of a full-size drape from these trials versus the other components of maximal barrier precautions such as gowns, gloves, eyewear, etc. In the absence of such information and given striking results of interventions that include a full-size drape, not using the larger drape could only add an unnecessary element of risk to an otherwise simple procedure. Using the analogy to surgery as cited immediately above, it would be unimaginable for a patient to undergo any surgical procedure in the operating room without a full-size drape in place.

I read that the central line bundle as written is designed to apply only to patients in the ICU. I want to include patients in the emergency room and the PACU. Why do you advise to use the bundle only in the ICU?

The reason for recommending application of the central line bundle first in the ICU has more to do with improvement methods and less to do with the utility of the intervention. It was originally tested with ICU teams working to improve teamwork and communication for improved outcomes. It was hoped that by starting in the ICU hospitals would become expert in application of the bundle in one location, develop the skill and manpower to translate the practice to other areas of the hospital, and ultimately do so. In general, it is recommended to start small and spread changes to larger domains over time. There is no reason not to apply the central line bundle in all areas that central lines are placed and where you can gain the cooperation of staff. However, it may be wiser to perfect the practice in one location than to launch an overly broad initiative that might fail before it begins. Be sure to check for guidelines from clinical expert panels related to other locations before spreading.

How can you compare central line infection rates between institutions?

The practice of comparing rates of disease entities or patterns of therapy across institutions is commonly known as "benchmarking." Benchmarking, while presently utilized by many oversight agencies to track performance, may not be a valid method to compare performance between facilities because of differences in patient population, resource availability, or severity of illness.

Fortunately, none of the work required to *improve* the care of patients receiving central lines requires a comparison of rates between institutions. As long as you establish methods in your institution to determine the patterns and methods of your regular data collection, your results will be consistent over time with respect to your own performance and your own improvement, which is our primary interest. Presumably, any improvements you make would be reflected in any benchmarking work that you do for other agencies.

Remember to benchmark based on improvement, rather than just by comparing rates. If you learn of a hospital that has significantly improved, based on data and using the same measure over time, then learn from their work! Even if they are using a different definition from your hospital or treat some different populations, there will still be value in finding out what practices and changes they used to achieve their results.

What are the inclusion and exclusion criteria for application of the central line bundle? For the individual bundle elements?

No specific exclusion criteria exist, but good clinical judgment should be exercised in conjunction with a close reading of the evidence cited in the How-to Guide. Likewise, no specific inclusion criteria are available. Instead, teams interested in improving their performance should develop these standards in conjunction with their clinical staff and apply them uniformly over time. In so doing, teams will have an accurate standard whereby they can measure their own progress in comparison to the only standard that is truly meaningful: their own data.

As an example, some institutions have decided that the central line bundle cannot be applied in emergent settings such as the ER. Accordingly, they have created policies and procedures to re-site those lines if a patient is subsequently admitted to a critical care unit. Policies such as this are best left to the discretion of the individual institutions.

Workable inclusion criteria, exclusion criteria, measurement systems, and protocols all require customization at the local level to be effective. The only key factor in all of these decisions is that the standards, once decided, are adhered to over time.

[1] Mermel LA. Prevention of intravascular catheter-related infections. *Ann Intern Med*. 2000;132(5):391-402.

[2] Soufir L, Timsit JF, Mahe C, Carlet J, Regnier B, Chevret S. Attributable morbidity and mortality of catheter-related septicemia in critically ill patients: a matched, risk-adjusted, cohort study. *Infect Control Hosp Epidemiol*. 1999;20(6):396-401.

[3] Elward AM, Hollenbeak CS, Warren DK, and Fraser VJ. Attributable cost of nosocomial primary bloodstream infection in pediatric intensive care unit patients. *Pediatrics* 2005;*115*;868-872. http://www.pediatrics.org/cgi/content/full/115/4/868

[4] Dominguez, Troy E.; Chalom, Rene; Costarino, Andrew T. Jr. *Crit Care Med* 2001;29:169-74 www.cdc.gov/mmwr/PDF/rr/rr5110.pdf

[5] Berenholtz SM et al. Eliminating catheter-related bloodstream infections in the intensive care unit. CCM 2004; 32: 2014-2020.

[6] McKee C et al. Reduction of catheter-associated bloodstream infections in pediatric patients: Experimentation and reality. PCCM 2008; 9: 40-46.

[7] Bonello RS, Fletcher CE, Becker WK, et al. An intensive care unit quality improvement collaborative in nine Department of Veterans Affairs hospitals: reducing ventilator-associated pneumonia and catheter-related bloodstream infection rates. Joint Commission Journal on Quality and Patient Safety. 2008; 34 (11): 639-645.

[8] Berenholtz SM, Pronovost PJ, Lipset PA, et al. Eliminating catheter-related bloodstream infection in the intensive care unit. *Critical Care Medicine*. 2004;*32*:2014-2020.

[9] McKee C et al. Reduction of catheter-associated bloodstream infections in pediatric patients: Experimentation and reality. *PCCM* 2008; 9:40-46

[10] Mermel LA, McCormick RD, Springman SR, Maki DG. The pathogenesis and epidemiology of catheter-related infection with pulmonary artery Swan-Ganz catheters: a prospective study utilizing molecular subtyping*. Am J Med.* Sep 16 1991;91(3B):197S-205S.

[11] Raad, II, Hohn DC, Gilbreath BJ, et al. Prevention of central venous catheter-related infections by using maximal sterile barrier precautions during insertion. *Infect Control Hosp Epidemiol*. 1994;*15*(4 Pt 1):231-238.

[12] Eggimann P and Pittet D*,* Infection Control in the ICU, *Chest* 2001; 120:2059–2093.

[13] McArdle FI et al, How much time is needed for hand hygiene in intensive care? A prospective trained observer study of rates of contact between healthcare workers and intensive care patients. *J Hosp Infect* 2006; 62(3); 304-310.

[14] Hugonnet S, Perneger TV and Pittet D. Alcohol-based handrub improves compliance with hand hygiene in intensive care units. *Arch Intern Med* 2002; 162 (9): 1037-1043.

[15] Chaiyakunapruk N; Veenstra DL; Lipsky BA; and Saint Sanjay, Chlorhexidine compared with povidone-iodine solution for vascular catheter–site care: A meta-analysis. *Ann Intern Med*. 2002;*136*:792-801.

[16] Maki DG, Ringer M, Alvarado CJ. Prospective randomised trial of povidone-iodine, alcohol, and chlorhexidine for prevention of infection associated with central venous and arterial catheters. *Lancet.* 1991;338(8763):339-343

[17] Mimoz O et al. Chlorhexidine-based antiseptic solution vs. alcohol-based povidine-iodine for central venous catheter care. Arch In tern Med 2007;167:2066-72

[18] Mermel LA, McCormick RD, Springman SR, Maki DG. The pathogenesis and epidemiology of catheter-related infection with pulmonary artery Swan-Ganz catheters: a prospective study utilizing molecular subtyping*. Am J Med.* Sep 16 1991;91(3B):197S-205S.

[19]McCarthy MC, Shives JK, Robison RJ, Broadie TA. Prospective evaluation of single and triple lumen catheters in total parenteral nutrition. *J Parenter Enteral Nutr.* 1987 May-Jun;11(3):259-262.

[20] Richet H, Hubert B, Nitemberg G, et al. Prospective multicenter study of vascular-catheter-related complications and risk factors for positive central-catheter cultures in intensive care unit patients. *J Clin Microbiol*. 1990; 28:2520.

[21] Collignon P, Soni N, Pearson I, et al. Sepsis associated with central vein catheters in critically ill patients. *Intensive Care Med*. 1988;14: 227.

[22] Merrer J, Jonghe BD, Golliot F, et al. Complications of femoral and subclavian venous catheterization in critically ill patients. A randomized controlled trial. JAMA. 2001;286:700.

[23] Deshpande KS, Hatem C, Ulrich HL, 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*. 2005;33:13.

[24] Parienti J-J et al. Femoral vs jugular venous catheterization and risk of nosocomial events in adults requiring acute renal replacement therapy. A randomized controlled trial. JAMA 2008;299:2413-2422

[25] Newman CD. Catheter-related bloodstream infections in the pediatric intensive care unit. Semin Pediatr Infect Dis. 2006 Jan;17(1):20-4. Review

[26] de Jonge RC, Polderman KH, Gemke RJ. Central venous catheter use in the pediatric patient: mechanical and infectious complications. Pediatr Crit Care Med. 2005 May;6(3):329-39. Review.

[27] Mirtallo J, Canada T, Johnson D, Kumpf V, Petersen C, Sacks G, Seres D, Guenter P, Task Force for the Revision of Safe Practices for Parenteral Nutrition. Parenteral nutrition administration. In: Safe practices for parenteral nutrition. JPEN J Parenter Enteral Nutr 2004 Nov-Dec;28(6):S65-70.

[28] Walder B et al. Prevention of bloodstream infection with central venous catheters treated with anti-infective agents depends on catheter type and insertion time: evidence from a meta-analysis. Infection Control and Epidemiology. 2002;23:748-756

[29] Making Health Care Safer: A Critical Analysis of Patient Safety Practices. Evidence Report/Technology Assessment: Number 43. AHRQ Publication No. 01-E058, July 2001. Agency for Healthcare Research and Quality, Rockville, MD

[30] Guidance on the use of ultrasound locating devices for placing central venous catheters. National Institute for Clinical Excellence September 2002.

[31] Bodenham R. Ultrasound imaging by anaesthetists: training and accreditation issues. British Journal of Anaesthesia 2006;96 (4): 414–17

[32] Hosokawa, Koji et al. A Randomized Trial of Ultrasound Image–based Skin Surface Marking versus Real-time Ultrasound-guided Internal Jugular Vein Catheterization in Infants. Anesthesiology, V 107, No 5, Nov 2007

[33] Lamperti M et al. An outcome study on complications using routine ultrasound assistance for internal jugular vein cannulation. *Acta Anaesthesiol Scand* 2007; 51: 1327–1330

[34] Eggimann P. Prevention of intravascular catheter infection. *Curr Opin Infect Dis* 2007;20:360–369

[35] O'Grady NP, Alexander M, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter-related infections. Centers for Disease Control and Prevention. Am J Infect Control 2008;36:309-32 http://www.cdc.gov/mmwr/PDF/RR/RR5110.pdf

[36] Cook D, Randolph A, Kernerman P et al. Central venous catheter replacement strategies: a systematic review of the literature. *Crit Care Med* 1997;*25*:1417-24.

[37] Mirtallo J, Canada T, Johnson D, Kumpf V, Petersen C, Sacks G, Seres D, Guenter P, Task Force for the Revision of Safe Practices for Parenteral Nutrition. Parenteral nutrition administration. In: Safe practices for parenteral nutrition. *JPEN J Parenter Enteral Nutr* 2004 Nov-Dec;28(6):S65-70.

[38] Snydman DR, Murray SA, Kornfeld SJ, Majka JA, Ellis CA. Total parental nutrition-related infections: prospective epidemiologic study using semi-quantitative methods. *Am J Med* 1982;73:695-9

[39] Ho KM, Litton E. Use of chlorhexidine-impregnated dressing to prevent vascular and epidural catheter colonization and infection: a meta-analysis. Journal of Antimicrobial Chemotherapy 2006 58(2):281-287

[40] Lok, CE; Stanley, KE, Hux, JE, Richardson, R, Tobe, SW, and Conly, J. Hemodialysis Infection Prevention with Polysporin Ointment. J Am Soc Nephrol 13: 169–179, 2003.

[41] Pronovost P, Needham D, Berenholtz S et al, An Intervention to Decrease Catheter-Related Bloodstream Infections in the ICU. N Engl J Med 2006;355:2725-32.

[42] Berenholtz S, Pronovost P, Lipsett P et al. Eliminating catheter-related bloodstream infections in the intensive care unit. Crit Care Med 2004; 32: 2014–2020.

[43] Horan, TC, Andrus, M, Dudeck, MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008;36:309-32.