Central Lines
Placement, care, and feeding

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**Objectives**

1: Understand the proper techniques of placing both acute and chronic central lines
2: Understand the major complications of central line placement and maintenance, and how to prevent them
3: Learn the specific aspects of the Michigan central line safety program, and its outcome.

**Types of Central Lines**

- Acute and Chronic
  - Acute – monitoring, fluids, TPN
  - Chronic – chemotherapy, TPN
- Venous access ports

**Types of Central Lines**

- Cuffed – Hickman, Broviac
- Central and Peripheral (PIC)

**Central Line Insertion Techniques**
Anterior Triangle of the Neck

Anterior Chest Wall

Central Veins

Veins of the Arm

Complications of Insertion

- Bleeding
- Arterial puncture
- Arterial injury
- Venous injury
- Pneumothorax
- Nerve injury
- Air embolism
- Malposition
- Failure

Complications of insertion

- Prospective observational study over 12 months
- 147 patients, 209 CVC’s
  - 52% burn, 48% trauma or general surgery
  - Mean age 52 years
- Complication rate 6%
  - 3% malposition
  - 2% pneumothorax
- The more attempts, the higher the complications

Abood, J. et al., J Trauma 2007;63:50-56
Clinical judgment vs. chest x-ray

- Pneumothorax 20%
- Sensitivity 71%
- Specificity 44%
- Positive predictive value 97%
- Negative predictive value 6%
- Accuracy 70%

Abood, et al, J Trauma 2007;63:50-56

Catheter-related blood stream infections

- Home TPN patients
- 481 patients, 52 with 63 BSI’s
- 31,337 catheter days
- 2.01 complications per 1,000 catheter-days
- 1.02 infections per 1,000 catheter-days


Complications in Cancer

- Double lumen Hickman tunneled, cuffed catheters
- 273 patients, 61 BSI on 70 occasions (23%)
- Gram negative 70%
- 73% required catheter removal
- Vancomycin and cefepime used.

Catheter related BSI

- 15 years of a home care program in Oxford
- 88 patients, 121 patient-years
- Complications
  - Sepsis 0.35 episodes per patient-year
  - Line occlusion 0.25 episodes per patient-year
  - Subacute bacterial endocarditis 0.02
  - Cholestasis 0.17
  - Central vein thrombosis 0.03


Ports vs Hickman

- 63 patients with chemotherapy for solid tumors
  - 30 Hickman, 83 days (6-585)
  - 33 Ports, 158 days (20-456)
- Complication rates
  - Hickman 5.09 per 1000 catheter-days
  - 9/16 due to infections
  - 16 removed
  - Ports 1.04 per 1000 catheter days
  - 5/6 due to infections
  - 5 removed

Ng F. Clin Oncol (R Coll Radiol) 2007;19:551-5
PICC Complications

- Retrospective study, France
- 127 PICC’s in 115 patients
  - TPN (54)
  - Long term antibiotics (29)
  - Chemotherapy (14)
  - Miscellaneous intravenous therapy (18)
- Duration 1-166 days, mean 16

PICC complications

- Venous thrombosis with PICC’s
  - With and without anticoagulatents
  - Doppler venous ultrasound at 5-7 and 12-14 days
- 56 patients, 38 non-ambulatory
  - 22 post-surgical
  - 9 cancer
- 21/56 had thrombosis,
  - 23% of those with anticoagulation, 62% without.


PICC Complications

- Complications (17%)
  - Occlusion (7%)
  - Rupture (1.6%)
  - Unintentional withdrawal (2.4%)
  - Infection (3.1%)
  - Thrombosis (2.4%)

Vidal V, Prospective Evaluation of PICC line Related Complications. J Radiol 2008;89:495-498

Catheter related BSI

- 2001-2003, Barcelona
- 147 patients had 159 episodes
  - 77 were peripheral, 0.19 per 1000 patient days
  - 73 were central, 0.18 per 1000 patient days
- Risk factors
  - Catheter inserted in ED

Pujol M, J Hosp Infect 2007;67:22-29

Costs of Central Line Infections

- Revenues and expenses studied in 54 patients
  - Allegheny General, Pittsburgh
  - 3 years, 2 intensive care units
- Comparison
  - Central line infection
    - Payment $65,000, expense $92,000
    - Gross margin -$27,000
    - Total loss $1,450,000
    - Infection costs were 43% of total costs


Conclusions

- Central line infections are common
- They strongly limit the use of central lines
- PICC’s are not the solution
- And lastly,
- Prevention is everyone’s business
Eliminating Central Line Associated Blood Stream Infections (CLA-BSI)

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Disclosures- member of Speaker Bureau for: Merck; Lilly; Edwards; Sage

Overview
- Strategy/Process
- Implement Best Practices
- Strategies to ensure practice changes and prevention of mistakes
- Process and Outcome Measures
- Financial Impact
- Next steps
- Keys to Success

Notes on Hospitals: 1859
“It may seem a strange principal to enunciate as the very first requirement in a Hospital that it should do the sick no harm.”
-Florence Nightingale

KEYSTONE PROJECT
- Statewide initiative-75 Hospitals, 127 ICUs
- In Collaboration with Johns Hopkins’ Quality and Research Institute
- Reduce errors and improve patient outcomes in ICUs
- Combination of evidence based medicine and quality improvement
- 5 interventions implemented over a 2 year period
  - Patient Safety Program and incident reporting
  - Eliminate Blood Stream Infections (BSI)
  - Improve care of the ventilated patient
  - Implement Daily Goals Sheet
  - Implement and evaluate an intervention to reduce ICU mortality

Keystone Center Strategies for Action
- Build Relationships
- Create Will
- Partner with Experts
- Use Our Voice
- Be Courageous

Approach
- Engage
  - Opportunity calculator, stories of harm
- Educate
  - Original papers, fact sheet, slides
- Execute
  - Standardize, create independent checks, learn
- Evaluate
  - Measure, Measure, Measure via the safety score card
**Strategy/Process**

- Assemble team
- Prioritize improvements
- Educate team members on evidence
- Identify and obtain buy in from other key stakeholders and medical and nursing leadership
- Identify barriers/issues to implementation and strategies to resolve them
- Integrate new process into existing workflow
- Purchase equipment and stock line carts
- Collect process and outcome data
- Share data with team and units
- Make needed changes based on the data

**Keystone ICU Team**

- Denise Harrison RN, MSN, project manager
- Greg Haagos, MD, physician project leader
- Pat Posa RN, MSA, assistant project manager
- Adel Abuzeid MD, surgical resident
- Amy Herg RN, BSN CCU-Livingston
- Brian Karyl RN, CCU
- Cathy Stewart RN, BSN, CCRN Resource Pool
- Diane Jones PA, cardiac surgery
- Irina Burman MD, Chief Medical Resident
- Jeanine Steinaway BS, RRT, Resp Therapy
- Jennifer Wooley MS, RD, CNSD, SICU dietitian
- Kelly Mandagare MD, Section Head, Endocrine and Metabolism
- Kerry Bryant PA, cardiac surgery
- LaVane Hance PA-C, cardiac surgery
- Manak Sood MD, cardiac surgeon
- Melinda Palmer RN CCU-Livingston
- Pat Dost RN, quality
- Sharon McCutcheon RN, MICU
- Shihla Kapila, Pharm. D
- Sue Faust MPH, infection control
- Sue Miller RN, LNC, MICU
- Jim Vanderweerker RN, SICU

**The Problem is Large**

- 80,000 CLA-BSI in U.S. ICUs annually
- Mortality: 18% (0-35%)
- Annual deaths: 500 - 28,000
- Cost per episode: $25,000-$45,000
- Annual cost: $296 million - $2.3 billion
- 25th percentile NISS rate was 3.4/1000 catheter days
- 7.6/1000 SJMH
- 7.7/1000 rate was 2.07/1000 catheter days
- State of Michigan-Keystone ICUs:
  - median rate was 2.07/1000 catheter days
  - mean rate was 7.7/1000 catheter days

CDC. MMWR 2002; Heiselman JAMA 1994; Dimick Arch Surg 2001

**Risk Factors Associated with Increased Infections**

- Prolonged hospitalization before catheterization
- Prolonged duration of catheterization
- Heavy microbial colonization at the insertion site
- Heavy microbial colonization of the catheter hub
- Internal jugular catheterization and femoral catheterization
- Neutropenia
- Total parenteral nutrition
- Substandard care of the catheter

SHEA and IDSA, Infection Control and Hospital Epidemiology Oct 2008
Blood Stream Infection (BSI) Prevention Bundle

- Remove/Avoid unnecessary lines
- Hand hygiene
- Maximal barrier
- Chlorhexadine for skin prep
- Avoid femoral lines

Care After Insertion

- Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter
- Change transparent dressing and perform site care with a CHG based antiseptic every 5-7 days or more frequent if the dressing is soiled, loose, or damp;
- Change gauze dressings every 2 days or more frequent if the dressing is loose, soiled or damp
- Replace administration sets not used for blood, blood products or lipids at intervals not longer than 96 hours

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To Do the Right Thing and Prevent Mistakes

- Create culture of safety:
  - Completed unit education on patient safety
  - Training to senior medical staff and residents
  - Education to nurses and respiratory therapists
  - Empower nurses/RT to stop line placement
  - Pre-procedure Briefing
- Improve Processes
  - Reduce complexity: Line cart; all inclusive catheter kit
  - Create independent checks for key processes: BSI checklist
  - Nurse in room during line insertion
  - Sign on door: ‘Procedure in progress’ to decrease traffic in room
- Automate:
  - put checklist and standard documentation in new bedside computer system

Pre-Procedure Briefing

- Make introductions
- Discuss patient information and procedure
- Agree upon a time for line insertion
- Review best practice for line insertion(if necessary)
- Nurse defines their role to physician: provide equipment, monitor patient, provide patient comfort, observe for compliance with best practices and STOP procedure if sterile process compromised
  - Establish communication expectation for sterile procedure breaks
  - Examples include: your sleeve has touched the IV pole, the guidewire touched the headboard

Pre-Procedure Briefing (cont)

- Identify any special supply or procedural needs
- Discuss any special patient issues (IE: patient confused, patient awake)
- Answer any additional questions

- TIME OUT: RIGHT PATIENT—RIGHT PROCEDURE
Strategy/Process

- Assemble team
- Prioritize improvements
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BSI CHECKLIST
ALL UNITS

<table>
<thead>
<tr>
<th>Lines inserted</th>
<th>May-June '04</th>
<th>July-August '04</th>
<th>Sept. '04</th>
<th>Nov-Dec '04</th>
<th>April-May '05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow correct procedure</td>
<td>65% (20/31)</td>
<td>86% (26/30)</td>
<td>87% (28/31)</td>
<td>66% (20/31)</td>
<td>86% (50/60)</td>
</tr>
<tr>
<td>Required correction</td>
<td>52% (26/50)</td>
<td>45% (22/49)</td>
<td>57% (18/32)</td>
<td>28% (11/39)</td>
<td>77% (45/59)</td>
</tr>
<tr>
<td>Femoral lines inserted</td>
<td>16% (5)</td>
<td>9% (2)</td>
<td>6% (1)</td>
<td>8% (2)</td>
<td>12% (8)</td>
</tr>
<tr>
<td>Average insertion time</td>
<td>42.5 minutes</td>
<td>40 minutes</td>
<td>34 minutes</td>
<td>44 minutes</td>
<td>35 minutes</td>
</tr>
</tbody>
</table>

BSI PRE-POST IMPLEMENTATION OF BEST PRACTICE JULY 2004
ALL UNITS

Outcome Impact - First Year

- CR-BSI Best Practices implemented July 04
- Statistically significant reduction in rate of CR-BSIs pre-post implementation of best practices: p=0.018
- MICU: no BSI for 10 months
- Livingston CCU: no BSI for 12 months
- CCU: No BSIs 5 months out of the last 8 months

September 2005
All Units BSI rate per 1000 calendar days CR-BSI Compared to state of MI and RRWS
CR-BSI Best Practices Implemented July 2004

YTD BSI rate is 2.12
Our Expectations Weren’t Met

- SICU continued to have 1-2 BSI per month— inconsistent with other units
- Why is this happening in SICU?
- SICU’s line days are greater than all the other units combined monthly

Further analysis/investigation was needed

IMPACT SICU

- SICU drill down analysis:
  - length of time catheter in place an issue for infections
  - Majority of infected catheters were Internal Jugular
- Post Implementation:
  - ALOS for post catheter patients: 12.06
  - ALOS for post catheter patients with infection: 39.41
  - Based on decreased rate: 45.67 days saved*
  - Potential increase of contribution margin: $43,014 (3.38 more discharges**)
  - Decrease of direct variable expenses: $33,764 ($8,800 per patient**)

*S one outlier of 189 days in post implementation population, counted as group ALOS
** Variable Expenses calculated from CSPD, Pharmacy, Labs, and Radiology from day 13 and up.

SICU Initial Analysis

- Infection Control Department
  - length of time catheter in place an issue for infections: > 7 days
  - Majority of infected catheters were Internal Jugular
  - Baseline information—90% of all SICU central lines are placed in the OR
  - Where infected lines were placed: 50% SICU; 50% OR
- Critical Care Committee
  - Reviewed data and recommended that the problem was related to line insertion in SICU

Learn from a Defect Tool

- Applied defect investigational tool to SICU’s continued CR-BSI
- Designed to rigorously analyze the various components and conditions that contributed to an adverse event and is likely to be successful in the elimination of future occurrences.
- Tool can serve to organize factors that may have contributed to the defect and provides a logical approach to breaking down faulty system issues.
Learn from a Defect tool (LDT)

Divided into three sections:

- **Section 1** asks the users to identify what happened or the defect they want to investigate.
- **Section 2** is a framework provided for the investigators to identify any contributing factors. These factors include: patient, task, caregiver, and team related, training and education, local environment, information technology and institutional environment.
- **Section 3** asks participants to develop an action plan with assigned responsibility for task completion and follow up dates for each item.

**Section 1 of LDT**
- Asks the users to identify what happened or the defect they want to investigate.

**Continued CLABSI in SICU even after best practices in place.**

**Section 2**
- Factors that contributed to the defect:
  1. High patient acuity with many co-morbidities increasing risk for infection
  2. Lack of clarity in the new procedure for line insertion and sterile technique
  3. Caregiver fatigue
  4. RN confidence and comfort in stopping procedure when break in sterile technique occurred
  5. Insufficient communication (verbal/written) amongst the team
  6. Insufficient support for residents during line insertion at bedside
  7. Insufficient training for residents related to line insertion
  8. Line cart not restocked regularly
  9. Unit workload didn't always allow nurse to be in attendance through entire procedure

**Section 3**
- Action Plan:
  1. Survey residents and PAs regarding central line placement process and elicit their suggestions for improvement
  2. Chart review of all patients with CR-BSI in SICU since new protocol in place. Components included number of blood products received, mean/median blood glucose levels and line insertion process documentation.
  3. Reform BSI checklist to ensure proper sequence of line insertion procedure
  4. Provide re-education to staff on surgical asepsis.
  5. Educate staff on pre-procedure briefing process
  6. Review current line cart restocking process
  7. Order vein finder

**Resident/PA Survey Results**
- The line cart was very helpful, but often not stocked.
- Felt that the nurse's presence in the room was valuable, but not consistently happening.
- Additional support and training was needed for them.
Chart Review

- No excess blood products given on these patients
- Median blood glucose was <140 mg/dl
- All of the patients that had CLA-BSI had a slick catheter that had been placed by the nursing staff into an existing cordis introducer.
- Further discussion identified that maximal barrier precautions were not being used during slick catheter placement

Follow-up

- Reformat BSI checklist to ensure proper sequence of line insertion procedure
- Provide re-education to staff on basic surgical asepsis
- Educate nursing staff to use maximal barrier precautions during slick catheter insertions
- Incoming residents able to take Fundamentals in Critical Care Course which includes line placement instruction and practice
- Educate staff on pre-procedure briefing process
- Line cart restocking process now 2 times per day
- Ordered vein finder

August 2006

All Units BSI rate per 1000 catheter days
SJMH Compared to state of MI and NHSN

CLA-BSI Best Practices Implemented July 2004

CR-BSI Best Practices Spread to Other Areas

Same process followed as best practice spread throughout hospital

BSI SUPPLIES-TACKLE BOX*

*courtesy of Ingham Regional Medical Center, Lansing, MI

Are we implementing the prevention strategies and are they effective???
### Use of CVC-Related Bloodstream Infection Prevention Practices by US Hospitals

- National survey of infection control coordinators regarding CVC related BSI prevention practices
  - Maximal Barrier Precautions, CHG prep or composite (MSP + CHG + avoidance of routine central line changes)
- March 2005 to August 2005
- Random sample of nonfederated hospitals with ICU and more than 50 beds (n=600) and VA hospitals (n=119)
  - 72% response rate (n=516):
    - VA hospitals: n=95
    - Non-VA hospitals: n=421

### Results:
- Use of maximal barrier precautions: 84% for VA vs 71% non-VA (p=.01)
- Use of CHG for insertion site prep: 91% for VA vs 69% non-VA (p=.001)
- Use of Composite approach: 64% for VA vs 44% for non-VA (p=.003)
- Antimicrobial catheter use: 32% for VA vs 38% for non-VA (p=.30)
- Use of CHG dressing: 29% for VA vs 25% for non-VA (p=.47)

Hospitals with higher safety culture score, having a certified infection control professional and participating in an infection prevention collaborative were more likely to use CR-BSI prevention practices.

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### St. Joseph Mercy Health System

- 3 hospital system: 2 hospital having 4 ICUs
- Implemented BSI Bundle in July 2004
  - 5 best practices
  - BSI checklist
  - Line cart
  - Empower nurses to stop line placement if procedure not followed
  - Nurse in room during line insertion
  - Education—Education—Education
  - Share data monthly and chart review each of CLA-BSI (Learn from a Defect)

**St Joseph Mercy Health System**

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Posa, P. Harrison, D & Vollman, K. AACN Advanced Critical Care, 2006; 17(4):446-454

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### St. Joseph Mercy Health System

**4 ICUs**

Results:
- Baseline rate: 7.6 per 1000 catheter days (2004)
  - 2005: 2.12 per 1000 catheter days
  - 2006: 1.11 per 1000 catheter days
  - 2007: 1.12 per 1000 catheter days
  - 2008: 0.99 per 1000 catheter days

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### St. Joseph Mercy Health System

**July 2004 to November 2008**

**Results:**
- Livingston CCU: 50 months without a BSI
- MICU: 36 months without a BSI (Dec 04-Dec 07)
- CCU: 29 months without a BSI
- SICU: 6 months without a BSI

In March of 2006—implemented the Surviving Sepsis Guidelines doubling the central line days without an increase in CLA-BSI

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### St. Joseph Mercy Health System

**July 2004 to November 2008**

**Results:**
- Marginal cost avoidance of $8,800 per BSI prevented
  - 2004: 38 BSIs
  - 2005: 13 BSIs
  - 2006: 8 BSIs (all but one in SICU)
  - 2007: 8 BSIs (all but two in SICU)
  - 2008: 7 BSIs

$220,000 marginal cost avoidance between 2004 and 2005
**Intervention to Reduce CA-BSI in the ICU**
- 103 ICU's in state of Michigan reported data
- Examine 375,757 catheter days
- Implementation of the BSI Bundle/checklist

**Results**
- Median rate of CA-BSI per 1000 catheter days went from 2.7 to 0 at 3 months (p<0.002)
- Mean rate of CA-BSI's per 1000 catheter days went from 7.7 to 1.4 at 18 month follow up (p<0.002)


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**Additional Strategies:**

**CHG Bath Reduces CLA-BSI**
- 52 week, 2 arm, cross-over design clinical trial
- 22 bed MICU with 11 beds in 2 geographically separate areas
- 836 MICU patients
  - 1st 28 weeks: 1 hospital randomize to bathe with Sage 2% CHG cloths & the other unit bathe with soap & water
  - 2 week wash out period
  - 2nd 24 weeks: methods were crossed over
- Measured: Primary outcomes: incidence of CA-BSI's & clinical sepsis. Secondary: other infections


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**Chlorhexidine Patch to IHI's BSI Bundle**
- BSI bundle implementation resulted in reduction of CA-BSI's from 24.8 to 3.1 per 1000 catheter days in 4 adult ICU's (30 beds)
- 8 month implementation regarding addition of the Chlorhexidine patch as part of site care

Results: Compared
- 277 patients with CVC from May-April 2005 (Bundle)
- 226 patients with CVC from Sept- Dec 2005 (Bundle & Patch) with 98% compliance of patch
- CA-BSI went from 3.1 to 0 per 1000 catheter days (p < 0.05)
- Cost savings estimate: $314,678

Garcia R et al. AJIC, 2006;34(5):E42

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**Elimination of Catheter Associated Blood Stream Infections**

<table>
<thead>
<tr>
<th></th>
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<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
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<tr>
<td>SJMHS</td>
<td>7.6</td>
<td>2.02</td>
<td>1.12</td>
<td>1.13</td>
<td>0.99</td>
</tr>
<tr>
<td>State of Michigan</td>
<td>7.7</td>
<td>1.50</td>
<td>1.25</td>
<td>1.18</td>
<td>1.00</td>
</tr>
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</table>

**CHG Bath Reduces CLA-BSI**

Results:
- CHG arm were significantly less likely to acquire a CA-BSI 6.4 vs. 16.8 infections per 1000 catheter days
- Benefit against primary CA-BSI's by CHG cleansing after 5 days in MICU
- No difference in clinical sepsis or other infections


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**Antimicrobial CVCs**
- Prospective 2 year before and after study (1998-2000 compared to 2000-2002)
- Use of chlorhexidine/silver-sulfadiazene catheter in 6 ICUs at large teaching hospital

Results:
- CRBSI decreased from 8.2 per 1000 catheter days to 5.4 per 1000 catheter days (p=.003)
- Prevention strategies used: maximal barrier precautions (not using CHG for skin prep)

Borschel DM, et al Am Jo Infect Control 2006;34
Antimicrobial CVCs

CDC Recommendations:
- Use of an antimicrobial or antiseptic-impregnated CVC in adults whose catheter is expected to remain in place for > 5 days if, after implementing a comprehensive strategy to reduce rates of CRBSI, the CRBIS rate remains above benchmarked goal (IE: 3.3/1000 catheter days)


Clinical effectiveness of CVC treated with anti-infective agents in preventing CLABSI: A Systematic review
Hockenhull, J et al CCM 2009 Vol 37:702-712
- Meta-analyses of data from 27 trials showed strong treatment effect in favor of AI-CVC
- Authors says: “however, it is important to establish whether this effect remains in settings where infection prevention bundles of care are established as routine practice”
- More research is needed to determine whether the strength of benefit remain after introduction of appropriate infection prevention methods

Next Steps at SJMHS
- Chart review of every CLA-BSI
- Dressing/line care audit
- Addition of CHG bath daily for all ICU patients
- Education--Education--Education

Next Steps: National Implementation of CUSP to Reduce CLABSI in ICUs
- AHA’s Health Research & Educational Trust (HRET) was awarded a contract from AHRQ to implement and test nationally the Keystone Project over 3 years
- 10 states---at least 100 hospitals
- California, Colorado, Florida, Massachusetts, Nebraska, North Carolina, Ohio, Pennsylvania, Texas, Washington

Interventions to ensure patient receives evidence
- Education
- Ask Daily if line needed
- Checklist, nurse/RT must be present
- Empower nurses/RT to stop line insertion if sterility is broken
- Line cart or central line bag
- Share data with staff and leadership
- Review data monthly for opportunities for improvement (if further analysis is needed can use Learn from a Defect Tool)

Keys to Success
- Team in place with key stakeholders overseeing implementation
- Project coordinators with lead clinical staff on each unit
- Strong physician leadership on team
- Education of staff through use of BSI checklist
- Empowerment of nursing staff to prevent errors
- Administrative support to help manage barriers
- Support from state-wide collaborative