DOI: 10.7860/IJNMR/2022/52245.2344

Original Article

Paediatrics Section

Central Line Associated Blood Stream Infections and Effectiveness of Care Bundle Approach: A Prospective Cohort Study

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ABSTRACT

Introduction: Insertion and maintenance of Central Venous Catheters (CVC) are integral components for the supportive care of critically ill neonates. Their use is often associated with the unavoidable risk of acquiring Healthcare Associated Infections (HAI) like Central Line Associated Blood Stream Infections (CLABSI) especially in resource limited public sector Neonatal Intensive Care Units (NICU). Adopting a care bundle approach to decrease CLABSI rates in such NICUs still remains a challenge.

Aim: To determine the baseline CLABSI rate, identify the risk factors associated with it and also to determine the effectiveness of care bundle approach in decreasing CLABSI.

Materials and Methods: An analytical prospective cohort study was conducted in Cheluvamba Hospital, attached to Mysore Medical College and Research Institute, Mysuru, Karnataka, India, from June 2018 to June 2020. In the preintervention phase (June 2018 to May 2019), the data of 307 neonates in whom Central Line (CL) was inserted were analysed to determine the baseline CLABSI rate and risk factors. CLABSI bundle involves a group of evidence-based practices which when implemented reliably and consistently have shown to significantly reduce CLABSI rates. CLABSI bundle was implemented in June 2019 and in the postintervention phase (July 2019 to June 2020), the data of 283 neonates were analysed and compared to those in the preintervention group in order to assess the effectiveness of the care bundle approach. Chi-square test was used to compare categorical variables whereas a two sample t-test was used to compare continuous variables.

Results: A total of 41 CLABSI episodes were documented in the preintervention phase (Group 1) as compared to 12 in the postintervention phase (Group 2). Mean birth weight and gestational age was significantly lower in neonates with CLABSI as compared to neonates without CLABSI in both the groups. The incidence of CLABSI was significantly higher in neonates with a catheter dwell time of more than eight days and in those who received Total Parenteral Nutrition (TPN). Implementation of the CLABSI bundle resulted in the reduction of the baseline CLABSI rate from 16.25 to 8.3/1000 CL days; a significant reduction in the catheter dwell time and duration of NICU stay was also noted in group 2. Duration of NICU stay and death rate among neonates who developed CLABSI did not differ significantly between both the groups.

Conclusion: Despite incorporating the care bundle approach, CLABSI rate remained to be high. Very preterm neonates with birth weight of <1500 grams and NICU stay of more than 25 days were more likely to develop CLABSI. Significant reduction in CLABSI rates can be achieved with widespread implementation of the CLABSI bundle in resource limited NICUs across India.

Keywords: Catheter related infection, Neonate, Resource limited, Sepsis

INTRODUCTION

The Healthcare Associated Infections (HAI) are recognised causes of increasing the mortality and morbidity of critically ill patients across all age groups. In comparison to developed countries, a meta-analysis has shown that the HAI rates are triple in the Intensive Care Units (ICU) of Low- And Middle-Income Countries (LMIC) [1,2]. The use of CVC in critically ill neonates allows continuation of lifesaving treatment thereby, improving their outcome. Blood Stream Infections (BSI) are the most common type of HAI and nearly 75% of these BSIs are associated with the presence of a CL [3]. The use of sophisticated and invasive interventions has led to improved survival of sick neonates and therefore, the number of neonates acquiring HAIs especially CLABSI has increased significantly [4]. Owing to certain physiological handicaps (like an immature immune system) preterm neonates are more susceptible to acquire CLABSI. Neonates experiencing CLABSI have prolonged stay in the NICU, increased mortality, poor growth and neurodevelopmental outcomes leading to increased medical costs.

A care bundle approach involves a group of evidence-based practices which when implemented reliably and consistently have shown to significantly reduce HAIs [4]. It is imperative to adopt such care bundle approach in resource limited NICUs in developing countries like India mainly to decrease neonatal mortality and also to significantly lower the hospital costs especially when less than 2% of the Gross Domestic Product (GDP) is spent on healthcare. Data regarding baseline CLABSI rates and the effectiveness of care bundle in reducing the burden of CLABSI in public sector NICUs are lacking in India.

The study aimed to determine the baseline CLABSI rate, identify the risk factors associated with it and also to determine the effectiveness of care bundle approach in decreasing CLABSI. The hypothesis was that the implementation of the CLABSI bundle results in significant decrease in the baseline CLABSI rate and also the duration of NICU stay.

MATERIALS AND METHODS

This analytical prospective cohort study was conducted at the NICU of Cheluvamba Hospital, a tertiary care teaching hospital attached to Mysore Medical College and Research Institute (MMC and RI), Mysuru, Karnataka, India, from June 2018 to June 2020. The

present study was approved by the Institutional Ethics Committee (EC REG: ECR/134/Inst/KA/2013/RR-16), and informed written consent was taken from the parents/caregivers of all the neonates who were included.

The first phase (preintervention) of the study was done from June 2018 to May 2019. After determining the baseline CLABSI rate and the risk factors associated with it, CLABSI bundle was implemented in June 2019. The second phase (postintervention) was done from July 2019 to June 2020.

Inclusion criteria: In both the phases, all neonates admitted in the NICU for receiving either medical or surgical care and in whom peripheral venous access was not possible or difficult to access and if central venous access was required either to administer intravenous fluid/drugs/TPN or inotropes were identified as potential subjects for inclusion. As per the Department protocol, a baseline complete haemogram, blood culture and sensitivity and C-Reactive Protein (CRP) was sent in all such neonates prior to inserting the CL.

Exclusion criteria: Those neonates who required the insertion of CL and showed either clinical (lethargy, temperature instability, apnoea, bradycardia) or laboratory evidence of sepsis [5], elevated/positive C-Reactive Protein (CRP), leucocytosis (total WBC count of >20,000 cells/mm^3, leucopenia (total WBC count <5,000 cells/mm^3), low absolute neutrophil count (<1,000 cells/mm^3) or positive blood culture} were excluded. Neonates born to mothers infected with HIV, Prolonged Rupture of Membranes (PROM) of more than 18 hours, maternal pyrexia/urinary tract infection prior to delivery of the baby and those neonates with umbilical arterial catheters were also excluded.

Babies born between 37-41 weeks of gestation were considered as term, $34^{0/7}$-$36^{6/7}$ weeks as late preterm, $32^{0/7}$-$33^{6/7}$ as moderate preterm and $28^{0/7}$-$31^{6/7}$ as very preterm neonates [6].

Study Procedure

Umbilical Venous Catheters (UVC) and CVCs were the first and second choice CLs inserted. A 40 cm, 3.5 Fr or 4 Fr UVC was used to cannulate the Umbilical Vein (UV), whereas a 22-gauge 10 cm single lumen CVC manufactured by Centvent was used to cannulate the Femoral Vein (FV), Internal Jugular Vein (IJV) or Subclavian Vein (SV). While the UVCs were inserted by the paediatric residents/faculty who were performing duties in the NICU, CVCs were inserted only by the paediatric surgery faculty either in the NICU or Operation Theatre (OT). All neonates requiring surgical management had their CL inserted in the OT.

The demographic and clinical details of the neonates including age, gender, birth weight, gestational age, type of CL, venue and anatomical site of CL insertion, catheter dwell time, duration of NICU stay, administration of TPN, organisms isolated and outcome were entered in a CLABSI register and a baseline CLABSI rate and its risk factors were determined.

In June 2019, CLABSI bundle was implemented which included both the insertion and maintenance bundle [Table/Fig-1] where all the paediatric medicine, paediatric surgery residents/faculty and NICU staff nurses were trained over a period of one month. Lectures, bedside training and audio-visual aids were used during the training. Knowledge and awareness of the CLABSI bundle was emphasised at the beginning of every month and the CLABSI bundle proforma was included as a part of the induction training material for any new nurse joining the NICU. Placards mentioning the CLABSI bundle were stunk on the walls of the NICU for timely referral. Data of neonates admitted in June 2019 were not included in the analysis.

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Insertion bundle

1. CL insertion kit with all items/equipments required for procedure ☐
2. Hand hygiene with an alcohol based product (Eg: 2% chlorhexidine with 70% ethyl alcohol) or disinfectant-containing soap before and after palpating insertion sites and before and after inserting CL ☐
3. Use of maximal barrier precautions –
   (i). Full length sterile gown ☐
   (ii). Sterile gloves ☐
   (iii). Surgical mask and head cap ☐
   (iv). Large sterile drape/hole towel ☐
4. Disinfection of skin with a proper antiseptic (Eg: 2% chlorhexidine with 70% ethyl alcohol) before CL insertion ☐
5. Use of sterile transparent semipermeable dressing (tegaderm) on a sterile gauze to cover insertion site ☐

Signature Doctor:
Staff Nurse:

Maintenance bundle

Date	Day of insertion of CL	Daily catheter care by aseptic technique			Any local signs of infection/ redness/ necrosis – YES/NO	CL still required or not? – YES/NO
		Alcohol rub decontamination for atleast 15 seconds during handling of CL hub/s.	Use of sterile gloves to handle CL hubs and hand hygiene before and after glove use.	Use of a suitable disinfectant (2% chlorhexidine with 70% ethyl alcohol) for insertion site dressing changes.		

Signature Doctor:
Staff Nurse:

[Table/Fig-1]: CLABSI bundle.

Neonates with a UVC or CVC were monitored for the development of BSI. Blood culture and sensitivity (drawn from a peripheral vein) was sent for all neonates who demonstrated clinical signs of sepsis (lethargy, temperature instability, apnoea, bradycardia, feed intolerance) after 48 hours of insertion of the CL or prior to the removal of the CL whichever was earlier. Following removal, the CL tip was also sent for culture and sensitivity.

As per the US Centers for Disease Control and Prevention (CDC)/ National Healthcare Safety Network (NHSN) 2014 [7], CLABSI was defined as Laboratory Confirmed BSI (LC-BSI) in a neonate with CL in-situ for atleast 48 hours after insertion or within 24 hours of its removal. LC-BSI was confirmed when a recognised pathogen was recovered from one or more blood cultures and the organism cultured from blood was not related to an infection at another site. If a skin commensal like coagulase negative Staphylococcus Aureus (CONS) or *Streptococci viridans* were isolated, atleast two blood cultures drawn 24 hours apart showing the same organism was required to confirm LC-BSI [7]. CLABSI was considered to be polymicrobial, if two or more organisms were isolated in blood culture. Line days were the total number of days of exposure to CL by all patients in the selected population and time period. CLABSI rate per 1000-line days was calculated by dividing the total number of CLABSI episodes by the total number of CL days and multiplying the result by 1000.

In the postintervention phase (July 2019 to June 2020), a CLABSI bundle proforma was attached to the case sheet of all neonates included in the study. The staff nurse and paediatric faculty in-charge of NICU ensured that all the steps/practices mentioned in the bundle were followed both during insertion and maintenance of the CL and the same were entered in the proforma. Details of the neonates were continued to be documented in the CLABSI register.

STATISTICAL ANALYSIS

In both phases, all neonates who met the inclusion criteria during the study period were recruited using consecutive sampling. Data obtained were computed using Microsoft excel and analysed using Statistical Package for the Social Sciences (SPSS) software version 20.0. Continuous data were presented as mean (SD) or median

(range) whereas categorical data were represented as frequency and percentage. Chi-square test was used to compare categorical variables whereas a two-sample t-test was used to compare continuous variables. Predictive analysis of significant risk factors was done using multiple logistic regression. A two tailed p-value of less than 0.05 was considered significant.

RESULTS

In the preintervention phase (group 1), out of the 326 neonates who were included, 12 neonates were Discharged Against Medical Advice (DAMA) and seven neonates succumbed within 48 hours of CL insertion. Similarly, in the postintervention phase (group 2), out of the 295 neonates, nine went DAMA and three succumbed within 48 hours of CL insertion. Therefore, the data of 307 and 283 neonates of the pre and postintervention phase respectively were analysed which resulted in the following observations.

A total of 41 CLABSI episodes were documented in group 1 as compared to 12 in group 2. Male babies encompassed majority of the study population in both groups (61.23% in preintervention and 55.12% in postintervention phase). Nearly three-fourths of the study population was constituted by preterm neonates and the incidence of CLABSI was significantly high in preterm as compared to term neonates. Mean birth weight and gestational age was significantly lower in neonates with CLABSI in both the groups. Nearly 20% of the study population received TPN and the incidence of CLABSI was significantly higher in neonates, who received TPN in both groups. Most of the CLs were inserted in the NICU and were UVCs [Table/Fig-2].

There was no significant difference in the incidence of CLABSI based on the type of CL, anatomical site and venue of CL insertion. However, the incidence of CLABSI was significantly higher in neonates with a catheter dwell time of more than eight days in group 1. There was no significant difference in the time interval between the onset of CLABSI and the type of CL in both groups. In group 1, there were five episodes of CLABSI that were polymicrobial. Gram negative bacteria were isolated in most cases. *Candida* species was the second most common organism isolated in all the polymicrobial CLABSIs [Table/Fig-3].

The CLABSI episodes were significantly less in the neonates of group 2 as compared to group 1. CLABSI rate was reduced by almost 50% in group 2. In comparison to group 1, catheter dwell time was significantly lower (9.31 days-group 1 vs 6.33 days-group 2, p-value<0.001) and the time interval between the CL insertion and onset of CLABSI (3.87 days-group 1 vs 5.5 days-group 2, p-value=0.004) was significantly higher in group 2. Though the duration of NICU stay was significantly less in group 2, there was no significant difference in the duration of NICU stay in neonates who developed CLABSI in both groups [Table/Fig-3]. There was no significant difference in the TPN related CLABSI episodes or deaths related to CLABSI in both groups [Table/Fig-2]. In both the groups, neonates with a birth weight of less than 1500 grams, catheter dwell time of more than eight days and NICU stay of more than 25 days were more likely to have CLABSI and remained significant risk factors in both univariate and multivariate analysis [Table/Fig-4].

DISCUSSION

The HAI represent a major burden for patients especially in a developing country like India. In comparison to the HAI rates ranging from 4.5 to 7.1 per 100 patients in the western world,

Demographic variables		Preintervention (n=307)			Postintervention (n=283)		
		CLABSI (n=41)	Non CLABSI (n=266)	p-value	CLABSI (n=12)	Non CLABSI (n=271)	p-value
Gender	Male (n,%)	22 (53.65)	166 (62.40)	0.284	6 (50)	150 (55.3)	0.715
	Female	19 (46.35)	100 (37.60)		6 (50)	121 (44.64)	
Birth weight (g), mean (SD)		1722.07 (650.03)	2153 (655.52)	0.002	1639.16 (535.95)	2210 (687.72)	0.003
Gestational age (weeks), mean (SD)		32.12 (3.62)	34.81 (3.01)	0.001	31.66 (3.02)	34.90 (3.72)	0.003
Gestational maturity	Preterm (n,%)	36 (87.80)	182 (68.42)	0.001	11 (91.67)	176 (64.94)	0.001
	-Very Preterm	20	36		7	41	
	-Mod. Preterm	9	99		2	77	
	-Late preterm	7	47		2	58	
	Term	5 (12.20)	84 (31.58)		1 (8.33)	95 (35.06)	
Type of CL	UVC (n,%)	160 (52.12)			148 (52.30)		
	CVC	147 (47.88)			135 (47.70)		
Venue of CL insertion	NICU (n,%)	279 (90.88)			271 (95.76)		
	OT	28 (9.12)			12 (4.24)		
TPN in CL	Given (n,%)	14 (34.15)	46 (17.29)	0.011	5 (41.67)	50 (18.45)	0.046
	Not Given	27 (65.85)	220 (82.71)		7 (58.33)	221 (81.55)	
TPN related CLABSI episodes		14			5		0.633
Duration of NICU stay (in days), mean (SD)	All cases	17.60 (5.56)			12.61 (5.47)		0.001
	CLABSI cases	23.34 (4.39)			22.83 (2.51)		0.614
Outcome	Death (n,%)	14 (34.15)	21 (7.89)	0.001	5 (41.67)	15 (5.54)	0.001
	Discharge	27 (65.85)	245 (92.11)		7 (58.33)	256 (94.46)	
Death due to CLABSI		14			5		0.633

[Table/Fig-2]: Characteristics of the study population.
CLABSI: Central line associated blood stream infection; Mod: Moderate; CL: Central line; UVC: Umbilical venous catheter; CVC: Central venous catheter; NICU: Neonatal intensive care unit; OT: Operation theatre; TPN: Total parenteral nutrition; p-value of less than 0.05 was considered significant

Characteristics			Preintervention CLABSI (n=41)		Postintervention CLABSI (n=12)	
			n (%)	p-value	n (%)	p-value
Type of CL		UVC	25 (60.98)	0.222	5 (41.67)	0.451
		CVC	16 (39.02)		7 (58.33)	
Anatomical site of CL insertion		UV	25 (60.98)	0.399	5 (41.67)	0.852
		FV	13 (31.71)		6 (50)	
		IJV	3 (7.31)		1 (8.33)	
		SV	0		0	
Venue of CL insertion		NICU	39 (95.12)	0.310	11 (91.67)	0.472
		OT	2 (4.88)		1 (8.33)	
Line days (in the total population)			2523		1443	
CLABSI rate/1000-line days (in the total population)			16.25		8.3	
Catheter dwell time (in days)		<4 days	10 (24.39)	0.005	0	0.121
		4-8 days	1 (2.44)		11 (91.67)	
		> 8 days	30 (73.17)		1 (8.33)	
Catheter dwell time (in the total population, in days)		Mean (SD)	9.31 (2.33)		6.33 (1.55)	0.001
Time to CLABSI after line insertion (days), mean (SD)		All lines	3.87 (0.92)	0.459	5.5 (1.16)	0.831
		UVC	3.96 (1.01)		5.6 (1.52)	
		CVC	3.75 (0.77)		5.43 (0.97)	
Time to CLABSI after line insertion (in total population, in days)		Mean (SD)	3.87 (0.92)		5.5 (1.16)	0.004
Type of CLABSI		Monomicrobial	36	-	12	-
		Polymicrobial	5		0	
Pathogens isolated	Gram positive bacteria	MRSA	9	-	3	-
		Enterococcus	3		-	
	Gram negative bacteria	*Klebsiella sp.*	10	-	5	-
		Pseudomonas sp.	7		2	
		E. coli	8		2	
		Acinobacter sp.	4		-	
	Fungi	*Candida albicans*	3		-	
		Candida non-albicans	2		-	
	Total number of isolates		46		12	0.001

[Table/Fig-3]: Characteristics of CLABSI episodes.
CLABSI: Central line associated blood stream infection; CL: Central line; UVC: Umbilical venous catheter; CVC: Central venous catheter; UV: Umbilical vein; FV: Femoral vein; IJV: Internal jugular vein; SV: Subclavian vein; NICU: Neonatal intensive care unit; OT: Operation theatre; MRSA: Methicillin resistant staphylococcus aureus; Sp: Species; p-value of less than 0.05 was considered significant

Risk factors	Preintervention (n=307)						Postintervention (n=283)					
	Univariate analysis			Multivariate analysis			Univariate analysis			Multivariate analysis		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Gestational maturity (Preterm)	3.32	1.25-8.77	0.015	1.59	0.49-5.17	0.442	5.93	0.75-46.69	0.009	1.88	0.18-19.19	0.591
Birth weight (<1500 g)	6.08	3.00-12.33	0.001	3.00	1.18-7.59	0.020	7.85	2.37-25.94	0.001	4.67	0.97-22.38	0.044
TPN administration through CL	2.48	1.20-5.09	0.013	0.67	0.26-1.72	0.408	3.15	0.96-10.35	0.048	1.75	0.39-7.71	0.456
Catheter dwell time of >8 days	3.17	1.52-6.59	0.002	2.48	1.08-5.71	0.032	2.58	0.66-10.04	0.017	1.01	0.18-5.57	0.010
Duration of NICU stay of >25 days	8.35	3.57-19.55	0.001	4.06	1.47-11.22	0.007	6.12	2.38-23.30	0.008	2.36	1.21-14.88	0.021

[Table/Fig-4]: Risk factors for CLABSI episodes.
OR: Odds ratio; CI: Confidence interval; TPN: Total parenteral nutrition; CL: Central line; NICU: Neonatal intensive care unit; p-value of less than 0.05 was considered significant

the prevalence of HAI in LMIC has been found to be substantially high (15.5 per 100 patients). In the setting of ICU acquired HAIs, this difference becomes even more striking where the prevalence was found to be as high as 47.7 per 1000 ICU patient days in the developing world as compared to 13.6 per 1000 ICU patient days in the USA [1,8]. The advantage of improved survival in critically ill patients with the support of invasive devices has been offset to certain extent by the unavoidable risk of infections related to these devices. The risk of HAIs like CLABSI posed by these invasive devices goes beyond an acceptable level in resource limited settings. In the present study, the risk factors for CLABSI and the effect of the CLABSI bundle in reducing CLABSI rate was analysed. Allegranzi B et al., had conducted a meta-analysis of HAIs in developing countries and had showed a pooled median CLABSI rate among both the paediatric and neonatal ICUs to be 18.7/1000 CL days [1]. A similar CLABSI rate of 16.25/1000 CL days was found in the present study. This seems to be considerably high as compared to the data

reported by Geldenhuys C et al., who had conducted a case-control study involving 95 neonates in a similar resource limited NICU in South Africa and found a CLABSI rate of 5.9/1000 line days [2]. NICU at Cheluvamba Hospital is a tertiary care unit catering to both the intramural sick neonates and also to those extramural sick babies who are referred to from the neighbouring talukas and sometimes districts. This results in overcrowding of the NICU, with consequent understaffing and very high patient to nurse/doctor ratio. Also, the limited resources are almost always overwhelmed with the case load resulting in a higher CLABSI rate. In addition, high percentage of preterm deliveries resulting in the birth of preterm/low birth weight neonates constituted nearly 80% of the study population. Increased use of CLs, prolonged NICU stay combined with other factors such as their immature skin, relatively immunocompromised status as well as low level of transplacentally acquired antibodies and the need for parenteral nutrition resulted in a significantly higher incidence of CLABSI in very preterm neonates.

Studies from the developed and few developing countries have shown that implementation of the CLABSI bundle resulted in the reduction of the CLABSI rate ranging from 59% to as high as 71% from the baseline [4,9-12]. Prakash SS et al., analysed data from various ICUs in JIPMER, Puducherry, India and found a reduction in the pooled paediatric and neonatal CLABSI rate by around 30% following implementing of the CLABSI bundle [13]. Data from this study has demonstrated a nearly 50% reduction from the baseline CLABSI rate following the incorporation of the care bundle approach. Though the postintervention CLABSI rate of 8.3/1000 CL days remains to be high, this data has emphasised the importance of adherence to the CLABSI bundle to prevent/reduce CLABSIs even when the resources are limited. Conflicting data are available regarding the type of CL and the occurrence of CLABSI. While Geldenhuys C et al., found that CLABSI was significantly higher in neonates with CVC, Ratna A et al., showed that CLABSI was significantly higher in neonates with UVC [2,12]. In the present study, there was no significant difference in the incidence of CLABSI with either UVC or CVC. Further, there was no significant difference in the incidence of CLABSI with respect to the anatomical site or venue of CL insertion. However, Geldenhuys C et al., found that the occurrence of CLABSI was significantly higher when the CL was inserted in the OT [2]. Most studies provide data to support the evidence that TPN increases the risk of BSI, especially CLABSI in neonates [3,13-15]. Data form the present study has shown similar evidence. Interestingly, data provided by Geldenhuys C et al., did not show any significant relationship between TPN and CLABSI episodes [2]. Although there was a decrease in the CLABSI rate and catheter dwell time, there was no difference in the mortality rate of neonates who developed CLABSI in both the pre and post intervention groups highlighting the fact that preventive measures aimed to prevent CLABSI can significantly reduce the duration of NICU stay, morbidity, mortality and most importantly the financial burden, and supporting the hypothesis designed for the study.

Limitation(s)

Data presented in the present study includes a large sample size, however, these findings need to be interpreted in the context of few limitations. Implementation of the CLABSI bundle was successful to a certain extent in the reduction of the baseline CLABSI rate, however, incorporation of Quality Improvement (QI) initiative along with a care bundle approach would further help in assessing the consistency of implementation of all aspects of the CLABSI bundle. Duration and type of TPN used, quantity of enteral feeds, and also the relation between inotrope use and CLABSI was not analysed. Finally, the antibiogram of the isolates was also not analysed, which would otherwise help to streamline the antibiotic usage and also to provide data to the infection control surveillance teams enabling better antibiotic stewardship.

CONCLUSION(S)

Public sector NICUs encounter unique challenges like overcrowding, understaffing, lack of training and infrastructure, and most importantly, limited resources resulting in a higher rate of HAIs like CLABSI. Amidst these challenges, this data proves beyond doubt that incorporation of a care bundle approach can significantly decrease CLABSI rates, and will also enable to benchmark the NICU of Cheluvamba Hospital against similar resource limited NICUs across India. Incorporation of QI initiative and regular audit of the CLABSI register by surveillance teams may further reduce CLABSI rates and sustain the advantage consistently over a longer period of time. Primordial preventive measures addressed to reduce the incidence of very preterm/low birth weight babies may also significantly reduce the burden on such NICUs, thereby, reducing the CLABSI rate. National programs meant to reduce neonatal mortality should also try to advocate uniform implementation of such bundles in public sector NICUs which may result in improved patient outcomes and significantly reduce the economic burden to the patient as well as to the nation.

Acknowledgement

The authors thank all the subjects and their parents for having taken part in this research. The authors also extend their gratitude to all their colleagues and postgraduate students who helped to conduct the present research.

REFERENCES

[1] Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet. 2011;377(9761):228-41. Doi: 10.1016/S0140-6736(10)61458-4.

[2] Geldenhuys C, Dramowski A, Jenkins A, Bekker A. Central-line-associated bloodstream infections in a resource-limited South African neonatal intensive care unit. The South African Medical Journal. 2017;107:758-62. Doi: 10.7196/SAMJ.2017.v107i9.12124.

[3] Zingg W, Tomaske M, Martin M. Risk of parenteral nutrition in neonates-an overview. Nutrients. 2012;4(10):1490-503. Doi: 10.3390/nu4101490.

[4] Ting JY, Goh VSK, Osiovich H. Reduction of central line associated bloodstream infection rates in a neonatal intensive care unit after implementation of a multidisciplinary evidence-based quality improvement collaborative: A four-year surveillance. Can J Infect Dis Med Microbiol. 2013;24(4):185-90. Doi: 10.1155/2013/781690.

[5] Eric CE, Anne RH, Camilie RM, Ann RS. Cloherty and Stark's Manual of Neonatal Care: Bacterial and Fungal infections. 8th edition. Philadelphia: Lippincott Williams and Wilkins; 2016. Pp. 689.

[6] Christine AG, Sherin UD. Avery's Diseases of the Newborn: Prematurity Causes and Prevention. 9th edition. Phildelphia: Elsevier Saunders;2012. Pp. 140.

[7] Centers for Disease Control (CDC)/Naitonal Healthcare Safety Network (NHSN). National Healthcare Safety Network overview.

[8] http://www.cdc.gov/nhsn/PDFs/pscManual/validation/pcsManual-2014-valid.pdf.

[9] Klevens RM, Edwards JR, Richards CL Jr. Estimating healthcare-associated infections and deaths in US hospitals, 2002. Public Health Rep. 2007;122:160-66. Doi: 10.1177/003335490712200205.

[10] Ista E, van der Hoven B, Kornelisse RF, van der Starre C, Vos MC, Boersma E, et al. Effectiveness of insertion and maintenance bundles to prevent central-line-associated bloodstream infections in critically ill patients of all ages: a systematic review and meta-analysis. Lancet Infect Dis. 2016;16(6):724-734. Doi: 10.1016/S1473-3099(15)00409-0.

[11] Stevens TP, Schulman J. Evidence-based approach to preventing central line-associated bloodstream infection in the NICU. Acta Paediatr. 2012;101(464):11-6. Doi: 10.1111/j.1651-2227.2011.02547.x.

[12] Ratna A., El-Saed A., Alsaif S., Tannous J., Dagunton N., & Balkhy, H. (2016). Effect of central line bundle implementation on central line-associated bloodstream infection rates in NICU in KSA. International Journal of Infection Control, 2016;12(2):1-7. https://doi.org/10.3396/ijic.v12i2.15641

[13] Prakash SS, Rajshekar D, Cherian A, Sastry AS. Care bundle approach to reduce device-associated infections in a tertiary care teaching hospital, South India. J Lab Physicians. 2017;9(4):273-278. Doi: 10.4103/JLP.JLP_162_16.

[14] Zingg W, Posfay-Barbe KM, Pfister RE, Touveneau S, Pittet D. Individualized catheter surveillance among neonates: a prospective, 8-year, single-center experience. Infect Control Hosp Epidemiol. 2011;32(1):42-9. Doi: 10.1086/657634.

[15] Perlman SE, Saiman L, Larson EL. Risk factors for late-onset health care-associated bloodstream infections in patients in neonatal intensive care units. Am J Infect Control. 2007;35(3):177-82. Doi: 10.1016/j.ajic.2006.01.002.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Sep 06, 2021
- Manual Googling: Mar 11, 2022
- iThenticate Software: Apr 18, 2022 (8%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Sep 04, 2021**
Date of Peer Review: **Dec 15, 2021**
Date of Acceptance: **Mar 11, 2022**
Date of Publishing: **Jun 30, 2022**