

Impact of Continuous Education and Training in Reduction of Central Line-associated Bloodstream Infection in Neurointensive Care Unit

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ABSTRACT

Background: Patients in the neurointensive care unit have high utilization of devices, thereby increased chance of getting device-associated infection (DAI). Central line-associated bloodstream infection (CLABSI) remains one of the most important DAI. Education remains an important part of the hospital infection control and improves the infection-control practices.

Materials and methods: To evaluate the effectiveness of a quality initiative in reducing incidence of CLABSI, a prospective study (January 2017–December 2018) was done estimating CLABSI incidence before and after the intervention. Continuous teaching and training for hand hygiene practice and central-line catheter hub care were used as the tool for this study.

Results: The quality improvement (QI) initiative achieved a 48% reduction in the CLABSI rate from the baseline rate of 8.7 to 4.5 per 1000 catheter days. The overall mortality showed a reduction from 1.5 to 0.05% during the post-intervention period. There was a significant improvement in compliance with the hand hygiene practice and catheter hub care in the post-intervention period.

Discussion and conclusion: This study demonstrates adherence to hand hygiene and catheter hub care with continuous teaching, training, and supervision was highly effective in reducing the CLABSI rate.

Clinical significance: Central line-associated bloodstream infection is one of the most important DAI causing significant morbidity and mortality in critically ill patient. Our findings support that continuous educational intervention of hand hygiene with and training on the catheter hub care are two most important preventive measures in the reduction of CLABSI incidence.

Keywords: Catheter hub care, Central venous catheters, Hand hygiene, Incidence, Teaching, Training.

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INTRODUCTION

Patients in neurocritical units are on prolong hospitalization due to stroke, brain injury, etc. This subsequently increases the utilization of external devices such as central line catheters, ventricular drains, urinary catheters, ventilators, etc. Hence, these patients are more prone to develop various health care-associated infections (HAIs) during their hospital stay.¹ Central line-associated bloodstream infection (CLABSI) is among the common device-associated infections (DAIs) among patients in neurointensive care units (NICUs). It contributes to nosocomial sepsis and subsequently leads to high morbidity and mortality.² The impact of the bundle of care approach for reduction of CLABSI has been evidenced by several studies. Hand hygiene is recognized as the most important and cost-effective measure of bundle approach for prevention of all DAIs.³ Due to the defective hand hygiene practice, microorganisms are often carried by the healthcare worker's hand from the patients or their surroundings and are transmitted to the adjacent patients and their environment during routine procedures. Adherence to the five moments of the hand hygiene has been evidenced with definite decrease in the infection rate. Catheter hub care is another important aspect of CLABSI bundle care and often found neglected during routine practices. To achieve good compliance, rate of the care bundles, continuous educational teaching, and training in all the levels of healthcare workers are proven to be very helpful.⁴

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Hence, this study was aimed to evaluate the impact of continuous teaching and training for strict adherence of the bundle care, especially the compliance of hand hygiene and central-line catheter hub care for the prevention of CLABSI among patients in neurocritical ICUs.

MATERIALS AND METHODS

A prospective observational study was conducted in the NICU over a time period of 2 years from January 2017 to December 2018. Quality improvement (QI) team was formed consisting of a microbiologist and infection-control nurses (ICNs). Ethical permission for this study was not required as this is part of routine ongoing surveillance activity. A total 50 nursing staff from three NICUs with total number of 31 beds participated in this study. The study was conducted in three phases where the CLABSI rate was monitored before and after the continuous teaching and training on the hand hygiene practice and catheter hub care.

Phase I was the pre-interventional period that included the continuous active surveillance of CLABSI cases among the patients in neurocritical care ICUs. Identification of CLABSI cases was made following the center of disease control's (CDC's) National Health Safety Network (NHSN) criteria. All the patients in neurocritical ICUs with a central line device for more than 48 hours were examined daily for the development of CLABSI. Blood specimen among clinically suspected CLABSI cases were sent to the microbiology department for culture, identification, and sensitivity testing. We used the tool for continuous active surveillance as per definition of CLABSI following the CDC/NHSN guideline as mentioned below.

NHSN Criteria for CLABSI

- Exposure to the central line catheter for more than 48 hours
- Laboratory-confirmed bloodstream infection (BSI)
 - More than equal to one blood culture positive for recognized pathogen
 - More than equal to two blood culture positive for common commensal with any one of the signs: fever, hypotension, or bradycardia
- There should not be evidence of infection of the any other site of the body caused by the same organism during that time frame period (3 days before and 14 days after the day of event).

The study was conducted from January 1, 2017 to December 31, 2017. Data compilation and analysis of the CLABSI rate, central line catheter days, and the device utilization ratio (DUR) were done during this period. Also, an evaluation based on the practices followed up routinely by the nursing staff for the insertion and maintenance bundle of care was also collected and analyzed (Table 1).

Phase II was the intervention period lasting for 1 month, i.e., January 1, 2018–January 31, 2018. During this period, the entire nursing staff working in the three NICUs in different capacity (assistant nursing superintendent (ANS), sister in-charge of the ward, and staff nurse), who directly come in contact with patients, underwent a continuous teaching and training course. The training included educational teaching in the form of lectures and training as practical demonstration on hand hygiene and central-line catheter hub care. The training on hand hygiene included knowledge regarding five moments, different zones during the hand hygiene practice (healthcare zone, patient zone, critical site zone), and steps of hand hygiene. During the training, cleaning the central-line catheter hub by rubbing with 70% alcohol swab at least 10 times during handling was also emphasized. All the training sessions were followed by an assessment test. Proper planning was made to target and include entire nursing staff appointed in these three ICUs (Fig. 1). All the ANSs were trained first followed by the junior

Table 1: Practices followed by the nursing staff during the pre-intervention period

Routine practices	Score (%)
Perform hand hygiene before handling	47
Use of only sterile devices to assess the catheter	100
Dressings replaced immediately when wet/soiled/dislodged	60
Performance of routine dressing with aseptic techniques using sterile gloves	90
Change the gauze at least in 2 days	100
Change of transparent dressing at least on 7 days	100
Scrub the assess port or hub immediately prior to each use with antiseptics (chlorhexidine/70% alcohol/povidone iodine)	0
Change of administration set for continuous infusions no more frequently than every 4 days but at least in 7 days	100
If blood or blood products are administered change of tubing in every 24 hours	100

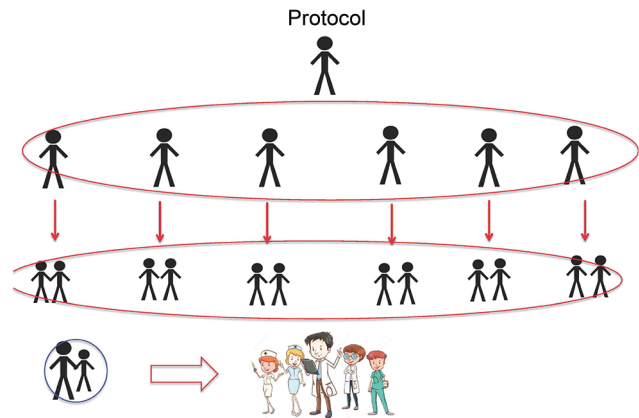


Fig. 1: Strategy for continuous teaching and training in the interventional and post-interventional period

staff. Each training cycle consisted of two phases. Phase IIA included the continuous teaching and training session followed by phase IIB, the questionnaire and practical based evaluation. Nursing staff who scored more than 90% in the evaluation test were certified as trained. Those who secured less than 90% were again put through the same training process until they secured more than 90%.

Phase III was the post-intervention period conducted from February 2018 to December 2018. After completion of training of all the nursing staff, two junior nursing individuals from each ICU were chosen to monitor the compliance of hand hygiene practices and central-line hub care by the healthcare workers (Fig. 1).

A proper format was made to monitor and record the hand hygiene action, opportunities, and action by the healthcare workers. Strict monitoring was done on the hand hygiene practices and catheter hub care. Continuous surveillance of CLABSI cases was monitored by the ICNs as per the standard protocol of CDC/NHSN for all the patients admitted to the NICU. Data were collected on total number of CLABSI rates, patient days, DUR, central-line days, and analyzed for both pre- and post-interventional periods (Table 2).

The CLABSI rate and device utilization ratios per 1,000 patient days were calculated using the following formulas:

CLABSI Rate

Total number of CLABSI/Total number of central-line catheter days × 1000

Device Utilization Ratio (DUR)

Number of central-line catheter days/Total number of patient days

Mortality Rate

Total number of deaths due to CLABSI/Total number of patient days × 100

RESULTS

A total of 50 individual nursing staffs participated in the study, out of which 4 were ANS, 9 were in-charges, and rest 31 were junior nursing staff.

Phase I (Pre-intervention Period)

The CLABSI rate of ICU A, ICU B and ICU C were found as 10.04/1,000 catheter days, 8.87/1,000 catheter days, and 7.3/1,000 catheter days, respectively, with the average rate of 8.73/1,000 central-line days. Total patient days of ICU A, ICU B and ICU C were observed as 1,797, 1,779, and 2,387, respectively, with average of 1987.6. ICU C showed increased patient days due to prolong stay in the hospitals because of underlying neurologic conditions. The DURs of ICU A, ICU B, and ICU C were 0.83, 0.59, and 0.59, respectively, with average rate of 0.67. The mortality rate due to CLABSI in ICU A was 0.22%, in ICU B was 0.16%, and in ICU C was 0.08% with average mortality of 0.15%. During this period, the average patient mortality rate was 1.56% and the attributable mortality rate was 1.31%.

While observing various care practices, catheter hub care and hand hygiene practices were observed to be practiced least in comparison to other practices (Table 1).

Phase II (Intervention Period)

A total of 50 nursing individuals participated in this part. During the intervention period, the entire nursing staff was trained continuously until they achieved ≥90% score.

Phase III (Post-intervention Period)

Comparing the pre- and post-intervention period, it was found that the knowledge and practice of hand hygiene had been drastically increased in the post-intervention period. All the nursing staff had good knowledge regarding the five moments, steps, and showed a positive attitude for the hand hygiene practice. Improvement had also been observed in the compliance of scrubbing the catheter hub with alcohol swab during its handling by the nursing staff in all the ICUs. Apart from this, knowledge on the duration of hand hygiene practice, difference between hand washing and hand rub, and lack of inhibition to use hand rub were improved significantly. Also, the practice for all five moments of hand hygiene as described by WHO was also followed.

There was significant decrease in the CLABSI rate in the post-intervention period (February 2018–December 2018) in comparison to the pre-intervention period. In the post-intervention period, the CLABSI rates of ICU A, ICU B, and ICU C were found as 7.14/1,000 catheter days, 4.5/1,000 catheter days, and 2.08/1,000 catheter days, respectively. The average CLABSI rate was observed as 4.57/1,000 central line days. Total patient days found in ICU A, ICU B, and ICU

Table 2: Comparison of parameters in three ICUs in the pre- and post-intervention period

	Pre-intervention period				Post-intervention period				p value (paired t-test)		
	ICU A	ICU B	ICUC	Average	SD	ICU A	ICU B	ICUC		Average	SD
CLABSI rate	10.04	8.87	7.3	8.73	1.3749	7.14	4.5	2.08	4.57	2.5308	0.0255
DUR	0.83	0.59	0.59	0.67	0.1480	0.86	0.52	0.46	0.61	0.2157	0.3570
Avg. central line days	1505	1051	1428	1328	242.9	1173	752	2388	1437.8	849.5	0.8206
Avg. patient days	1796	1779	2387	1987.3	346.2	1350	1427	5171	2649.3	2184.1	0.596
Mortality rate	0.22	0.16	0.08	0.15	0.0702	0.07	0.07	0.01	0.05	0.0346	0.0501



C were 1,350, 1,427, and 5,171 with average of 2649.3. The DURs in ICU A, ICU B, and ICU C were 0.86, 0.52 and 0.46, and average: 0.61. The mortality rates due to CLABSI in ICU A, ICU B, and ICU C were 0.07, 0.07, and 0.01% with an average mortality of 0.05%. The patient days were 1987 in 2017 and 2649.3 in 2018. The DUR in 2017 was 0.67 and 0.61 in 2018. The mortality was also found to be 0.15 in 2017 and 0.05 in 2018 (Table 2). During this period, the average patient mortality rate was 2.01% and the attributable mortality rate was 1.9%.

Statistical Analysis

The paired *t*-test was applied to determine the difference between the mean of various observations in the pre- and post-intervention period. With 95% confidence interval, the difference in the CLABSI rate and mortality rate in the pre- and post-intervention period was found significant ($p < 0.05$) (Table 2).

DISCUSSION

The QI initiative remains very effective in identifying the gap in knowledge as well as easy to implement in routine practice. Prolong use of central line is one of the important risk factors for the development of CLABSI. Prevention of incidence of CLABSI can reduce the adverse outcome of the patient and cost of hospital stay. In the pre-assessment period of the current study, we realized that important components of central-line care bundle such as the hand hygiene practice and catheter hub care were practiced least in comparison to other components routinely. Hence, we emphasized to strengthen these two components and evaluated the role of continuous teaching and training tool on reduction of the CLABSI rate. There is 47.6% decrease in the CLABSI rate in the post-intervention period in comparison to the pre-intervention period. The decrease in the rate was also found unanimously in all the ICUs. The central-line days and the patient days mostly remain the same in the pre- and post-intervention period (Table 2). This shows that there was a definite gap in the knowledge and practice toward the hand hygiene practice and catheter hub care, which had played a major role in the CLABSI incidence. In this prospective study, data related to DAI were only collected and the patients could not be followed up after being shifted from ICU to other patient care area. Hence, detailed and long-term follow-up data on mortality may give better idea on the total patient mortality rate and attributable rate.

Several other studies had shown the decline in the DAI rate by adhering to the bundle of care. Fisher et al. showed a reduction of CLABSI rate up to 71% adhering to the bundle of care.⁵ Other studies also showed a decrease in the CLABSI rates due to surveillance and knowledge on the insertion and maintenance bundle.⁶ The bundle of care has been observed to have a great impact in the decrease of DAI in many studies. As well as adherence to these practices is now encouraged in many parts of the world.⁷⁻⁹

Our study showed that small quality improvement initiative helps to find out the exact lacunae in the knowledge and compliance. We focused on repeated teaching and continuous monitoring, which resulted in subsequent decrease in the CLABSI

rate. The study by Rallis et al. also showed significant reduction in the CLABSI from 12 cases/1,000 CVC days to 3.4 cases/1,000 CVC days by adapting comprehensive bundles.¹⁰ Hand hygiene remains one of the most effective ways to reduce the DAI. Proper education, knowledge, and appropriate training of why, when, and how to perform hand hygiene resulted in reduction of the CLABSI rates in our study.

CONCLUSION

Our study highlighted the key strategies, which were identified as neglected and targeted for intervention. Continuous teaching and training about why, when, and where hand hygiene increases the compliance along with the practices among the nursing staff. Proper decontamination of the catheter hub helped in reduction of development of CLABSI.

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