

Decreasing Central Line-associated Bloodstream Infections Through Quality Improvement Initiative

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Objectives: To study the impact of a quality improvement (QI) initiative using care bundle approach on Central-line associated bloodstream infections (CLABSI) rates.

Methods: A QI team for infection control in NICU was formed in a tertiary-care neonatal intensive care unit (NICU) from June 2015 to August 2016. Baseline data were collected over first 3 months followed by the intervention period of 1 year. Measures with respect to strengthening hand hygiene and central line bundle care were implemented during the intervention period. Audits assessing the compliance to hand hygiene and CLABSI bundle protocols were used as process indicators. Multiple PDSA cycles were used to strengthen the practices of proposed interventions, documentation of data and audits of the processes during the study period.

Results: The QI initiative achieved a 89% reduction in CLABSI from the baseline rate of 31.7 to 3.5 per 1000 line-days. The blood stream Infections reduced from 7.3 to 2.3 per 1000 patient-days. The overall mortality showed a reduction from 2.9% to 1.7 % during the intervention period. There was a significant improvement in compliance with hand hygiene protocol and compliance with CLABSI protocols.

Conclusion: This study demonstrated that simple measures involving hand hygiene and strengthening of the care bundle approach through quality improvement could significantly reduce the blood stream Infections and CLABSI rates.

Keywords: Bundle care, Infection control, PDSA cycle, Prevention.

Nosocomial sepsis in the neonatal intensive care unit (NICU), often by drug-resistant strains is a major cause of mortality, prolonged hospitalization and increased hospitalization costs [1,2]. Infections also contribute to increased risk of morbidities such as necrotizing enterocolitis, bronchopulmonary dysplasia, retinopathy of prematurity, neurodevelopmental impairment and cerebral palsy [3-5].

Central line-associated blood stream infections (CLABSI) contribute considerably to nosocomial sepsis in a tertiary NICU. Various aspects of the central line care have been shown to decrease the incidence of line related infections, however, care bundle approach has been shown to have the highest yield. Several studies have reported the impact of care bundle approach in infection control among various age groups [6,7]. Despite knowing the evidence for care bundles in preventing infections, implementation of the same is a challenge and hence quality improvement (QI) principles are needed to bridge the know-do gap.

QI initiatives have been effective in looking at practices that work for the issue in question and stop or change practices that are ineffective or potentially harmful [8]. Sepsis being a feature that is different from center to center, QI measures finds a major role in reducing the sepsis rates. Our tertiary care NICU is a 30-bedded unit catering to both intramural and extramural babies. Infections, particularly hospital acquired infections were an important cause of death and adverse outcomes. The rate of hospital acquired infections prior to the onset of the study was not available accurately. Local database indicated the incidence was 2.5 per 1000 patient days. A QI project was designed to address accurate measurement of the problem, implement steps to reduce the hospital acquired infection rates and sustain the results achieved. The aim of the study was to use care bundle approach to reduce the CLABSI rates amongst neonates admitted to NICU by 25% over a 3-month period and to sustain this over the next 9 months.

METHODS

This QI initiative was started in June 2015. At the

beginning of the study, a QI team was formed involving doctors (from the departments of neonatology and microbiology), NICU nurses and members from administration. Regular documentation of the number of young infants in the NICU, those with central lines, and those on antibiotics, invasive ventilation, non-invasive ventilation, and parenteral nutrition was strengthened. The data was cross-verified on a periodic basis. This data served as denominator data. Root cause analysis for the CLABSI in the unit identified various causes (**Web Fig. 1**), based on which, the QI initiative focused on hand hygiene (HH) and care bundle approach to central line care (**Box I**).

The key outcome indicators were Bloodstream infections (BSI) and CLABSI. All positive cultures were entered prospectively into the infection control register. A laboratory-confirmed bloodstream infection that was not secondary to an infection at another site was considered as a BSI. Blood cultures that were positive on admission and those reported as contaminants were not included. In addition, at every month-end, the online laboratory data of each patient admitted was reviewed for any positive culture reports that were missed. A primary BSI in a patient that had a central line within the 48-hour period before the development of the BSI was considered CLABSI. The process indicators were based on hand hygiene (30 audits per month) and central line care audits (10 audits per month). If all the steps of hand hygiene including the six core steps and the duration were correctly performed, it was considered 'overall compliant to HH'. The central line care audits focused on insertion practices (number of central lines inserted by eligible Healthcare Personnel (HCP), checklist analysis) and maintenance practices (breaks in circuit, 2 HCPs handling the central line, scrubbing the hub for 15 seconds, 2% chlorhexidine used for scrub, use of single lumen central line and needleless connectors). This data was shared with all HCPs in the monthly meetings PDSA cycles were:

Area 1 – Denominator data collection: Daily data collection of the NICU to serve as a denominator began in the baseline period. A set of four PDSA cycles was done to set a system to get accurate data.

- (a) Trained and designated QI nurses were initially involved in this process, however due to lack of coverage on all days; this was abandoned.
- (b) Data collection responsibility was expanded to multiple trained nurses. However as it was voluntary and some considered this data collection 'not so important' this was abandoned as well.

BOX I BUNDLE APPROACH TO CENTRAL LINE CARE

Insertion bundle

Insertion privilege for healthcare personnel (HCP) who had assisted 5 central line insertion; Checklist for insertion; Insertion to be a 2 HCP job.

Maintenance bundle

Central line card displayed on infant warmer to document the need of line daily and number of circuit breaks; Break in circuit – 2 HCP job; Scrub the hub – 2% chlorhexidine for 15 seconds

Removal bundle

Review the need every day and remove as soon as possible.

- (c) Subsequently it was made part of inventory check to ascertain the completeness of the data, however with minimal success.
- (d) A monthly roster for denominator data collection displayed on the QI board was successful. Audits of the denominator data were performed on 5 random days per month to verify the accuracy.

Area 2 – Change in HH policy: Hand hygiene policy between babies was revised from routine hand wash to hand rub. All the HCPs were educated about HH through posters, regular classes and one to one communication. The compliance with HH was studied with the help of audits, which found that the main problem was duration of hand hygiene. To ensure 20-30 seconds of hand rub, recitation of a nursery rhyme or doing each step 8 times were tried. However these were quickly abandoned, as they did not ensure 20 seconds of hand rub. The successful PDSA cycle was to do the hand rub by the clock for 20-30 seconds. It was ensured that a clock with a second hand was easily visible from each bed of the unit.

Area 3 – Insertion of central line: Defining eligibility criteria to place a central line ensured safety. Only those HCPs certified by the QI team (those who had assisted five central line insertions) were privileged to place the central line. A senior nurse or doctor supervised the process of insertion using a checklist and any deviation from the policy was noted and stopped promptly. Initially the checklist had only "done/ not done". It was revised to include done/ done after reminder.

Area 4 – Maintenance bundle: The CLABSI protocol detailed the maintenance bundle. Adherence to the maintenance bundle was assessed by audits done by the QI team. The number of audits was not meeting the set

target of 10/ month (only 72 of the planned 120 were done) and hence multiple PDSA cycles were run to improve the audits. More HCPs were incorporated into the team for the audits.

Area 5 – Central line removal: A central line card was used to note the number of times / day the circuit was breached. It also served as a constant reminder to remove the line.

The study period is described as baseline period of 3 months and intervention period of 12 months in 3 phases. Phase 1 was the initial intervention period of 3 months and Phase 2 and 3 were the sustenance period of 4 and 5 months, respectively. Institutional ethical committee clearance was obtained for the study. However individual patient consent was waived off.

Statistical analysis: To observe a 25% decline in the CLABSI rates, from the baseline of 3% infection rate assuming 100 admissions per month, 270 subjects needed to be enrolled for the study to have 80% power and alpha error of 0.05. Thus the time frames needed in the baseline period and intervention period were at least 3 months. Categorical variables were compared by chi-square test or Fisher's exact test as applicable. Continuous variables distributed over time were compared with ANOVA. Incidence rates were calculated as number of events per 1000 patient days or per 1000 device days as applicable. The trend of incidence rates of infections over time was displayed and analyzed with the help of process control charts using Microsoft Excel software.

RESULTS

A total of 338 infants (69.5% intramural) were admitted to the NICU in the baseline period of the study. A total of 1227 infants (69.7% intramural) were admitted to the NICU in the intervention period of the study. The baseline characteristics of the babies admitted to the NICU were similar between the baseline period and intervention period. The mean gestational age in the baseline period was 34 weeks and 33-35 weeks in the 3 intervention phases. The mean birthweight in all the phases was between 2000-2100 g. The total patient days were 2052 in the baseline period and 2158, 3069 and 3876 in the three phases of the intervention period. The average (SD) bed occupancy was 22.3 (0.3) and 24.9 (0.7) per day during baseline and intervention periods, respectively.

There were a total of 54 central lines inserted during baseline period and 175 in intervention period (**Web Table I**). Checklists for central line insertion were used in 112 of the 175 central lines inserted. The audits have shown that all the steps of insertion were performed

consistently except measurement of the central line length to be inserted (missed on 11 occasions). The process (as assessed by audits) and outcome indicators are depicted in **Web Table I**. The control charts of BSI and CLABSI are depicted in **Web Fig. 2**. The overall mortality between the baseline and intervention period had shown a reduction from 2.9 to 1.7 per 100 admissions.

DISCUSSION

This study has shown that a significant decline in healthcare-associated infections is possible by using the principles of quality improvement. This QI project for infection control in NICU resulted in 89% reduction in rates of line related infections and 68% reduction in blood stream infections. The central line days reduced by 52%. This study focused on using QI principles to address accurate measurement of the problem, using simple evidence-based practices like HH and bundle care and health care personnel training to sustain the project.

The HH overall compliance rates increased from 0% to around 50%. The compliance rates measured in our study are lower than that quoted from other studies [9]. The 0% overall compliance was intriguing as the HH compliance in NICU as monitored by the hospital infection control committee (HICC) team was always >85%. The QI HH audit was more stringent and noted not only if hand hygiene was done or not but if all the core steps and the duration was adhered to. The stringent denominator data collection was initiated as a part of the study. This led to accurate measure of the infection parameters.

Various other studies conducted as large collaborative efforts have shown similar trends of results with care bundle approach and strengthening using QI principles. Fisher, *et al.* [10] published similar reduction in the rates of CLABSI by 71% over a period of 1 year among NICUs in North Carolina. There was also associated decrease in mortality between the two time frames of the study by 42% simply confirming the fact that NICU infection rates contribute significantly to the overall outcomes. Different studies have shown that surveillance of existing data, assessment of knowledge on a regular basis, checklist guided insertion practices and care bundle approaches have resulted in decreased CLABSI rates [9,10].

One of the key challenges in any QI program is to keep up the morale of the team and of the HCPs. Sharing data regularly during monthly ward meetings, giving a feedback both group and individualized, including personnel from all levels of care in the team were some of

WHAT IS ALREADY KNOWN?

- Central lines in NICU contribute to bloodstream related - infections in the Neonatal intensive care unit (NICU).

WHAT THIS STUDY ADDS?

- A quality improvement initiative can help reduce Central-line-associated Bloodstream Infection rates in NICU.

the steps taken to keep the team together. Improving knowledge and awareness of the CLABSI protocol was done by various measures such as introducing it in the induction program for every new nurse, personal email of the protocol, regular teaching sessions and a competitive quiz for the nurses. Feedback to administrators has been a routine part of our QI initiative, irrespective of the outcomes. These measures helped garner support for the program, promoted behavioral change of all HCPs towards infections, brought recognition for the NICU and for the nurses. QI initiative is a continuous process. Though we had initially planned the intervention period of 3 months to achieve a reduction of 25% in CLABSI rates, the results encouraged us to further lower the CLABSI rates and we continued the QI program and we have reported the sustenance of the gains over 1 year.

One of the main limitations of using a bundle approach is the inability to link specific intervention with change in infection rates. The other limitation has been that the targeted number of audits had not been met. However, this did not affect outcomes. Attempts were made to improve by recruiting more volunteers into the QI team for audits. Despite these limitations, this study highlights that QI principles are useful to address the common significant problem of nosocomial sepsis in NICU.

In conclusion, this study demonstrates the effectiveness of QI initiative in reducing CLABSI rates in a single center. The challenge remains in strengthening the processes and sustaining the achievements while further exploring new interventions and strategies to further reduce infections.

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revising the manuscript, approving the final version and accept accountability for all aspects of the work.

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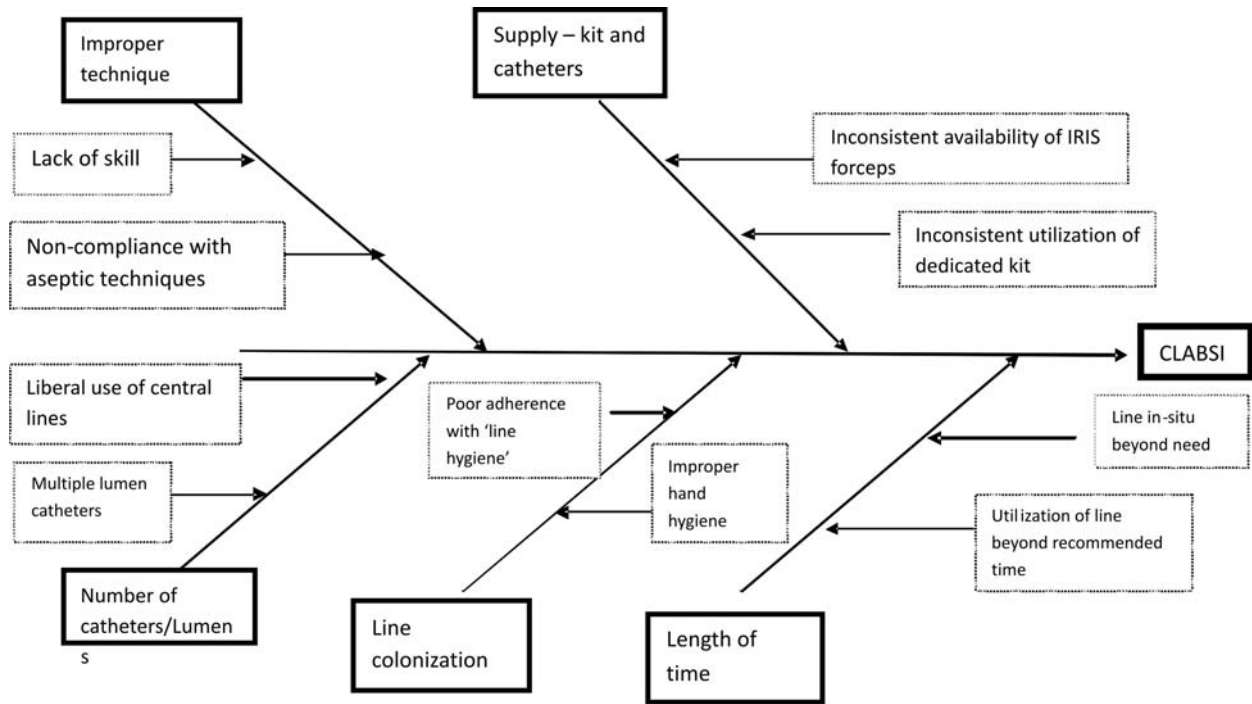
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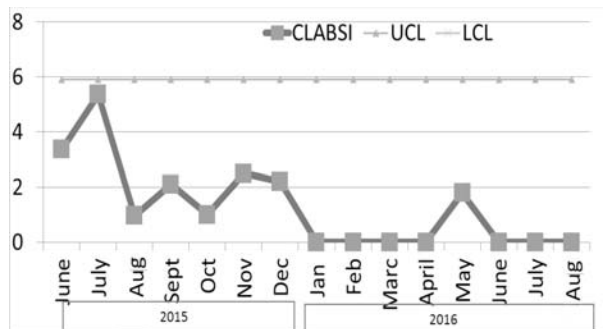
WEB TABLE I OUTCOME MEASURES AND PROCESS INDICATORS

<i>Attribute</i>	<i>Baseline</i>	<i>Phase 1</i>	<i>Phase 2</i>	<i>Phase 3</i>
CLABSI/1000 line days*	31.74	18.58	3.73	3.53
BSI/1000 patient days*	7.3	4.6	4.2	2.3
Line days/1000 patient days*	153.50	124.65	86.35	73.22
<i>Hand hygiene audits</i>				
Total audits (n)	20	36	92	98
Hand hygiene before (%)	90	100	98.6	97.9
Gloves when needed (%)	100	100	100	100
Hand hygiene after (%)	37	47	71.6	51
Correct number of steps (%)	NA	50	80.4	83.7
Adequate time for hand hygiene (%)	0	50	50	38.8
Overall compliance to HH (%)	0	47	50	39
<i>Central line maintenance bundle audits</i>				
Total audits (n)	NA	22	22	30
HH before (%)	NA	100	100	100
Accurate documentation of circuit break (%)	NA	81.8	59.1	70
Scrub the hub (%)	NA	81.8	68.2	66.7
Two persons job (%)	NA	59.1	86.4	76.7
Single port (%)	NA	100	100	100
Use of needleless connector (%)	NA	59.1	77.3	86.7
Overall compliance to maintenance bundle (%)	NA	59.1	68.2	66.7

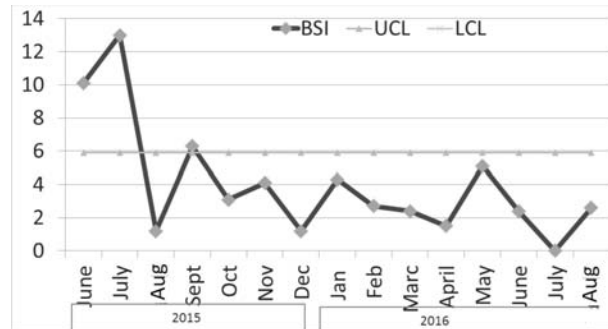
BSI: Blood stream infection; CLABSI: Central-line-associated blood stream infection; HH: hand hygiene; P<0.05; NA: Not available.



WEB FIG.1 Root cause analysis for CLABSI.



(a)



(b)

WEB FIG. 2 Control charts (a) CLABSI rates (per 1000 line days) (b) BSI rates (per 1000 patient days).