Actionable Patient Safety Solutions (APSS) #2F:
Central line-associated blood-stream infections (CLABSI)

How to use this guide
This guide gives actions and resources for creating and sustaining safe practices for CLABSI. In it, you'll find:

Patient Safety
MOVEMENT

Executive summary checklist

Central line-associated bloodstream infections (CLABSI) are a source of serious harm and death in hospitalized patients. A CLABSI is a serious infection that occurs when germs—usually bacteria or viruses—enter the bloodstream through the central line (CDC, 2016).

Use this checklist to help you prioritize your actions and measure your organization's progress in each area. Prevention of CLABSIs requires the following actions.

Create an action plan

- ☐ Implement evidence-based guidelines to prevent the occurrence of CLABSIs, including:
    - ☐ Insertion
    - ☐ Maintenance
    - ☐ Standardized access procedures

*If implementing guidelines for all 3 processes simultaneously is not feasible, prioritize interventions based on your institution's experience.

Ensure best patient care

- ☐ During insertion of a central catheter, doctors should always:
    - ☐ Perform a "time-out"
    - ☐ Perform hand hygiene procedures, either by washing hands with conventional soap and water or with alcohol-based hand rubs (ABHR).
    - ☐ Prepare clean skin with a >0.5% chlorhexidine preparation with alcohol before central venous catheter and peripheral arterial catheter insertion and during dressing changes. If there is a contraindication to chlorhexidine, tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives.
    - ☐ Place sterile drapes over the entire patient and wear a sterile mask, hat, gown, and gloves
    - ☐ Put a sterile dressing over the catheter site after the insertion
- ☐ Standardize a central-line kit based on the needs of your facility, and implement technology that will have a significant return on investment (ROI)
- ☐ Minimize blood sample draws from central access catheters

Engage staff and use data to find areas for improvement

- ☐ Develop a standardized educational plan for doctors and nurses to cover key curriculum about the insertion and maintenance of central lines
- ☐ Encourage continuous process improvement through the implementation of quality process measures and metrics
- ☐ Complete a root cause analysis (RCA) or multidisciplinary review when CLABSIs are identified in the unit where the infection occurred using a multidisciplinary approach including nurses, doctors, and infection prevention professionals.
- ☐ Implement—and share—all learnings from the RCA
- ☐ Use patient stories - written & in video - to help teach and inspire change in your staff

What we know about CLABSI

There are more than 700,000 healthcare-associated infections (HAIs) each year in the U.S. resulting in 99,000 deaths and $28-$45 billion in extra health care costs (Klevens *et al*., 2007) (Scott, 2009). Researchers estimate that up to 41,000 patients in US hospitals acquire central line-associated infections each year (O'Grady *et al*., 2011).

Researchers think CLABSIs occur due to (Mermel et al., 1991; Kallen, et al., 2009, Haddadin et al., 2019):

- Heavy bacterial colonization at the insertion site
- "Non tunneled" catheter is placed in the arm or leg rather than placement in the chest
- Catheterization lasts longer than 3 days
- Catheter insertion with less stringent barrier precautions significantly increase the risk of a catheter-related infection
- The presence of multiple lumens may increase opportunity for infection
- Host factors including complex, chronic illness, immunocompromised state, prolonged hospitalization

The problems with the standard treatment

While intensive care unit (ICU) patients have the highest chance of acquiring CLABSIs, central venous catheters are becoming increasingly used outside the ICU, exposing more patients to the risk. In fact, recent data suggest that the greatest numbers of patients with central lines are in hospital units outside the ICU , most notably dialysis units (Vonberg et al., 2006; Kallen et al., 2009). . While central line use is increasing outside the ICU, since 2008 the Centers for Medicare and Medicaid Services (CMS) has implemented a policy of reduced reimbursement for reasonably preventable hospital-acquired conditions, including CLABSIs. This policy change can represent a significant financial burden to a hospital because increased hospital costs due to CLABSIs can be more than $48,000 per case (AHRQ, 2016).

Preventing CLABSIs

CLABSIs and other HAIs, however, are mostly preventable. Interventions that focus on reducing CLABSIs have resulted in reductions ranging from 38% to 80% (Pronovost, et. al., 2006; Drews, et al., 2019). . In one study, researchers observed a 66% decrease in CLABSIs after implementing a multi-component intervention in the ICUs of 67 Michigan hospitals (Pronovost et al., 2006). In another study conducted across 32 hospitals in Pennsylvania, CLABSIs decreased by 68%, following targeted interventions between April 2001 and March 2005 (CDC, 2005). Other studies have shown similar reductions in CLABSIs, saving lives and dramatically reducing costs (Rosenthal et al., 2012; Hong et al., 2013; Gozu et al., 2011).

A variety of guidelines and recommendations have been identified to prevent CLABSIs including those published by:

- The Healthcare Infection Control Practices Advisory Committee (O'Grady *et al*., 2017)
- The Institute for Healthcare Improvement (IHI, n.d.)
- The Agency for Healthcare Research and Quality (AHRQ, 2014)

These recommendations share the following components to reduce and prevent CLABSIs:

- Implementing a method to detect the true incidence of CLABSI, such as information technology to collect and calculate catheter days

- Providing adequate infrastructure for the intervention including an adequately staffed infection prevention and control program, and adequate laboratory support for timely processing of samples
- Implementing a catheter insertion and maintenance checklists
- Monitoring the continued need for intravascular access on a daily basis and prompt removal when the catheter is no longer needed
- Measuring unit-specific occurrence of CLABSIs as part of performance evaluations

Researchers estimate that the use of process change and the use of technology to reduce CLABSI can save up to $2.7 billion per year while significantly improving quality and safety (Scott, 2009). Closing the performance gap will require hospitals and healthcare systems to commit to action in the form of specific leadership, action, and technology plans, examples of which are delineated below for utilization or reference. This is provided to assist hospitals in prioritizing their efforts at designing and implementing evidence-based bundles for CLABSI reduction.

Leadership plan

Hospital governance, senior administrative leadership, clinical leadership, and safety/risk management leadership need to work collaboratively to reduce CLABSIs. To achieve a goal of zero preventable deaths, leaders need to commit to taking these key actions.

Show leadership's commitment to reducing CLABSIs

- Hospital governance and senior administrative leadership must commit to becoming aware of major performance gaps in their own organization
- Hospital governance, senior administrative leadership, and clinical/safety leadership must close their own performance gap by implementing a comprehensive approach
- Healthcare leadership must reinforce their commitment by:
    o Taking an active role in championing process improvement
    o Giving their time, attention, and focus
    o Removing barriers
    o Providing necessary resources
- Leadership must demonstrate their commitment and support by:
    o Shaping a vision of the future
    o Clearly defining goals
    o Embracing and reinforcing a Culture of Safety so that staff feel empowered to actively participate in CLABSI prevention activities
    o Supporting staff as they work through improvement initiatives
    o Measuring results
    o Communicating progress towards goals
- Actions speak louder than words. As role models, leadership must 'walk the walk' as well as 'talk the talk' when it comes to supporting process improvement across your organization.
- There are many types of leaders within a healthcare organization and for process improvement to truly be successful, leadership commitment and action are required at

all levels

- o The Board, the C-Suite, senior leadership, physicians, directors, managers, and unit leaders all have important roles and need to be engaged

Create the infrastructure needed to make changes

Change management is a critical element that must be included to sustain any improvements. Recognizing the needs and ideas of the people who are part of the process—and who are charged with implementing and sustaining a new solution—is critical in building the acceptance and accountability for change. A technical solution without acceptance of the proposed changes will not succeed. Building a strategy for acceptance and accountability of a change initiative greatly increases the opportunity for success and sustainability of improvements. "Facilitating Change," the change management model The Joint Commission developed, contains four key elements to consider when working through a change initiative to address HAIs (go to **Appendix A**).

In addition to the change management model, leaders must:

- Include fundamentals of change outlined in the National Quality Forum safe practices, including:
  - o Awareness
  - o Accountability
  - o Ability
  - o Action
- Meet with the ICU team, infection control staff, quality and safety leaders, nurse educators, and physician champions to:
  - o Understand barriers (walk the process)
  - o Use 4E grid to develop strategy to:
    - Engage—use stories and show baseline data
    - Educate—teach staff about the evidence
    - Execute—practice change
    - Evaluate—assess feedback performance and view infections as defects
  - o Use surveillance data to drive improvement
  - o Monitor and provide feedback of compliance with best practices over time
- Utilize patient stories - written & in video - to identify gaps and inspire change in your staff
  - o The story of Nora Bostrom, daughter of Claire McCormick and Thomas Bostrom, is an inspiring story about a CLABSI which can be freely viewed: **https://www.youtube. com/watch?v=-DNuFp6KDVM**

Action plan

Use of current evidence-based guidelines and/or implementation aids regarding the prevention of CLABSIs:

Insertion

- Create a standardized central line insertion kit or line cart that contains all needed supplies (go to Technology plan to learn more)

- Ensure an insertion checklist is part of your electronic medical record
- Wear sterile clothing (Personal Protective Equipment, PPE)—gowns, mask, gloves, and hair covering and insure that personnel involved in insertion and maintenance of catheters are trained in correct use of PPE
- Cover patients with a sterile drape, except for a very small hole where the central line goes in
- Maintain strict sterile techniques when placing the central line
- Perform hand hygiene procedures, either by washing hands with conventional soap and water or with alcohol-based hand rubs (ABHR)
  - Hand hygiene should be performed before and after palpating catheter insertion sites, as well as before and after inserting, replacing, accessing, repairing, or dressing an intravascular catheter (CDC, 2002)
  - Palpation of the insertion site should not be performed after the application of antiseptic, unless an aseptic technique is maintained (O'Grady *et al*., 2002)
  - Go to APSS #2A Hand Hygiene to learn more
- Use ultrasound guidance for all non-emergent central line placements
- For directly inserted central lines, the internal jugular and subclavian veins are less frequently associated with infections than the femoral vein.
- Perform a "time-out" before commencing the procedure
- Position patient appropriately

Prepare insertion site
- Prepare clean skin with a 0.5% chlorhexidine preparation with alcohol before central venous catheter and peripheral arterial catheter insertion and during dressing changes
  - If there is a contraindication to chlorhexidine, tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives
- Don't use iodine ointment - Do not use topical antibiotic ointment or creams on insertion sites, except for dialysis catheters, because of their potential to promote fungal infections and antimicrobial resistance
- Following insertion, ensure line aspirates blood to confirm proper catheter placement
- Apply a sterile dressing to the site
- Use a prepackaged or filled insertion cart, tray, or box that contains all the necessary supplies
- Use an insertion checklist with staff empowerment to stop non-emergent procedure:
  - Include a checklist to ensure adherence to proper practices
- Use a full sterile barrier for providers and patients:
  - Use maximal sterile barrier precautions, including the use of a cap, mask, sterile gown, sterile gloves, and a sterile full body drape, for the insertion of CVCs, PICCs, or guidewire exchange
  - Use a sterile sleeve to protect pulmonary artery catheters during insertion
- Provide insertion training for all providers
- Monitor performance and compliance with the insertion bundle on a routine basis
  - A minimum of 20 audits per month is recommended to acquire ample data to assess staff performance

Maintenance

- Perform daily assessments of need for line and remove when no longer needed:
  - o Only healthcare personnel who are properly trained should be doing the maintenance on the central line based on a standardized maintenance bundle
  - o Create a checklist with all required maintenance bundle elements
  - o Standardize procedures for line access, dressing, cap and tubing changes
  - o Discuss with the medical team continued necessity of line
  - o Discuss with the medical team the function of the line and any problems
  - o Discuss with the medical team the frequency of access and utilization of the line
    - Limit line access by bundling labs
  - o Document daily discussion of line necessity in the patient's medical record
- Conduct regular assessment of dressing to assure clean/dry/occlusive:
  - o Replace catheter site dressing if the dressing becomes damp, loosened, or visibly soiled
  - o Replace dressings used on short-term central venous catheter sites according to CDC or institution's protocol
- Perform daily CHG bathing and linen changes—follow manufacturer recommendations for usage
- Perform weekly safety rounds
- Send monthly data to team and leadership
  - o Celebrate successes: post a running tally of CLABSI-free days in your unit where it can be easily seen
  - o Use a systematic approach to review all hospital-acquired CLABSIs
  - o Perform in-depth case reviews when infections do occur: Include members of the Infection Prevention and Control and Infectious Disease teams.
  - o Identify the risks that could've been avoided and modifications needed moving forward, during timely safety huddles

Standardized access procedure

- Go to Hand Hygiene details in APSS #2A
- Use clean (for temporary CVLs) or sterile (for permanent CVLs) gloves when accessing the line
- Scrub the hub:
  - o Alcohol (15 second scrub + 15 second dry)
  - o CHG (30 second scrub + 30 second dry)
- Follow standardized dressing, cap, and tubing change procedures/timing:
  - o Scrub skin around site with CHG for 30 seconds (2 minute for femoral site), followed by complete drying. For patients with contraindication to CGH (allergy), scrub skin with alcohol or povidone-iodine
  - o Note: there may be institutional preference for CHG use for infant < 2 months of age
- Change crystalloid tubing no more frequently than every 72 hours
- Change tubing used to administer blood products every 24 hours or more frequently per institutional standard

- Change tubing used for lipid and TPN infusions every 24 hours
- Document date dressing/cap/tubing was changed or is due for change
- Consider when hub of catheter or insertion site are exposed, wear a mask (all providers and assistants), shield patient's face, endotracheal tube (ETT), or trach with mask or drape

In the pediatric ICU and neonatal ICU*:

- Create a monthly Rreport-out CLABSIs and prevention bundle compliance data monthly at team/quality committee and leadership meetings
- Line stability and securement is a challenge in all pediatric patients, but especially in preterm neonates in whom skin integrity is not yet fully developed. Therefore, extra attention to insertion site and dressings is required
- Implement standardized central venous catheter (CVC) practices:
  - Use pediatric-specific Iinsertion and maintenance bundle checkslists
  - Daily assessment of need for and functionality of the line, insertion site, securement and dressing with documentation in the medical record
  - For infants receiving parenteral nutrition, create an Eelectronic health record prompt to remove catheter when the threshold for adequate enteral intake has been achievedbased on feeding volume
  - 24-hour catheter tubing change for lines used to provide PN or blood products, with access only by, experienced staff and compliance with standard access procedurenurses only
  - Enhanced nursing education and competency for standardized CVC care
  - Educate caretakers (parents, guardians) on best practices and empower them to reinforce compliance with maintenance care standards.
    - Consider creating printed safety sheets or "key" cards using easy-to-understand language that summarize maintenance care elements (See Fig. 1)

Provide staff training

- Nursing education—care and maintenance bundle
  - "Just in Time" training incorporates immediate feedback to staff at the time of line care
- Enhanced Pediatric and Neonatal ICU nursing education with regular assessment of —enhanced and competency standard for CVC care practices for all staff who handle central lines
- Central Line Simulation Program
  - Develop education for attendings, residents, and nurses
  - Key Curriculum Concepts—reinforcement
    - Hand hygiene
    - Appropriate gowning and gloving
  - Key Curriculum Concepts
    - Standardized central line insertion best practice
      - Ultrasound guided cannulation for all line placement
    - Insertion checklist
      - Maintaining sterile technique – immediate feedback

- Central Line Navigator documentation
- General Medical Education (GME)
  - MD rounding navigators (removal prompt)
  - Resident infection prevention training
- Evidence-based practice adherence
- Remain current with new literature findings:
  - "Guidelines for the Prevention of Intravascular Catheter- Related Infections" 2011 compendium by the CDC (Miller *et al*., 2010)
- Patient/Family education document (see **Figure 1** below)

Figure 1: My/(Child's) CVL Plan (developed by Hospital for Sick Children, Toronto)

Quality process measures and metrics

Monthly CLABSI rate (expressed per 1000 catheter days)

- Complete documentation elements
  - Number of operator attempts per line placement
  - % of patients compliant with daily CHG treatments, site disinfection
  - % insertion with completed checklist
- Bundle compliance – insertion and maintenance to be measured separately. Direct observation by dedicated, trained "champions" is the best practice for generating reliable procedural compliance data.
  - % of line insertions following all bundle components
  - % compliance with standard maintenance bundle during access and/or dressing, cap or tubing change
  - Hospitals can choose to include additional bundle components. Including more than 5 may confuse and overwhelm providers.

- Quality and effectiveness of patient education
  - % of patients/families educated about infection prevention
- Repetitive patterns, trends, or variables
  - Complication rate
  - PICC v. Central Lines
  - Insertion site choice
- Perform a minimum of 20 audits per month. If procedures are fewer than 20, then include all procedures.

Technology plan

These suggested practices and technologies have shown proven benefit or, in some cases, are the only known technologies for certain tasks. If you know of other options not listed here, please complete the form for the PSMF Technology Vetting Workgroup to consider: **https://patientsafetymovement.org/actionable-solutions/apss-workgroups/technology-vetting/**

Consider implementing the following technologies to reduce or prevent CLABSIs in your organization:

System or Practice	Available Technology
ONC Meaningful Use Certified EHR system Electronic Health Record (EHR) System with the following capabilities: • Computerized Provider Order Entry (CPOE) • Drug-drug interaction check • Drug-allergy interaction check • Clinical Decision Support tools (CDS)	
A central venous catheterization (CVC) kit to prepare, insert and maintain a safe central line. • Kits should be custom designed to fit the needs of one hospital or hospital system. Input from all relevant stakeholders should be included before finalizing the kit components. Design with should focus on convenience and usability. • Two such kits are used at the University of Vermont Medical Center and have been included:	

Electronic Hand Hygiene Compliance technology	• Go to APSS #2A to learn more
• ensure accurate and reliable measurement, feedback and improvement of this essential performance indicator	

Measuring outcomes

Topic:

Central line-associated bloodstream infections (CLABSI)

CLABSI CLABSI is defined by the CDC National Healthcare Safety Network (NHSN) as a primary bloodstream infection (BSI) in a patient that had a central line within the 2 calendar days before the development of the BSI and is not related to an infection at another site.

Outcome measure formula (CLABSI Rate):

Numerator: A laboratory-confirmed bloodstream infection based on the above CDC NHSN definition (CDC, 2016)

Denominator: Device days

Metric recommendations

Indirect Impact:

Any patient with a peripheral or central line will benefit from several of the interventions being instituted

Direct Impact:

All patients that require a central line

Lives Spared Harm:

Lives = (CLABSI Rate $_{baseline}$ - CLABSI Rate $_{measurement}$) X Line days $_{baseline}$ || Patient Days $_{baseline}$

Lives Saved:

Lives Saved = Lives Spared Harm X Mortality Rate

Notes:

To meet the NHSN definitions, infections must be validated using the hospital acquired infection (HAI) standards (CDC, 2016). Infection rates can be stratified by unit types further defined by CDC. Infections that were present on admission (POA) are not considered HAIs and not counted.

Data collection

CLABSI and Line days can be collected through surveillance (at least once per month) or gathered through electronic documentation. Denominators documented electronically must match manual counts (+/- 5%) for a 3-month validation period.

CLABSI can be displayed as a Standardized Infection Ratios (SIR) using the following formula:

SIR = Observed CLABSI/Expected CLABSI

Expected infections are calculated by NHSN and available by location (unit type) from the baseline period.

Mortality (will be calculated by the Patient Safety Movement Foundation)**:**

The PSMF will use the mortality rates associated with Hospital Acquired Conditions targeted in the Partnership for Patient's grant funded Hospital Engagement Networks (HEN), when available.The program targeted 10 hospital acquired conditions to reduce medical harm and costs of care. "At the outset of the PfP initiative, HHS agencies contributed their expertise to developing a measurement strategy by which to track national progress in patient safety— both in general and specifically related to the preventable HACs being addressed by the PfP. In conjunction with CMS's overall leadership of the PfP, AHRQ has helped coordinate development and use of the national measurement strategy. The results using this national measurement strategy have been referred to as the "AHRQ National Scorecard," which provides summary data on the national HAC rate (AHRQ, 2019). Central Line associated bloodstream infections was included in this work with published metric specifications. This is the most current and comprehensive study to date. *Based on these data the estimated additional inpatient mortality for Central Associated Bloodstream Infection Events is 0.185 (185 per 1000 events).*

Conflicts of interest disclosure

The Patient Safety Movement Foundation partners with as many stakeholders as possible to focus on how to address patient safety challenges. The recommendations in the APSS are developed by workgroups that may include patient safety experts, healthcare technology professionals, hospital leaders, patient advocates, and medical technology industry volunteers. Some of the APSSs recommend technologies that are offered by companies involved in the Patient Safety Movement Foundation. The workgroups have concluded, based on available evidence, that these technologies work to address APSS patient safety issues. Workgroup members are required to disclose any potential conflicts of interest.

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Appendix A

"Facilitating Change," the change management model developed by The Joint Commission, contains four key elements to consider when working through a change initiative to address Healthcare Associated Infections (HAIs).

Plan the Project:

- At the start of project, build a strong foundation for change by:
  - o Assessing the culture for change
  - o Defining the change
  - o Building a strategy
  - o Engaging the right people
  - o Painting a vision of the future

Inspire People:

- Ask for support and active involvement in the plan to reduce:
  - o HAIs
  - o Get agreements
  - o Build accountability for the outcomes
- Identify a leader for the HAI initiative (this is critical to the success of the project)
- Understand where resistance may come from

Launch the Initiative:

- Align operations and guarantee the organization has the capacity to change, not just the ability to change
- Launch the HAI initiative with a clear champion and a clearly communicated vision by leadership

Support the Change:

- All leaders within the organization must be a visible part of the HAI initiative
- Frequent communication regarding all aspects of the HAI initiative will enhance the initiative
- Celebrate success as it relates to a reduction in HAIs or a positive change in HAI organizational culture
- Identify resistance to the HAI initiative as soon as it occurs