

Eliminating CLABSI, A National Patient Safety Imperative

A Progress Report on the National *On the CUSP: Stop BSI*
Project, Neonatal CLABSI Prevention

A Project of:

Health Research & Educational Trust

Neonatal CLABSI in partnership with:
Perinatal Quality Collaborative of North Carolina (PQCNC)
Missouri Center for Patient Safety (MOCPS)

Disclaimer: This report was developed with data collected and analyzed under contract with the Agency for Healthcare Research and Quality (AHRQ). The information and opinions expressed herein reflect solely the position of the authors. Nothing herein should be construed to indicate AHRQ support or endorsement of its contents.

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TABLE OF CONTENTS

Table of Contents.....	2
Executive Summary	3
Introduction & Objectives	4
Methods.....	5
Data Collection and Analysis.....	6
Results.....	8
Participation	8
Central Lines.....	9
Infections	10
Maintenance	10
Team Check-Up Tool.....	11
Rates.....	12
Rate Overall.....	12
Rates By Weight	14
Rates By Bed Size	17
Impact	18
Conclusion	19
Next Steps.....	19

EXECUTIVE SUMMARY

Introduction

In August 2011, the Health Research & Educational Trust (HRET), partnering with the Perinatal Quality Collaborative of North Carolina (PQCNC), implemented a national, neonatal central line-associated bloodstream infection (NCLABSI) reduction project in Neonatal Intensive Care Units (NICU). This effort was a component of the AHRQ-funded national project to reduce CLABSI, which is a significant contributor to morbidity and mortality for infants as well as adults and to excess costs.

This NCLABSI project brought together neonatal State-based networks recruited and led by a neonatologist, also referred to as a State clinical lead. These State clinical leads worked with their State hospital associations and recruited NICUs to participate, submit CLABSI data to PQCNC for real-time feedback, and engage unit teams to improve safety culture using the Comprehensive Unit-Based Safety Program (CUSP). The project had two primary aims: 1) create and support statewide CLABSI collaboratives committed to reducing CLABSI and 2) improve safety culture.

Results

- A total of 100 units participated representing 9 States.
- Through the course of the study, over 17,000 central lines were placed.
- Over 127,000 maintenance notes were logged representing over 8,400 unique patients.
- CLABSI rates decreased from 2.043 at baseline to 0.855 in August 2012, a 58 percent relative reduction.
- During the course of the study, an estimated 131 infections were prevented which translates to an estimated 14 – 41 deaths prevented and over \$2.2 million in excess costs averted.

Next Steps

All nine participating States in NCLABSI have completed plans to sustain this work. Six new States have also expressed commitment to spreading the interventions of this project to NICUs in their State.

Conclusion

Moving forward, the work started in NCLABSI will continue to gain momentum through the State neonatal quality collaboratives and can only grow stronger with additional partnerships through quality improvement organizations, hospital engagement networks, insurers, family and patient groups, and other national stakeholders.

Approximately \$906,000 was invested in the national NCLABSI project resulting in infections prevented and deaths avoided. With over \$2.2 million in excess costs averted, the return on investment is over 143 percent to date.

INTRODUCTION & OBJECTIVES

On the CUSP: Stop BSI project provided funding to improve culture and prevent central line blood stream infections in U.S. hospitals – mainly in adult intensive care units. In August 2011, the Health Research & Educational Trust (HRET), partnering with the Perinatal Quality Collaborative of North Carolina (PQCNC), implemented a national, neonatal central line-associated bloodstream infection (NCLABSI) reduction project specifically focused in Neonatal Intensive Care Units (NICU). CLABSI is a significant contributor to morbidity and mortality for infants. This population is specifically susceptible to infections because of immature immune systems. While many NICUs no longer view these infections as inevitable, NICUs confront a range of unique obstacles in the work to eliminate CLABSI. For example, premature infants require intravenous access until they can tolerate enteral feedings which for extremely premature infants can take several weeks, if not months to accomplish.

Leveraging existing State-based neonatal networks, nine States were recruited into this NCLABSI project: Colorado, Florida, Hawaii, Massachusetts, Michigan, New Jersey, North Carolina, South Carolina, and Wisconsin. Each neonatal State-based network was led by a neonatologist, also referred to as a State clinical lead. These State clinical leads worked with their State hospital associations and recruited NICUs to participate, submit CLABSI data to PQCNC for real-time feedback, and engage unit teams to improve safety culture using the Comprehensive Unit-Based Safety Program (CUSP).

The project had two primary aims:

1. Create and support nine statewide CLABSI collaboratives committed to reducing CLABSI.
2. Improve safety culture.

With a condensed project time line, each State was asked to develop a State consortium that included providers (neonatologists, nurses, nurse practitioners, infection control professionals [ICPs]), State leaders such as Departments of Public Health (DPH), payers (Medicaid and other significant payers) and family organizations.

The NCLABSI project model differed from the adult *On the CUSP: Stop BSI* model in that:

1. The State leads were neonatologists, not employed by a State hospital association.
2. Education on CUSP was provided by the Missouri Center for Patient Safety, not Johns Hopkins University.
3. Data was collected by PQCNC, not Michigan Health and Hospital Association's Keystone Center for Patient Safety.
4. The technical intervention focused more on maintenance than insertion given the clinical considerations of NICU populations.
5. The implementation timeline was shortened.

METHODS

The NCLABSI project time line was rapid with all project data and deliverables planned for over an 11-month time frame. To initiate the project, the following were completed in the first four months: identification of States and State leaders, NICU recruitment by State leaders, action plan creation, designation of key metrics and development a data collection system. Recruitment included 9 States and 100 NICUs.

A key element in the execution of NCLABSI was the formal introduction of CUSP principles to all participants. The Missouri Center for Patient Safety (MOCPS) was selected to lead this effort. The NCLABSI action plan focuses on central line insertion and maintenance (a summary of the maintenance bundle can be found in Table 1). Insertion elements were based on the Centers for Disease Control and Prevention (CDC) recommendations and were similar to those used in other CLABSI collaboratives. Given the longer dwell time for NICU central lines, NCLABSI also uniquely concentrated on maintenance activities related to central lines. This unique concentration included maintenance bundle elements based on CDC recommendations but also included a recommendation to consider removing central lines when infants reached enteral feeding levels of 120 cc/k/day. NCLABSI also intended daily reporting on maintenance practice for every NCLABSI line.

Table 1. NCLABSI maintenance bundle summary

Maintenance	Considerations
<i>Assessment & Site Care</i>	
1. Daily assessment and documentation of catheter need included as part of multidisciplinary rounds and review of daily goals	
2. Removal of catheters in place for nutritional purposes when infant reaches ≥ 120 ml/kg/day enteral nutrition	
3. Review dressing integrity and site cleanliness daily	No routine dressing changes, perform p.r.n. using sterile technique and chlorhexidine gluconate or povidone-iodine for skin antisepsis
<i>Tubing, injection ports, catheter entry</i>	
1. Use "closed" systems for infusion, blood draws and medication administration	-May use manufactured or improvised closed system. If stopcocks are used, port(s) are capped with swab-able needleless connector(s). -Define consistent practice to be used when accessing catheters
2. Assemble and connect infusion tubing using aseptic or sterile technique. Configure tubing consistently for each type of arterial or venous access device.	- Sterile technique ideally includes sterile barrier for tubing assembly and wearing of face mask, hat, sterile gloves and two staff members performing connection to central catheter - Aseptic technique includes clean barrier for

	tubing assembly and wearing of clean gloves
3. Scrub needleless connector using friction with either alcohol or CHG/alcohol swab for at least 15 sec. prior to entry. Allow surface to dry prior to entry.	
4. Clean gloves for all device entries & hand hygiene utilized before and after glove use	Standard precautions
5. Use pre-filled, flush containing syringes wherever feasible	-Higher risk of contamination when flush withdrawn from another container by a nurse
6. Staff empowered to stop non-emergent procedure if sterile technique not followed	

As with the *On the CUSP: Stop BSI* project, the NCLABSI project included both a technical intervention and an adaptive intervention.

For these interventions, the national project team provided the State clinical leads and their units with the following resources and educational materials:

1. Project Charter
2. Leadership Role Descriptions
3. Data Dictionary
4. Hospital Tool Kit
5. Action Plan
6. CUSP Manual Adapted for NCLABSI
7. CUSP Content Calls (seven total) and CUSP Coaching Calls (five total) presented by the Missouri Center for Patient Safety
8. Pilot CUSP Toolkit
9. Team Check-Up Tool
10. *On the CUSP: Stop BSI* project website
11. National Faculty Participation at Site Visit/Statewide Collaborative Meeting
12. State Clinical Lead Calls and Face-to-Face Meetings

DATA COLLECTION AND ANALYSIS

Unit teams submitted their baseline data for the months of October 2011 through December 2011. All project data was collected by PQCNC. The data collection system that supported NCLABSI offered participants real time dashboard metrics for key initiative metrics. When possible, participating hospitals were matched to their American Hospital Association (AHA) 2010 Annual Survey which provides hospital level characteristics such as total number of beds, teaching status, and urban status. Results presented in this report utilize data through September 15, 2012 unless otherwise noted. Some catheters do not have removal dates entered in the database indicating the line has not been removed. Lines without removal dates are not included when calculating number of device days.

Due to the rapid initiation of the project, the neonatal National Project Team (NPT) elected not to administer a patient safety cultural measurement tool. However, to better understand some of the barriers the teams were facing in the project, the neonatal NPT developed and administered a monthly Team Check-Up Tool. The tool was developed based on the adult *On the CUSP: Stop BSI* Team Check-Up Tool. The NCLABSI tool was tailored to the neonatal project and contained 18 questions categorized into 3 sections: 7 questions in Knowledge/Skills,

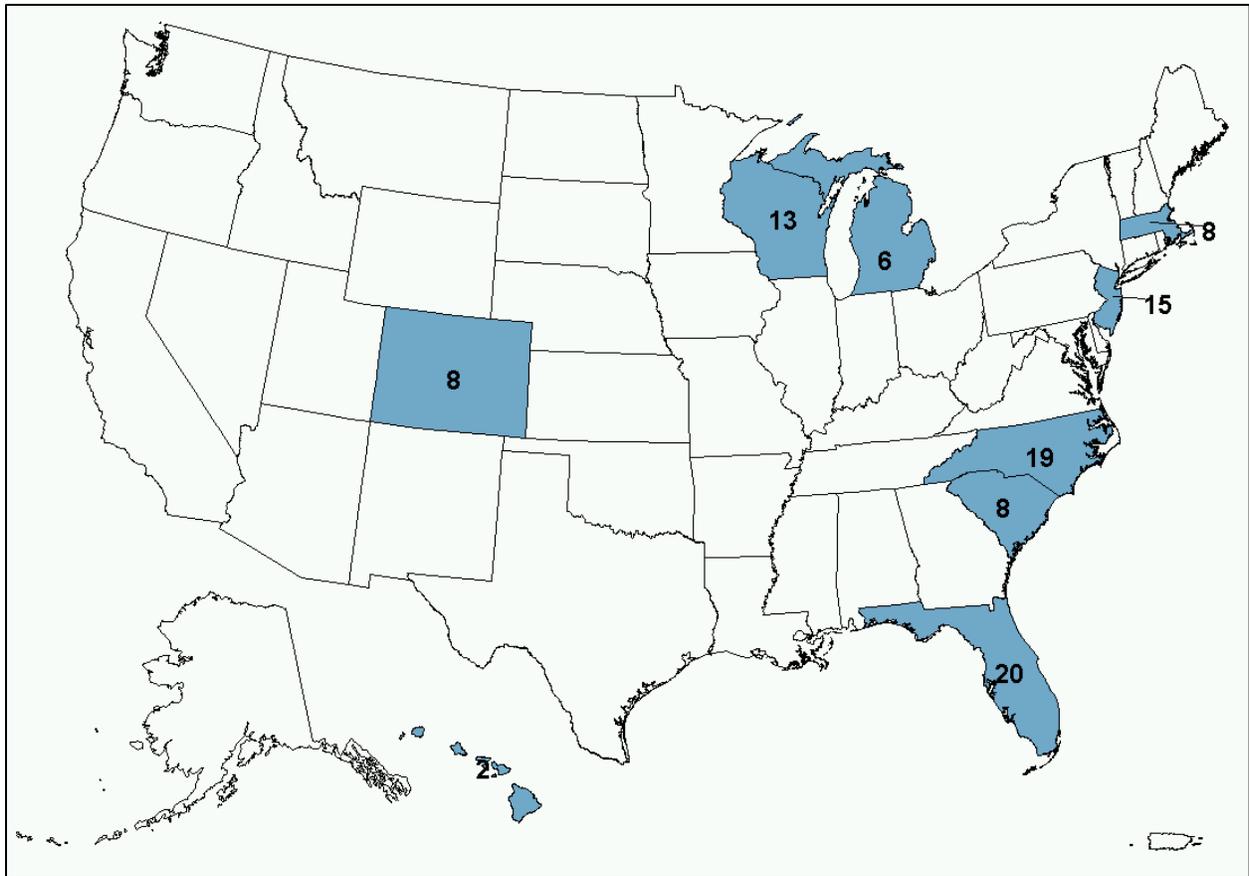
6 questions in Attitudes/Beliefs and 5 questions in the Resource section. Six of the 18 questions were negatively worded.

RESULTS

Participation

A total of nine States participated in the quality improvement initiative (CO, FL, HI, MA, MI, NC, NJ, SC, WI) with a total of 100 units (see Figure 1), 98 percent of which were matched to their 2010 AHA annual survey. The majority of participating units were located in general medical/surgical hospitals (96 percent) although some were located in children's general medical/surgical facilities (4 percent). All hospitals had 100 or more beds with the majority of participating facilities having 500 or more beds (47 percent). Additionally, the majority of participating hospitals were teaching facilities (76 percent), had Level III obstetric units (78 percent), and were in metropolitan settings (70 percent). On average, hospitals had 26 neonatal ICU beds (minimum, 0; maximum, 105) and 13 neonatal intermediate care beds (minimum, 0; maximum 68).

Figure 1. States and number of units participating in initiative*



*One unit is located in Georgia, a State which did not formally participate in the initiative.

Central Lines

Central lines were classified as: peripherally inserted central catheter (PICC), umbilical artery catheter (UAC), umbilical venous catheter (UVC), Broviac (a surgically placed, tunneled central venous catheter), or "other" (all other percutaneously placed central lines). To date, 17,212 central lines have been placed (see Table 2) with 16,067 of these lines having both insertion and removal dates. Lines are more frequently missing removal dates later in the project than earlier in the project (of missing line removal dates, 29.4 percent occur in August compared to 3.6 percent in January), illustrating the "real time" nature of the database system.

Table 2. Central lines placed by type

Catheter Type	N (%)
Other	185 (1.1)
Broviac	577 (3.4)
UAC	4,270 (24.8)
UVC	5,397 (31.4)
PICC	6,783 (39.4)

Approximately 90 percent of central lines were new (8 percent placed outside the unit; 2 percent were repairs or replacements of an existing line). Of the new lines placed, the procedures followed during placement can be found in Table 3. Most frequently, skin was prepped using povidone iodine (41.9 percent) followed by chlorhexidine (39.9 percent). Other skin preps such as alcohol (2.7 percent), sterile water (0.34 percent) or combinations of techniques (e.g. chlorhexidine and alcohol) were infrequently used accounting for approximately 15 percent of skin preparations. No skin prep was noted for approximately 1 percent of patients.

Table 3. Procedures followed for 15,404 new lines placed

	Without Prompt	With Prompt	Not Done
Unit Timeout Procedure Followed	95.8%	1.1%	3.1%
Insertor Performed Hand Hygiene	98.8%	0.2%	1.0%
Wore Sterile Barrier Precautions	98.3%	0.5%	1.2%
Covered With Drapes	98.6%	0.2%	1.1%

Infections

To date, 166 infections have been reported. Most patients with a positive infection also had a secondary culture noted as being obtained at the time of the initial culture (59.6 percent). The types of catheters in use among patients with infections can be found in Table 4. Patients with PICC lines had the greatest number of infections overall (50.6 percent); however, as a proportion of lines placed to date, infections were most frequently found among patients with Broviac (18/577 or 3.1 percent) followed by PICC lines (84/6,783 or 1.2 percent).

Table 4. Types of catheters in use among patients with infections*

Catheter Type	N (%)
PICC	84 (50.6)
UVC	21 (12.7)
Broviac	18 (10.8)
UAC, UVC	13 (7.8)
PICC, UAC	10 (6.0)
Missing	8 (4.8)
UAC	4 (2.4)
Broviac, Other	2 (1.2)
UAC, UVC, Other	2 (1.2)
PICC, Broviac	1 (0.6)
PICC, Other	1 (0.6)
PICC, UVC	1 (0.6)
UAC, Broviac	1 (0.6)

*Classification of "Other" includes all other percutaneously placed central lines. Eight infections had no catheter type noted.

Maintenance

As of August 31, 2012, 127,578 line maintenance notes have been entered representing 8,427 unique patients. The majority of patients were noted as having feedings <120 cc/k/d (87.6 percent). During multidisciplinary rounding, lines are typically assessed as necessary (90.3 percent) with 2.8 percent considered unnecessary (for 6.7 percent of lines it was unknown if the line was necessary). When lines were accessed, procedures followed can be found in Table 5. On shifts when tubing was changed (n=52,077), clean gloves were used without prompting 99.7 percent of the time.

Table 5. Procedures followed when accessing lines (n=102,029)

	Without Prompt	With Prompt	Not Done
Glove Before Access	96.4%	0.3%	3.4%
Hand Hygiene Prior to Gloving	98.7%	0.2%	1.0%
Hub/Connector Cleaned for 15 Seconds	99.3%	0.2%	0.5%
Air Dry Completely*	99.0%	0.2%	0.8%

*When lines were accessed, cleaning was not noted in 0.8 percent of instances.

Team Check-Up Tool

The number of unit teams submitting Team Check-Up Tool data per month has varied from 75 to 38 units over 8 months of data currently available (January – August 2012). Within the Knowledge/Skills section all questions have shown improvement over time. Five out of the six questions in the Attitudes/Beliefs section have shown improvement since baseline. Results for “A junior staff member feels comfortable to question a more senior staff member who is not following the maintenance bundle,” showed initial improvement but in the last two reporting months, results dropped below baseline levels. Finally, three out of the five Resources section questions showed improvement with one question remaining fairly stable over time (“Data collection has not been a burden”) and one question showing a drop below baseline levels in the last data collection period (“Unit leadership is stable, i.e. low turnover”). The highest scoring questions in each of the categories can be found in Table 6.

Table 6. Highest scoring questions in each of the three NCLABSI team check-up tool domains

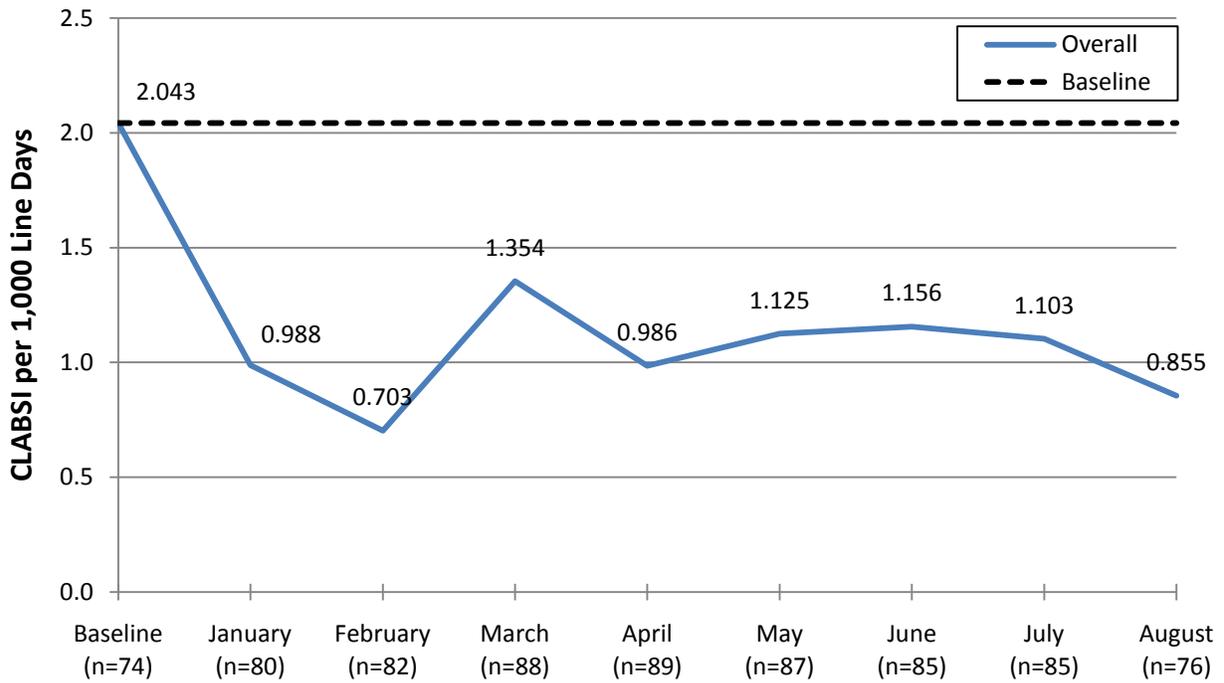
Domain	Highest Rated Question
Knowledge/Skills	Five randomly selected staff (nurses, physicians, etc.) in our unit can list at least three maintenance interventions
Attitudes/Beliefs	We have had good buy-in from physician staff in this unit
Resource	Our NCLABSI team meets minimally once a month

Rates

Rate Overall

Baseline data was collected during the months of October, November, and December 2011. Overall, units reported a baseline CLABSI rate of 2.043. Relative to baseline, a NCLABSI rate reduction of 46 percent occurred in July increasing to 58 percent in the month of August.

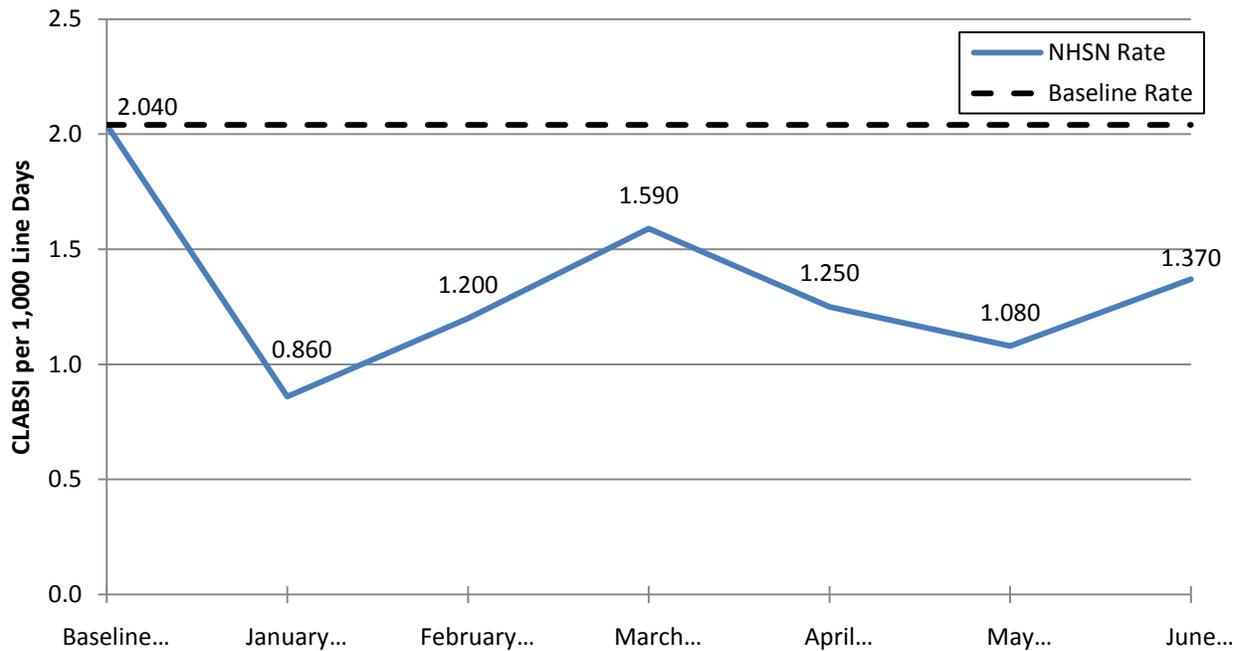
Figure 2. CLABSI rate over time – overall*



*Sample size per time period represents the number of facilities providing data during that period. Facilities not contributing to the denominator (i.e. zero line days) are not included in the count of facilities and, as such, variability in the number of reporting facilities can be found.

As a confirmatory analysis, units submitting infection data to the National Healthcare Safety Network (NHSN) were requested to submit quarter three and four data from 2011 as well as data moving forward into 2012. Sixty-two units provided some amount of data although variability was found month-to-month (range of 19-58 units). Since the lowest reporting rates were found in the most recent months and probably reflect ongoing data submission rather than missing data (NHSN data from 39 units in July and 19 units in August), Figure 3 reflects data through June, 2011. Although 100 percent of units are not currently reporting into NHSN, results are strikingly similar with a baseline rate of 2.040 (versus 2.043 found in PQCNC database) and an overall trend line following a similar pattern and magnitude (most notably an increased rate in March).

Figure 3. CLABSI rate estimated from unit data submitted to NHSN*



*Sample size per time period represents the number of facilities providing NHSN data.

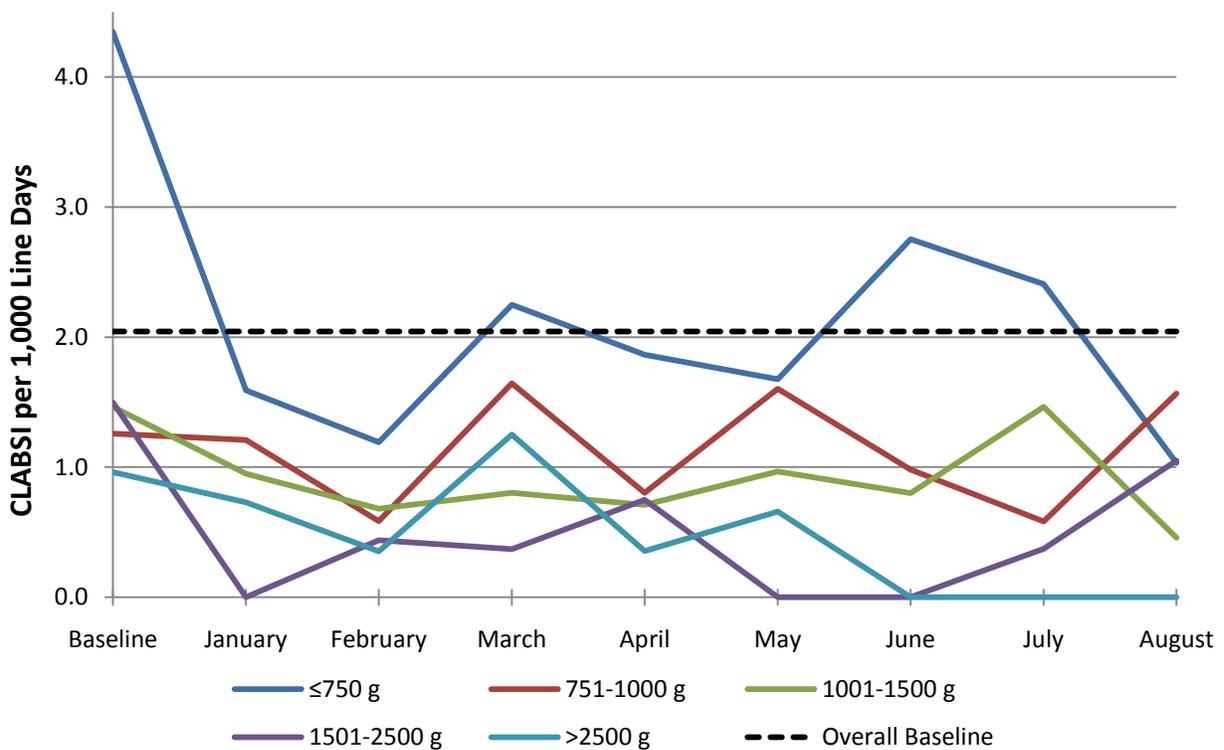
Rates By Weight

Weight was classified using NHSN classifications¹ and represents weight at the time of admission/birth. Overall patient characteristics can be found in Table 7. On average, patients weighed 1,365 grams at admission with a gestational age of 31.6 weeks. CLABSI rates overall are shown in Figure 4. Figure 5 through Figure 9 illustrate CLABSI rates for each weight category and the corresponding baseline rate for that weight category.

Table 7. Sample size and gestational age by birth-weight category

Birth-Weight Category	N (%)	Gestational Age (STD)
≤750 g	1,280 (13.4%)	25.1 (3.56)
751-1000 g	1,341 (14.1%)	26.8 (1.80)
1001-1500 g	2,249 (23.6%)	29.4 (2.00)
1501-2500 g	2,057 (21.6%)	33.2 (2.50)
>2500 g	2,598 (27.3%)	38.0 (2.21)

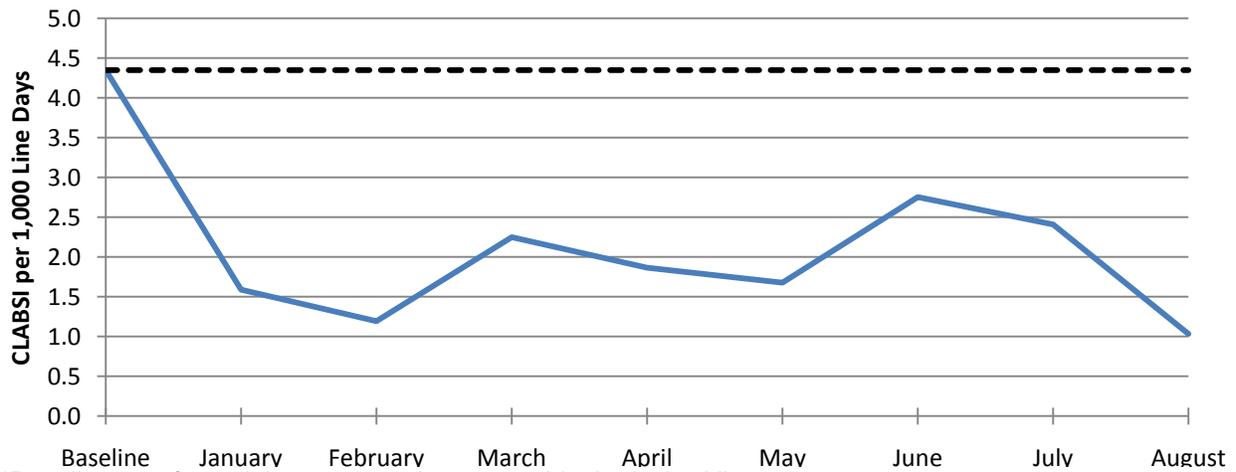
Figure 4. CLABSI rate over time by birth-weight (in grams)*



*Overall baseline rate of 2.043 shown as a black, dashed line.

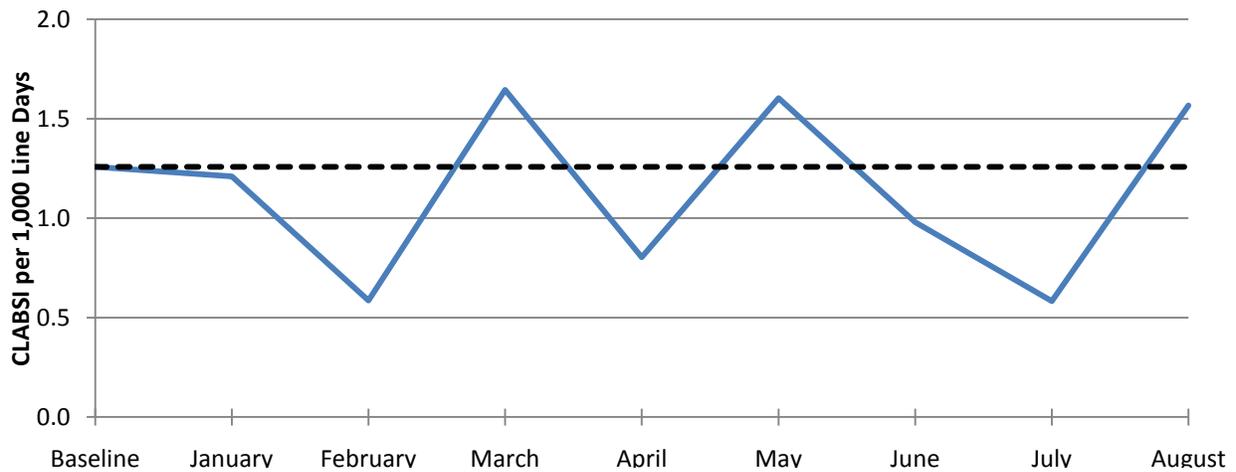
¹ "National Healthcare Safety Network (NHSN) report: Data summary for 2006 through 2008, issued December 2009." Accessed on: 5/16/2012
<http://www.cdc.gov/nhsn/PDFs/dataStat/2009NHSNReport.pdf>

Figure 5. CLABSI rate over time – birth weight ≤ 750 g*



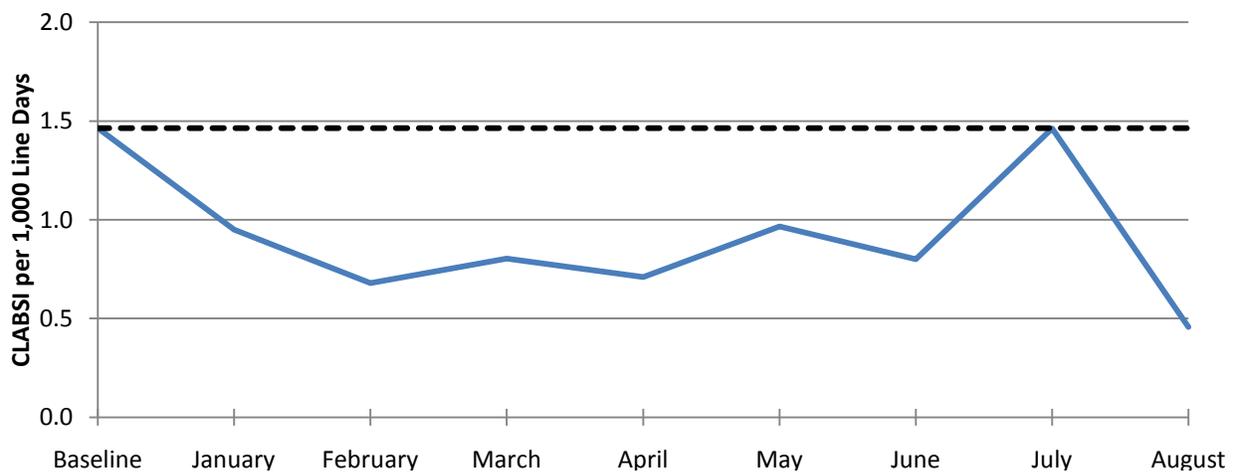
*Baseline rate for weight category shown as a black, dashed line.

Figure 6. CLABSI rate over time – birth weight 751-1000 g*



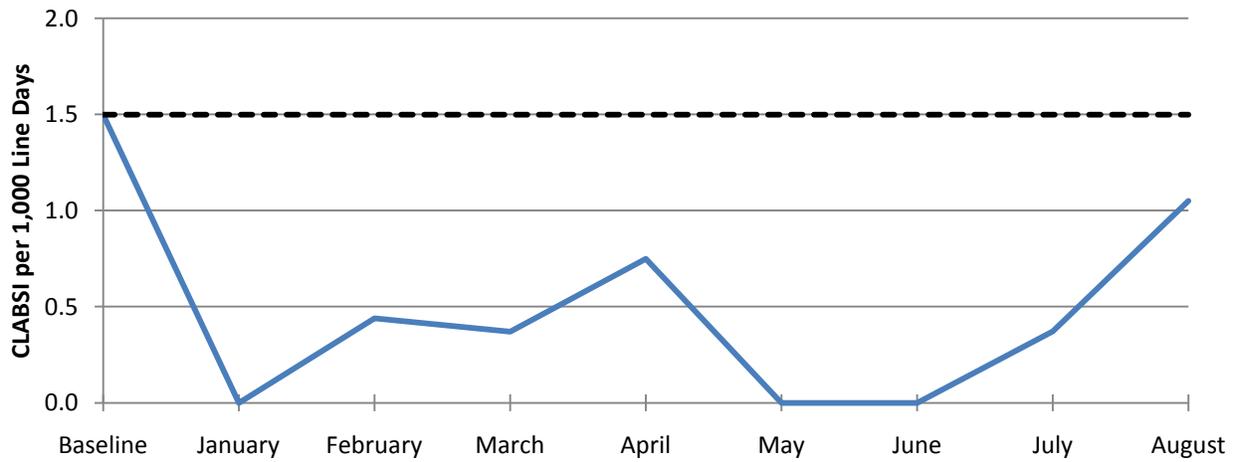
*Baseline rate for weight category shown as a black, dashed line.

Figure 7. CLABSI rate over time – birth weight 1001-1500 g*



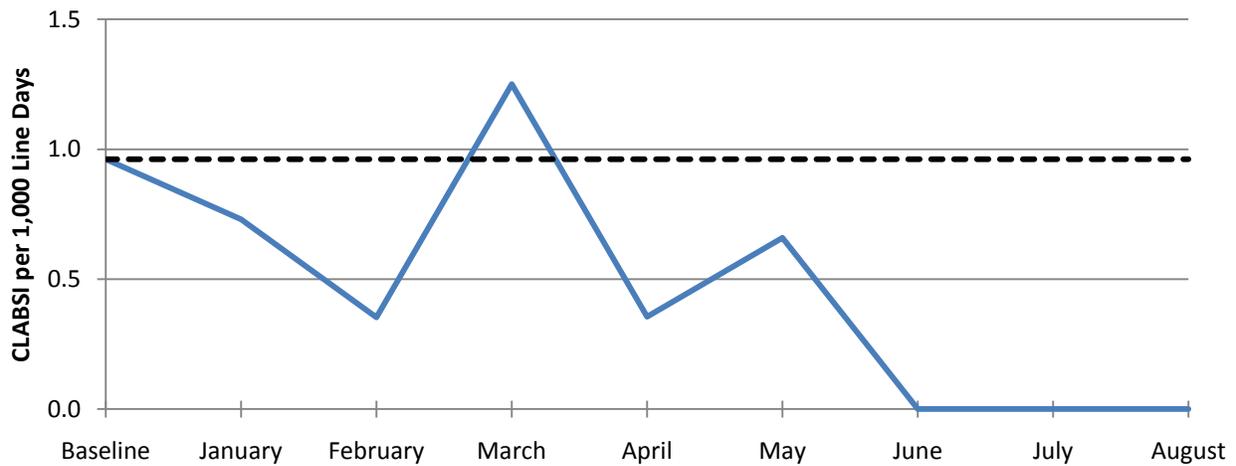
*Baseline rate for weight category shown as a black, dashed line.

Figure 8. CLABSI rate over time – birth weight 1501-2500 g*



*Baseline rate for weight category shown as a black, dashed line.

Figure 9. CLABSI rate over time – birth weight >2500 g*



*Baseline rate for weight category shown as a black, dashed line.

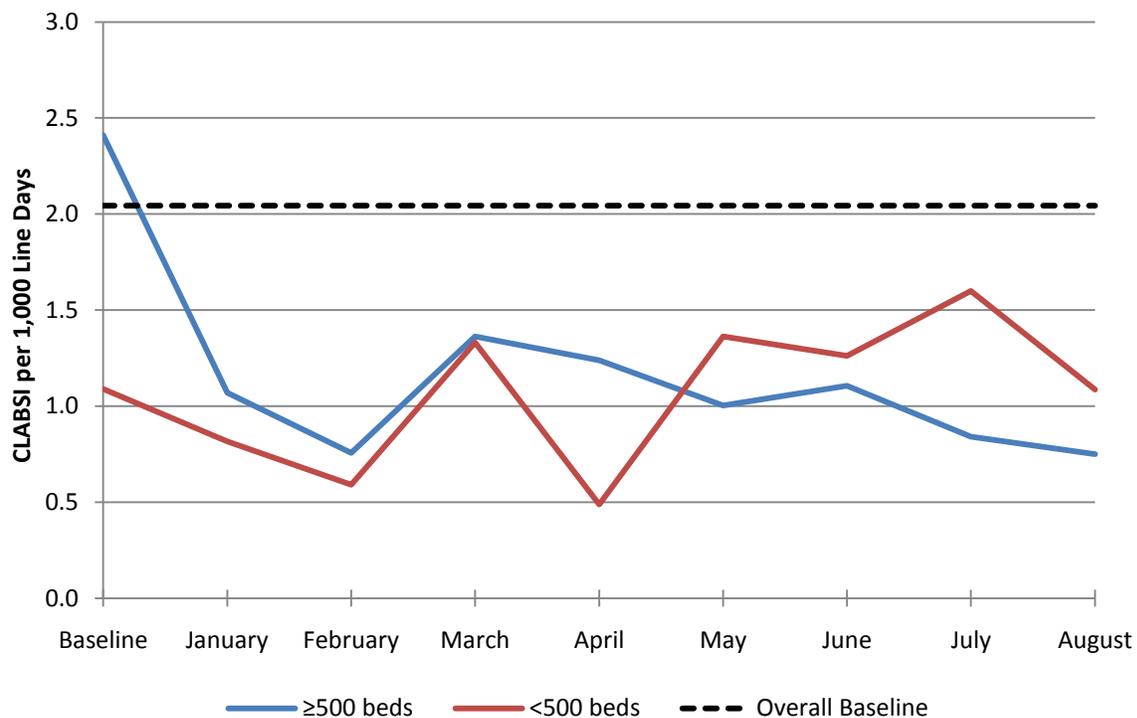
Rates By Bed Size

Units were classified based upon the total number of beds within the hospital they reside in as either ≥ 500 beds or < 500 beds. Total bed size was obtained from the 2010 AHA Annual Survey. Two units that did not have survey results were classified as having < 500 beds. Table 8 illustrates total bed size classification of participating hospitals and Figure 3 illustrates CLABSI rate over time when units are classified as residing in hospitals with ≥ 500 beds or < 500 beds.

Table 8. Total hospital bed size classification (n=100)

Bed Size	N	%
1-99	0	0%
100-199	4	4%
200-299	19	19%
300-399	17	17%
400-499	11	11%
≥ 500	47	47%
Missing	2	2%

Figure 10. CLABSI rate over time by total hospital bed count*



*Total hospital bed count obtained from 2010 AHA Annual Survey. Two units did not have AHA survey data and were classified as having < 500 total beds. Overall baseline rate of 2.043 shown as a black, dashed line.

Impact

The impact of the intervention was assessed by estimating the number of infections prevented, lives saved, and excess costs averted. To estimate the number of CLABSIs prevented, the number of actual CLABSIs reported are compared with the number of CLABSIs that would have occurred if the pre-intervention (“baseline”) rate of CLABSIs per 1,000 line days had persisted (see Equation 1). These calculations were done on a monthly basis and totaled between January and August 2012. To estimate the deaths prevented, a range in mortality was assumed (11 – 31 percent)². Thus, for each 100 CLABSIs prevented, 11-31 deaths are prevented.

Equation 1. Number of CLABSIs prevented per time period

Table 9 illustrates the estimated CLABSIs prevented to date. In total, an estimated 131 infections were prevented over the course of the study which translates to an estimated 14 – 41 deaths prevented. In a 2012 study by Donovan et al.³, \$16,800 in excess costs were attributed to NICU-associated bloodstream infection. As such, preventing 131 infections is equivalent to \$2,201,776 in excess costs averted. These estimates only consider data currently available and as such do not include infections avoided, deaths prevented, and excess costs averted projected forward.

Table 9. Estimation of infections prevented

	Baseline	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Total CLABSIs (Numerator)	27	15	11	24	18	22	20	18	10
Total Central Line Days (Denominator)	13,215	15,187	15,655	17,728	18,257	19,558	17,296	16,318	11,690
CLABSI Rate Per Thousand Line Days	2.043	0.988	0.703	1.354	0.986	1.125	1.156	1.103	0.855
CLABSIs at Baseline CLABSI Rate (Baseline Rate x days/1000)		31	32	36	37	40	35	33	24
CLABSIs Prevented (CLABSIs at Baseline Rate - CLABSIs at Quarterly Rate)*		16	21	12	19	18	15	15	14

*Total CLABSIs prevented may not sum to 131 due to rounding.

² Powers, RJ & Wirtschafter, DW (2010). Decreasing central line associated bloodstream infection in neonatal intensive care. *Clinics in Perinatology*, 37(1), 247-272.

³ Donovan EF, et al. (2012). The investment case for preventing NICU-associated infections. *American Journal of Perinatology* [in press].

CONCLUSION

NCLABSI progressed towards the achievement of its primary objective: to reduce catheter associated blood stream infections in NICUs nationally. A second objective of the NCLABSI effort was the establishment of State teams with the capacity and capability to continue quality improvement and patient safety efforts by leveraging existing State neonatal networks, and identifying a State physician to partner with State hospital associations and other State stakeholders in perinatal care. These State teams worked together to reduce neonatal infections in their State, and have developed State perinatal collaboratives capable of performing future quality improvement projects.

The NCLABSI initiative has to date demonstrated remarkable results. NCLABSI has currently evaluated insertion practice for 17,212 central lines and 127,578 daily maintenance activities have been logged. It is our suspicion that the regular reporting of maintenance observations not only provides unique insights into maintenance practice, but it also serves as a tool to reinforce best maintenance practices. In effect, the maintenance bundle has come to serve the same function as the insertion checklist that is recommended best practice for the insertion of any central line.

Through the course of the study, an estimated 131 infections were prevented which translates to an estimated 14 – 41 deaths prevented and \$2,201,776 in excess costs averted.

Approximately \$906,000 was invested in the national NCLABSI project resulting in infections prevented and deaths avoided. With over \$2.2 million in excess costs averted, the return on investment is over 143 percent to date.

Next Steps

All nine participating States in NCLABSI have completed plans to sustain this work. These plans highlight a continued desire to monitor and report out on rate data and focus on safety culture. Many States are planning additional activities around unit team engagement and sharing of lessons learned through more site visits by the State clinical lead or an increased number of statewide collaborative meetings. Six new States have also expressed commitment to spreading the interventions of this project to NICUs in their State. These new State clinical leads have also completed plans to spread the success of the NCLABSI project. Many of them expressed interest in trying to use the NCLABSI project to achieve some consistency across their State NICUs in following evidence-based best practices in CLABSI prevention through insertion, and care and maintenance of central lines. There are efforts to have these 15 State neonatal quality collaboratives examine and compare their data, and learn from each other.

Leveraging these State partnerships and this collective data set will be crucial to maintaining the NCLABSI project's successes. Moving forward, the work started in NCLABSI will continue to gain momentum through the State neonatal quality collaboratives and can only grow stronger with additional partnerships through quality improvement organizations, hospital engagement networks, insurers, family and patient groups, and other national stakeholders.