

Impact of Needle-Free Connector and Prefilled Flushing Syringe Shortage on CLABSI Rates in Pediatric Intensive Care

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ABSTRACT

Objective: We aimed to discuss our experience of a higher incidence of catheter-associated bloodstream infections (CLABSIs) during the needle-free connector (NFC) and single-use prefilled flushing syringe (PFS) shortage.

Materials and Methods: Retrospective analyses were carried out to investigate the CLABSI rates at a tertiary training hospital from January 1, 2023, to December 31, 2023, and the study period included a three-month shortage of NFCs and PFSs in April and June 2023.

Results: The CLABSI rate for the three months was 5.94 per 1000 CL days from January 1 to March 31, 18.07 per 1000 CL days from April 1 to June 30, 5.42 per 1000 CL days from July 1 to September 30, and 6.52 per 1000 CL days from October 1 to December 31. Following the three-month shortage period, the rate of CLABSI significantly increased from 5.94 per 1000 CL days to 18.07 per 1000 CL days. After the shortage of needle-free connectors and single-use PFSs was resolved, the rate of CLABSI significantly decreased to 5.42 per 1000 CL days ($p < 0.001$).

Conclusion: Even a three-month lack of NFC and PFS caused three-fold CLABSI. The efficacy and ongoing success of CLABSI prevention depend on maintaining the materials' continuity.

Keywords: prefilled flushing syringes, needle-free connectors, catheter-associated bloodstream infections, pediatric intensive care unit

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INTRODUCTION

The most common and serious complication of central venous catheter usage is central line-associated bloodstream infections (CLABSIs) in children and adults (1). Between 2011 and 2014, CLABSIs were the most frequently reported health-care-associated illness among hospitals in the USA (2). Bloodstream infections associated with central lines are the most significant complications of central venous access devices and increase morbidity, mortality, hospital length of stay, and hospital expenses (2-5).

The International Society for Infectious Diseases (ISID), the Infectious Diseases Society of America (IDSA), and the Infusion Nurse Society (INS) recommended using single-use prefilled flushing syringes (PFSs) to flush the catheter and use needle-free connectors (NFCs) in place of three-way stopcocks (6, 7). Previous research from our institution showed that the use of PFSs and central line bundles, which substitute NFCs for 3-way stopcocks, was linked to a noteworthy drop in the rates of CLABSI in the pediatric intensive care unit (PICU) (8-10).

In 2023, we faced a three-month shortage of the medicinal supplies needed to prevent CLABSI. In this study, we aimed to present our experience with the raised CLABSI rates at the PICU during the NFC and PFS shortage in this study.

MATERIALS AND METHODS

This retrospective study was carried out at a tertiary training hospital from January 1, 2023, to December 31, 2023. Starting in June 2013, our hospital implemented a central line bundle that included the following measures: ultrasonography during insertion, strict hand hygiene, aseptic skin preparation (2% chlorhexidine in 70% alcohol solution), and barrier precautions (mask, gown, protective eyewear, cap, sterile gloves). During maintenance, we additionally used BD Q-Syte™ needle-free connectors (Becton, Dickinson and Company, USA), daily catheter site and cap connection evaluations, and BD PosiFlush™ NaCl 0.9% 10-mL sterile single-use prefilled syringes (Becton, Dickinson and Company, USA).

CLABSI was proven when bacteremia or fungemia was found in a patient with a central venous catheter for more than 48 hours, multiple positive blood cultures from a peripheral vein, and clinical indications of infection.

The statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) 20.0 (IBM Corp., Armonk, NY, USA). The Poisson 95% confidence interval (CI) was used to compute the daily count of CLABSI for each time period and the relative risk reduction across groups, which was expressed as a percentage. In order to compare the risks for each of the two groups with a 95% CI for the incidence rate, the relative risk ratio was also computed using MedCalc 11.6 software (MedCalc Software Ltd, Belgium). The statistical significance was set as $p < 0.05$.

The Ethics Committee of Dr. Behçet Uz Children's Diseases and Surgery Training and Research Hospital approved the study on March 28, 2024, with decision number GOA-27/28.03.2024.

RESULTS

A total of 32 patients with CLABSI included 19 (59.4%) males and 13 (40.6%) females. With a range of 4 months to 17 years, the patient's median age was 15 months. Of the patients, 28 (87.5%) had an underlying disease and, 4 (12.5%) had no underlying condition. The prevalent underlying illnesses included congenital heart disease ($n=4$, 12.5%), cerebral palsy ($n=4$, 12.5%), spinal muscular atrophy

HIGHLIGHTS

- Threefold many catheter-associated bloodstream infections (CLABSIs) were reported in our hospital during a three-month shortage of the needle-free connector and the single-use prefilled flushing syringe.
- After the shortage of needle-free connectors and single-use prefilled flushing syringes was resolved, the rate of CLABSI significantly decreased.
- Ensuring the continuity of the materials used is essential for permanent success in preventing CLABSI.

Table 1. Three monthly analyses, including patient counts, patient days, central catheter days, CLABSI number, CLABSI rate and catheter usage density.

	Patient (n)	Patient days	Central catheter days	CLABSI (n)	CLABSI Rate	Catheter usage density	p*
01 January-31 March	98	2083	842	5	5.94	0.4	
01 April-30 June*	82	1926	996	18	18.07	0.52	
01 July-30 September	105	1887	738	4	5.42	0.39	
01 October-31 December	100	1914	767	5	6.52	0.4	
Total	385	7810	3343	32	9.57	0.43	<0.001

*The rate of CLABSI considerably increased from 5.94 per 1000 CL days in the pre-shortage period to 18.07 per 1000 CL days in the 3-month shortage period ($p<0.001$). It decreased significantly to 5.42 per 1000 CL days after BD Q-Syte™ needle-free connectors and BD PosiFlush™ sterile single-use prefilled syringes were reintegrated into the bundle ($p<0.001$).

($n=3$, 9.4%), neuro-metabolic diseases ($n=15$, 46.9%), and pediatric cancer ($n=2$, 6.3%). The most frequent causes of hospitalization in the PICU were heart failure ($n=3$, 9.4%), renal failure ($n=2$, 6.3%), sepsis and septic shock ($n=6$, 18.8%), pneumonia ($n=15$, 46.9%), and status epilepticus ($n=6$, 18.8%). Of the patients, 96% ($n=29$) had a nasogastric tube, 93.4% ($n=30$) had urine catheters, and 84.4% ($n=25$) were on mechanical breathing. Additionally, whole par-enteral feeding was used by 56.3% ($n=18$).

There were 385 patients overall in 2023-2024 and 7810 patient days. Table 1 shows 3343 catheter line days in total; 32 CLABSIs were recorded, equivalent to an overall rate of 8.57 CLABSIs per 1000 CL days. The CLABSI rate for three months was as follows: 5.94 per 1000 CL days between January-March, 18.07 per 1000 CL days between April-June, 5.42 per 1000 CL-days between July-September and 6.52 per 1000 CL days between October-December. During the three-month shortage period, the rate of CLABSI increased dramatically from 5.94 per 1000 CL days to 18.07 per 1000 CL days. After BD Q-Syte™ needle-free connectors (Becton, Dickinson and Company, USA) and BD PosiFlush™ sterile single-use prefilled syringes (Becton, Dickinson and Company, USA) were reintegrated into our practice, the incidence of CLABSI significantly fell to 5.42 per 1000 CL days ($p<0.001$) (Table 1, Figure 1).

Microorganisms with a single origin caused 29 (90.7%) CLABSIs, and polymicrobial pathogens caused 3 (9.3%). *Klebsiella pneumoniae* (17.1%, $n=6$)

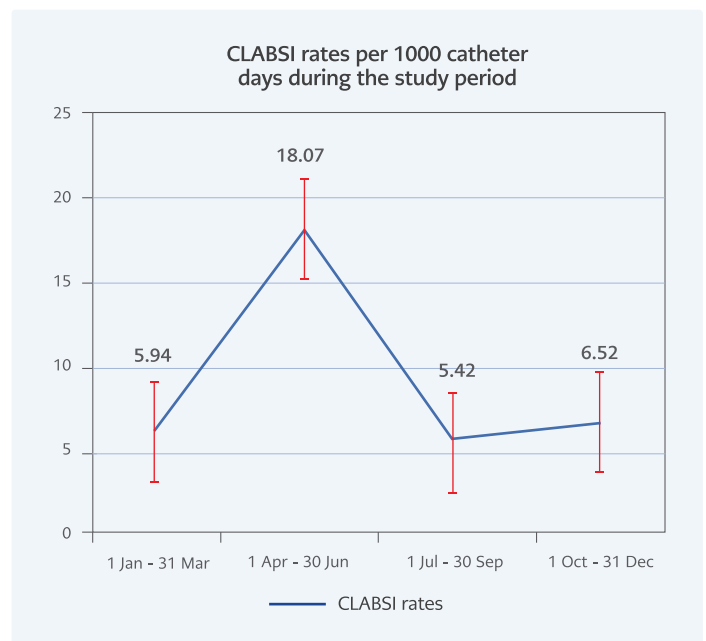


Figure 1. The rate of CLABSI increased between the period of 01 April to 30 June 2024.

and *Candida parapsilosis* (34.3%, $n=12$) were the most frequently isolated microorganisms. Table 2 shows all species isolated.

DISCUSSION

In this study, the CLABSI rate increased approximately threefold when NFC and PFS were in short supply. It then sharply declined as soon as they were once again available. Our study is one of the

Table 2. The microbiological distribution of causative agents of CLABSI.

	n (%)
<i>Acinetobacter calcoaceticus-baumannii</i> complex	2 (5.7)
<i>Candida glabrata</i>	1 (2.9)
<i>Candida parapsilosis</i>	12 (34.3)
<i>Candida albicans</i>	3 (8.6)
<i>Candida guilliermondii</i>	1 (2.9)
<i>Candida tropicalis</i>	1 (2.9)
<i>Candida</i> spp.	1 (2.9)
<i>Escherichia coli</i>	1 (2.9)
<i>Serratia marcescens</i>	1 (2.9)
Coagulase negative <i>Staphylococcus</i> spp.	2 (5.7)
<i>Chryseobacterium indologenes</i>	1 (2.9)
<i>Klebsiella pneumoniae</i>	6 (17.1)
<i>Enterobacter cloacae</i> complex	1 (2.9)
<i>Enterobacter aerogenes</i>	2 (5.7)
Total	35*

*Three of the CLABSI were polymicrobial including two *C. parapsilosis* plus *K. pneumoniae*, and one *K. pneumoniae* plus *Enterobacter aerogenes*.

few examinations in which the lack of medical devices produced undesirable results.

About one-third of the microorganisms detected in our study were related to *C. parapsilosis*, the most prevalent microbe. Catheter infections linked to *C. parapsilosis* have been linked to longer central line days and the ability to form biofilms (11). Biofilms formed by *C. parapsilosis* can nevertheless form on medical devices such as peripheral venous catheters and central venous catheters, even though reports suggest that the microorganism creates a less complicated biofilm than *Candida albicans* in terms of both quantitative and structural characteristics (12). Furthermore, because of its tendency to colonize in the hands of medical professionals, *C. parapsilosis* is a high-risk candidate for catheter infections (13). The most frequently isolated organism causing CLABSIs in the PICU at the same research facility was *C. parapsilosis* (8). According to additional research from our center, the complete central line bundle successfully reduced the rate of *Candi-*

da-related central line-associated bloodstream infections, including NFC and PFS (9). Unexpectedly, this indicated that the shortage of medical supplies led to an increase in the rate of CLABSIs caused by *C. parapsilosis*.

When demand outpaces supply, it is referred to as a shortage event and can impact both medical services and devices (14). The temporary suspension and distribution of dehydrated alcohol in the United States from April to September 2011 led to a change in the dosage and use of ethanol for the prevention of catheter infections. Ralls et al. hypothesized that a decrease in ethanol use led to a rise in catheter infections (15). Furthermore, a recent multicenter survey found that 58% of the centers anticipated higher CLABSI during ethanol storage (16).

This experience demonstrated the significance of maintaining medical devices for a successful central line prevention program, even though it was not the same device. A study conducted at our center from 2007 to 2020 found that the CLABSI rate dropped from 10.5 to 3.6 per 1000 CL days (8). A considerable rise was also seen when compared to previous historical cohorts, including pre-COVID-19 eras, as reported (8-10). We intended to replace central venous catheters with peripherally implanted central lines in our institution to reduce catheter infections.

Numerous studies highlight that a significant barrier to effective infection prevention measures is a lack of human and material resources. In addition to the effects of the COVID-19 pandemic, hand-washing soap, alcohol hand rubs, gloves, and other personal protective equipment have been identified as being in limited supply. Reusing sterile gowns because there were not enough of them during the pandemic's first two waves may have played a significant role in the development of CLABSI (17). Catheter infections and related late-onset sepsis in neonates may be caused by a variety of causes, including the misuse or lack of equipment (18).

This study has some limitations. Firstly, the data was collected retrospectively from hospital data systems and medical records. Moreover, it lacked information on bundle compliance and other po-

tentially influencing factors, including the nurse-to-patient ratio. One of the central line bundle's tenets is its adherence to every bundle step; yet, since two principal elements were missing, we were unable to distinguish between the multiplicative effects of disregarding those two steps.

Based on our experience, close coordination between all parties, including the infection control committee, hospital administration, and health authorities, is required to prevent medical supply shortages and related issues. During the tender and purchase processes, healthcare authorities should

highlight the end users' prior experience, and they ought to communicate opinions in particular. Future studies should concentrate on better collaborating with the Ministry of Health throughout the procurement process, using artificial intelligence to determine precise numbers of medical devices used, and the financial implications of issues brought on by a lack of medical supplies.

In conclusion, even a three-month lack of NFC and SUF led to threefold CLABSI. The efficacy and ongoing success of CLABSI prevention depend on maintaining the materials' continuity.

Ethical Approval: The Ethics Committee of Dr. Behçet Uz Children's Diseases and Surgery Training and Research Hospital approved the study on March 28, 2024, with decision number GOA-27/28.03.2024.

Informed Consent: Informed consent was obtained from all patients.

Peer-review: Externally peer-reviewed

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– İ.D., Y.O., C.A., N.T., Ö.S.; Data Collection and/or Processing – İ.D., H.Ö., G.A., D.E., S.S.Ç., Y.O., N.T., C.A., Ö.S., H.A.; Analysis and/or Interpretation – İ.D.; Literature Review – İ.D., Y.O., C.A., H.Ö., D.E., N.T., Ö.S.; Writer – İ.D.; Critical Reviews – İ.D., S.S.Ç., G.A.

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