Boletín Médico del
Hospital Infantil de México

PERMANYER

Check for updates

RESEARCH ARTICLE

Reducing CLABSI through a quality strategy for the implementation of the aseptic non-touch technique in a pediatric ward

Ana C. Guerrero-Díaz[1], Daniela De la Rosa-Zamboni[2], Ma. A. Martin-Martin[3], Isabel Rosas-Mateos[1], Marisol Medina-Pelcastre[1], Margarita Torres-García[1], Almudena Laris-González[4], and Martha Avilés-Robles[4]*

[1]Departamento de Epidemiología; [2]Departamento de Atención Integral al Paciente; [3]Departamento de Pediatría; [4]Departamento de Infectología. Hospital Infantil de México Federico Gómez, Mexico City, Mexico

Abstract

Background: *Central line-associated bloodstream infections (CLABSIs) are among the most epidemiologically relevant health care-associated infections. The aseptic non-touch technique (ANTT) is a standardized practice used to prevent CLABSIs. In a pediatric hospital, the overall CLABSI rate was 1.92/1000 catheter days (CD). However, in one unit, the rate was 5.7/1000 CD.* **Methods:** *Nurses were trained in ANTT. For the implementation, plan-do-study-act (PDSA) cycles were completed. Adherence monitoring of the ANTT and epidemiological surveillance were performed.* **Results:** *ANTT adherence of 95% was achieved after 6 PDSA cycles. Hand hygiene and general cleaning reached 100% adherence. Port disinfection and material collection had the lowest adherence rates, with 76.2% and 84.7%, respectively. The CLABSI rate decreased from 5.7 to 1.26/1000 CD.* **Conclusion:** *The implementation of ANTT helped reduce the CLABSI rate. Training and continuous monitoring are key to maintaining ANTT adherence.*

Keywords: *Aseptic non-touch technique. Central line-associated blood stream infections. Pediatrics. Quality improvement.*

Reducción de infecciones relacionadas con catéteres venosos centrales por medio de una estrategia de calidad para la implementación de la técnica aséptica «no tocar» en una sala de pediatría

Resumen

Introducción: *Las infecciones relacionadas con catéteres venosos centrales son unas de las infecciones asociadas a la atención de salud con mayor relevancia epidemiológica. La técnica aséptica «no tocar» es una práctica estandarizada que se utiliza para prevenir estas infecciones. En un hospital pediátrico, la tasa de infecciones relacionadas con catéteres venosos centrales fue de 1.92/1000 días de catéter. Sin embargo, en una de las unidades la tasa fue de 5.7/1000 días de catéter.* **Método:** *Se capacitaron enfermeras en la técnica aséptica «no tocar». Para la implementación se cumplieron ciclos de planificar-hacer-estudiar-actuar (PHEA). Se realizaron seguimiento de la adherencia a la técnica y vigilancia epidemiológica.* **Resultados:** *Se logró una adherencia a la técnica aséptica «no tocar» del 95% después de seis ciclos. La higiene de manos y la limpieza general alcanzaron un 100% de cumplimiento. La desinfección de los puertos y la recolección de material*

***Correspondence:**
Daniela De la Rosa-Zamboni
E-mail: rzdaniela@hotmail.com

Date of reception: 08-09-2023
Date of acceptance: 04-04-2024
DOI: 10.24875/BMHIM.23000134

Available online: 25-06-2024
Bol Med Hosp Infant Mex. 2024;81(3):182-190
www.bmhim.com

alcanzaron la menor adherencia, con un 76.2% y un 84.7%, respectivamente. La tasa de infecciones relacionadas con catéteres venosos centrales disminuyó de 5.7 a 1.26 por 1000 días de catéter. **Conclusiones:** *La implementación de la técnica aséptica «no tocar» ayudó en la reducción de infecciones relacionadas con catéteres venosos centrales. La capacitación y el seguimiento continuo son clave para mantener el cumplimiento de la técnica.*

Palabras clave: *Técnica aséptica «no tocar». Infecciones relacionadas con catéteres venosos centrales. Pediatría. Mejora de la calidad.*

Introduction

Central line-associated bloodstream infections (CLABSIs) are a significant type of health care-associated infections (HCAIs) that have a major impact on patient morbidity, mortality, hospital stay, complications, and health-care costs[1-3]. Several guidelines recommend the implementation of preventive bundles[4-7], supported by studies demonstrating their effectiveness in reducing CLABSI rates[8-10].

Numerous strategies have been developed to address CLABSIs, particularly in implementing preventive bundles. The aseptic non-touch technique (ANTT) is a standardized practice widely utilized in the United Kingdom and other countries to prevent CLABSIs[10-13]. This technique emphasizes fundamental infection control rules, including hand hygiene (HH), protection of key parts and sites from contact, and using alcohol-based solutions for decontamination, focusing on adequate cleaning and natural evaporation[14].

Quality improvement methodologies such as plan-do-study-act (PDSA) have been employed to implement interventions on a small scale to reduce errors and variability. This approach involves formulating and executing a plan with specific goals, evaluating results, and deciding on further implementation, adaptation, or discontinuation of the intervention. This cycle is repeated until the desired change is achieved and has been utilized in the field of quality improvement in health-care settings, particularly in the implementation of ANTT[13,15,16].

Approximately one in ten children with a central venous catheter (CVC) develops a CLABSI[17], making this type of infection the most frequent and lethal among HCAIs[18]. Effective strategies and heightened awareness are crucial to prevent these events. Implementing CLABSI bundles is a cost-effective approach[19] that could be adopted in middle-income countries to alleviate the burden of these infections.

While the ANTT can be utilized in any invasive clinical procedure and does not require significant resources, there is limited information on its application in low- and middle-income countries and in the pediatric population. This study aimed to assess whether implementing a quality strategy to adapt and implement the ANTT would enhance adherence and reduce the rate of CLABSIs in pediatric patients at a tertiary-level hospital in Mexico City.

Methods

Context

A quality improvement study was conducted from January 2016 to December 2019 in a pediatric unit of the "Hospital Infantil De México Federico Gómez." This tertiary care public teaching hospital serves low-income and uninsured populations in Mexico City. This unit comprises 30 beds for patients across various pediatric subspecialties, including gastroenterology (9 beds), cardiology (7 beds), neurology (4 beds), rheumatology (2 beds), pulmonology (2 beds), and general pediatrics (6 beds). This unit was selected for the quality improvement study due to significantly higher CLABSI rates than the rest of the hospital (5.71 CLABSIs/1000 catheter days [CD] vs. 1.92 CLABSIs/1000 CD, respectively).

All patients aged 1 month to 18 years who had a CVC placed for at least 1 day during their stay in the pediatric unit were included. Subjects were prospectively assessed daily to identify those who developed CLABSI. Data collected for each case included sex, age, inpatient days, and CD.

Information on each HCAI was gathered through active epidemiological surveillance, as described by de la Rosa et al.[20] Trained nurses visited the unit 3 times a week to identify signs suggestive of CLABSI, with validation from an infectious disease physician and the medical and nursing chiefs of the department of hospital epidemiology (DHE).

During active surveillance, incidental education was provided for asepsis or antisepsis omissions. The preventive measures, or bundles, included catheter replacement for malfunctioning catheters, removal of unnecessary catheters, catheter port cleaning, use of

Table 1. ANTT checklist

1. Perform hand hygiene with chlorhexidine.
2. Wash the biological safety cabinet, the Pasteur cart, the drug preparation area, the tripod, atomizers, and scissors with enzymatic detergent once per every work shift.
3. Check IV infusion equipment dates for every patient, to make appropriate exchanges. Perform hand hygiene as often as necessary.
4. Put on a facemask.
5. Perform hand hygiene with hand sanitizer containing 60-80% alcohol.
6. Prepare medication labels. Make precise medication dose calculations and annotations for administration intervals.
7. Finish the cleaning process by removing the enzymatic detergent with a damp cloth from the biological safety cabinet, Pasteur carriage, and tripod. Rinse the aseptic field, atomizer, and scissors under running water and allow them to dry in ambient air. Subsequently, carry out disinfection with 70% alcohol. Place the aseptic field inside the biological safety cabinet or table.
8. Gather all pieces of the equipment and materials necessary for the procedure in the Pasteur cart: Medications, syringes, metriset, needles, infusion sets, venopacks, extensions, solutions, diluents, tray with sterile gauze, alcohol pads, alcohol-based preparation between 60 and 80%, sharps container, facemasks, adhesive cloths, bioconnectors, and sterile fields. Disinfect the packaging of the solutions, ampoules and drug containers and solutions, with damp gauze with 70% alcohol before putting them in the cabinet or on the table.
9. Perform hand hygiene with chlorhexidine.
10. Adhere medication labels on the top of the cabinet in a conspicuous place.
11. Put on an apron previously disinfected with 70% alcohol or wear a full surgical uniform.
12. Perform hand hygiene with hand sanitizer containing 60-80% alcohol.
13. Remove the packaging of the syringes and needles and place them in order in the aseptic field. Place needles in syringes that do not have them, protecting the key parts.
14. Again, perform hand hygiene with hand sanitizer containing 60-80% alcohol.
15. Disinfect the key points of medicines for 8 s with gauze moistened with 70% alcohol. When you finish using the gauze, throw it away in the proper garbage bin.
16. Prepare the indicated dose in the syringe and change the needle without touching the key part, then label it. Perform the same procedure with the syringes for the rinse. Perform hand hygiene between each medication preparation and whenever necessary.
17. Organize the syringes and solutions in the aseptic field by bed number (if the key part is contaminated when preparing, discard it and repeat the procedure). At the end of the preparation of medicines and solutions, discard the surplus. In case of multi-dose medications, load each into a syringe, label the syringe, and place it within the aseptic field.
18. Transfer the aseptic field with the medications, previously placed on the Pasteur cart, to the patient's unit. Perform a double check before the administration of medications and change of solutions with the nurse assigned to the patient (the 10 steps of medication administration apply here).
19. Perform hand hygiene with chlorhexidine.
20. Locate and expose venous access. To change the infusion set, place the sterile field and 3 alcohol pads inside the aseptic field without wrapping.
21. Perform hand hygiene with hand sanitizer containing 60-80% alcohol.
22. Disinfect the injection site with alcohol pads on top of the equipment for 8 s and allow it to dry. Subsequently, administer the medication without touching the key parts. If the drug is administered as an infusion, disinfect the syringe-equipment joint before disconnection for the change. If the medication is administered as a bolus, disinfect the injection port.
23. Administer the medications, and at the end, rinse the line with physiological solution.
24. Dispose the material in the corresponding containers.
25. Make the patient comfortable.
26. Perform hand hygiene with hand sanitizer containing 60-80% alcohol.

transparent dressings, regular dressing changes, and full-barrier precautions during catheter insertion.

Adherence to this bundle was documented at over 95%. In addition, the hospital maintained a strong and ongoing HH program established in 2013[20]. All these measures remained unchanged during the intervention.

Interventions

Five nurses trained in hospital epidemiology and infection control, along with two infectious diseases specialists from the DHE, reviewed the free checklist provided on the official website of the ANTT for medication and intravenous (IV) fluid preparation and administration. This checklist was adapted to the hospital's context and resources. Table 1 contains the adapted version of the checklist. The entire unit nursing staff received theoretical training followed by one-on-one hands-on training for the morning shift nurses. Training began with the morning shift when the largest number of IV medications and fluids were administered. Subsequently, all shifts received training. Practical training included on-site assessments with immediate feedback, continuing until each nurse demonstrated error-free preparation and administration of IV fluids and drugs. Personalized training for all staff lasted approximately 1 month, with the entire training process taking 4 months. After training, a single rotating nurse was assigned to prepare and administer IV solutions

Table 2. PDSA cycles

PDSA cycle	Plan	Do	Study	Act
Cycle 1 January-May 2016	Adaptation of the ANTT technique and training for nursing staff. It was expected that, with the training, the nursing staff would be able to prepare medications with the ANTT.	The steps of the ANTT were adapted and translated to Spanish. Theoretical training was provided to the nursing staff of the morning shift through a power point presentation.	It is noted that theoretical training was not enough to properly follow all the steps of the ANTT. Practical training is required. In addition, it is necessary to optimize the number of steps as well as to make a checklist to monitor the adherence of the nursing staff to the ANTT. CLABSI rate: 1.93	Adjustments were made to improve the training A checklist is made to monitor adherence to the ANTT (Table 1). Practical and personalized training for nurses is proposed.
Cycle 2 June-September 2016	Implementation of the practical and personalized training of the ANTT. An adherence to the ANTT of over 80% was expected, which will be measured by means of the checklist	Practical training was carried out, 17 weeks were required for 15 nurses (8 nurses of the morning shift, 5 of the evening shift, and 2 of the night shift), dedicating 7-14 days to each nurse to improve adherence to the technique.	After training, an adherence of 81.7% was observed. Opportunity Areas Medication labels (step 6) 55.9% Equipment gathering (step 8) 39% Unpacking the material to be used (step 13) 67.8% Organization of syringes and IV solutions (step 17) 57.6%. CLABSI rate: 1.76 There was a complaint of work overload since a single nurse had to prepare all the medications in the ward.	Since adherence was greater than 80%, it was decided that ANTT would be implemented, and monitoring would continue with the checklist. To improve adherence, it was planned to raise awareness of the importance of ANTT through feedback on the appearance of any CLABSI. It was suggested that, if there was any medication that needed to be prepared urgently, a second nurse could help with the preparation to reduce the workload.
Cycle 3 October-December 2016	The program "Let everyone know about bacteraemia" was created, which was responsible for informing physicians and nurses about any CLABSIs documented. Bacteraemia was plotted daily. A happy face sticker was added to the graph for every 10 days without bacteraemia and a star sticker for 100 days without bacteraemia. Improvement in adherence to the ANTT technique was expected.	Implementation of the program "Let everyone know about bacteraemia" for 15 weeks. During the same time period, monitoring of ANTT adherence continued.	The program succeeded in motivating the staff. Overall adherence improved, 90.6%. Opportunity Areas: Finishing the cleaning process (step 7) 42.9% Equipment gathering (step 8) 0% CLABSI rate: 2.22	The program "Let everyone know about bacteraemia" was implemented. It was decided to continue with the training of nurses who were new to the unit or who had not yet been trained. Compliance with the ANTT continued to be monitored. Step 8 had an adherence of 0%, because they had to gather all the material and if they forgot even one thing, they did not get that point on the checklist. It was decided to place, in the room where the medicines were prepared a poster with the checklist, which contains the material to be collected.
Cycle 4 January-December 2017	New nurses were trained in the ANTT. Continued with the "Let everyone know about bacteraemia" program. Adherence to ANTT was expected to further improvement, especially adherence to step 8.	5 nurses were trained in the ANTT. Monitoring of the adherence to ANTT continued with the checklist.	Overall adherence: 92.1% Opportunity Areas Equipment gathering (step 8) 55.6% HH 77.3% CLABSI rate: 1.42 A decrease in HH time was observed as well as a lack of awareness during the process	It was planned to reinforce the multimodal strategy of HH with sensitization aimed at avoiding bacteraemia. *NOTE: The HH program has been carried out at the hospital since 2013.
Cycle 5 January-December 2018	HH training was provided. Improved adherence to ANTT was expected.	HH training is provided. Monitoring of the adherence to ANTT continues with the checklist.	Overall adherence 93.3% Opportunity areas – Gathering the equipment (step 8) 43.8% – HH 87.5% CLABSI rate: 0.61	It is planned to continue with the reinforcement of the HH. During HH training two more HH moments arise to be added to the checklist.

(Continues)

Table 2. PDSA cycles *(continued)*

PDSA cycle	Plan	Do	Study	Act
Cycle 6 January-December 2019	Reinforcement of HH and training of rotating staff of the same hospital continued. Improved adherence to ANTT was expected.	Training continued with good acceptance as well as reinforcement of the HH program.	Overall adherence 95% Opportunity areas Medication labels (step 6) 73.3% Gathering the equipment (step 8) 75% Disinfection of key points of medicines (step 15) 75% Disinfection of the injection site (Step 22) 76.2% CLABSI rate: 1.26	A new deficiency was observed: lack of compliance in disinfection time. It was sensitized to be 8 seconds of disinfection. After reaching 95% adherence to ANTT, it was decided to end the PDSA cycles, however monitoring continues.

PDSA: plan Do Study Act; ANTT: Aseptic non touch technique; CLABSI: central line-associated bloodstream infection; HH: hand higyene.

Table 3. Baseline characteristics of the patients

Characteristics	Total	Baseline January-December 2015	Cycle 1 January-May 2016	Cycle 2 June-September 2016	Cycle 3 October-December 2016	Cycle 4 January-December 2017	Cycle 5 January-December 2018	Cycle 6 January-December 2019
n	4006	792	322	274	191	813	786	828
Female sex no. (%)	2003 (50.7)	378 (47.7)	152 (47.2)	146 (53.3)	103 (53.9)	439 (54)	401 (51.0)	414 (50.0)
Patients per unit no. (%)								
Cardiology	990 (24.7)	184 (23.2)	88 (27.3)	68 (24.8)	39 (20.4)	195 (24)	176 (22.4)	240 (29.0)
Gastroenterology	1206 (30.1)	210 (26.5)	75 (23.3)	61 (22.3)	52 (27.2)	269 (33.1)	257 (32.7)	282 (34.1)
Pneumology	235 (5.9)	59 (7.4)	20 (6.2)	20 (7.3)	7 (3.7)	30 (3.7)	51 (6.5)	48 (5.8)
General pediatrics	1133 (28.3)	251 (31.7)	100 (31.1)	85 (31)	65 (34.0)	225 (27.7)	225 (28.6)	182 (22.0)
Rheumatology	442 (11.0)	88 (11.1)	39 (12.1)	40 (14.6)	28 (14.7)	94 (11.6)	77 (9.8)	76 (9.2)
Age in years	3 (0.9-11)	2 (0.8-10)	4 (1-11)	4 (1-11)	4 (0.8-11)	4 (0.9-12)	3 (1-11)	5 (1-12)
Median (IQR)								
Inpatient days	7 (3-14)	7 (4-14)	7 (3-15)	6 (3-13)	6 (4-11)	7 (3-13)	7 (4-14)	7 (2-14)
Median (IQR)								
Number of CLABSIs	32	16	3	2	2	4	2	3
Catheter days	14.888	2.802	1.555	1.135	902	2.818	3.289	2.387
CLABSI rate/1000 catheter days	2.15	5.71	1.93	1.76	2.22	1.42	0.61	1.26

No: number; IQR: interquartile range; CLABSI: central lines associated bloodstream infections.

and medications, with weekly covert assessments and one-to-one feedback.

Weekly meetings were conducted with the ANTT nurses and DHE staff throughout the intervention. PDSA cycles were executed to address any factors that led to non-adherence, including infrastructure, material availability, and staff-related concerns. Action was taken accordingly to solve problems and barriers. The primary aim was to reduce CLABSI rates through ANTT implementation, as detailed in table 2. Each PDSA cycle measured CLABSI rates and ANTT adherence as outcome measures.

Table 4. Compliance to the different components of ANTT

Components of ANTT	Total (n = 160)	Cycle 2 May-September 2016 (n = 56)	Cycle 3 October-December 2016 (n = 19)	Cycle 4 January-December 2017 (n = 21)	Cycle 5 January-December 2018 (n = 43)	Cycle 6 January-December 2019 (n = 21)	p (χ^2)
All 26 steps Mean (min-max)	88.8 (9.1-100)	81.7 (9.1-100)	90.3 (81.8-95.5)	92.4 (62.5-100)	93.3 (42.9-100)	95.0 (88.0-100)	< 0.0001
Cleaning and disposal[1] Mean (min-max)	91.4 (0-100)	84.8 (33.3-100)	82.5 (66.7-100)	92.5 (0-100)	99.0 (66.7-100)	100 (100-100)	0.0002
Port disinfection[2] Mean (min-max)	86.4 (0-100)	85.3 (0-100)	94.7 (50-100)	90.2 (0-100)	92.6 (0-100)	75.6 (0-100)	0.131
HH[3] Mean (min-max)	93.4 (0-100)	90.8 (0-100)	97.4 (83.3-100)	95.1 (66.7-100)	95.9 (0-100)	100 (100-100)	0.0009
PPE[4] Mean (min-max)	94.0 (0-100)	87.0 (0-100)	100 (100-100)	100.0 (100-100)	96.7 (50-100)	96.9 (50-100)	0.226
Material collection and labeling[5] Mean (min-max)	77.0 (20-100)	66.5 (20-100)	69.5 (40-80)	89.3 (60-100)	85.2 (60-100)	83.8 (60-100)	0.000001
Syringe loading[6] Mean (min-max)	89.1 (0-100)	74.5 (0-100)	98.2 (66.7-100)	98.3 (66.7-100)	96.7 (66.7-100)	96.8 (66.7-100)	< 0.000001

Min: minimum; Max: maximum; HH: hand hygiene; PPE: personal protective equipment; χ^2: Chi-squared test for proportions. 1 ANTT steps: 2,6,24; 2 ANTT steps: 15, 22; 3 ANTT steps: 1, 5, 9, 12, 14, 19, 21, 26; 4 ANTT steps: 4, 11; 5 ANTT steps: 3, 7, 8, 10, 13; 6 ANTT steps: 16,17,18.

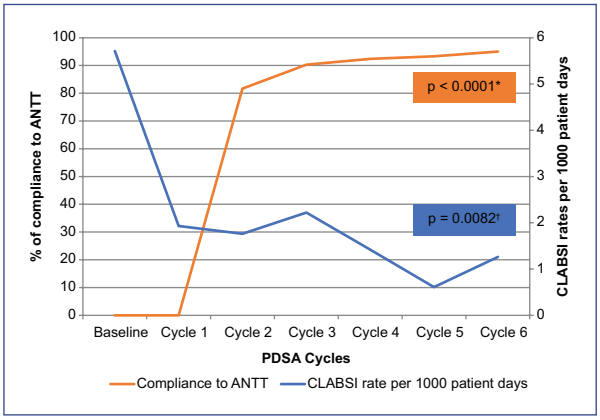

Figure 1. Compliance to aseptic non-touch technique and central lines associated bloodstream infections rates. *χ^2 test.
†Comparison of baseline and cycle 6 rates.

Study of the interventions

To evaluate adherence to the ANTT, monitoring was performed using the checklist in table 1. Each step was scored as completed or not, resulting in a score from 0 to 100% each time the technique was monitored. Immediate feedback was provided to each nurse. Monitoring was solely carried out during the morning shift due to insufficient personnel in the other shifts.

CLABSI definitions from the Centers for Disease Control and Prevention and the National Health-care Safety Network were employed[4]. Monthly CLABSI incidence rates/1000 CD were calculated monthly for each PDSA cycle.

Statistical analysis

Measures of central tendency and dispersion were used for quantitative variables, while frequencies were employed for qualitative data. The Chi-square test for proportions was used to compare ANTT adherence during PDSA cycles, and a comparison of two rates was utilized to assess CLABSI rate differences at the study's start and end. SPSS version 21 was used for statistical analysis, and the standards for quality improvement reporting excellence 2.0 guidelines were followed.

Ethical considerations

As a quality improvement program, no informed consent or ethics committee approval was necessary,

according to hospital regulations. Subject confidentiality was maintained throughout the study.

Results

Data from 4006 patients, corresponding to 14,888 CD, were analyzed. The median age was 3 years, with a median hospital stay of 7 days. The CLABSI rate showed a statistically significant decrease from 5.71 to 1.26/1000 CD over the cycles (incidence rate difference 4.45; 95% confidence interval 1.15-7.75; p = 0.0082). Table 3 displays patient characteristics and CLABSI rates at baseline and during each PDSA cycle.

During the study period, 160 monitoring sessions were conducted. Adherence to the ANTT significantly improved from 81.7% (min 9.1%, max 100%) in cycle 2-95.0% (min 88.0%, max 100%) in cycle 6 (χ^2 110.06; p < 0.0001). Figure 1 illustrates how ANTT adherence significantly increased while CLABSI rates significantly decreased.

All 26 components of the ANTT improved through the PDSA cycles (Table 4). Only material collection and port disinfection did not achieve > 85% adherence in the last cycle.

Discussion

Summary

This study demonstrates the outcomes of adapting and implementing the ANTT through a quality improvement program with PDSA cycles, which reduced CLABSI rates.

Throughout the PDSA cycles, ANTT adherence improved, variability decreased, and the CLABSI rate was reduced. PDSA cycles were crucial for identifying, addressing, and resolving issues related to the implementation and adoption of the ANTT in our context, from increasing HH moments within the technique due to the resources available within our hospital to creating awareness so that this program could be carried out. These areas of improvement are discussed in depth below.

Interpretation

We consider that the quality improvement program was successful for several reasons:

First, our hospital lacked a standardized technique for medication and solution preparation. Before the study, the same nurse attended to patients with various conditions and prepared their medications. Implementing ANTT with a single nurse responsible for all preparations likely contributed to the reduction in CLABSIs. The eight moments of HH performed during the ANTT steps, the duration of asepsis, and the vascular access management likely influenced the study results.

During the PDSA cycles, we found that theoretical training alone was insufficient for nurses to carry out ANTT medication preparation. We adjusted the strategy to provide practical and individualized training, which was crucial for implementation. Initially, we believed that theoretical training, based on nurses' experience, would suffice; however, practical training instilled confidence in carrying out the technique. Sonoiki et al. observed that nurses with more experience may feel anxious when learning new techniques with[21] which they are not familiar. For this reason, the WHO recommends providing training in these new techniques, both theoretical and practical[22]. The Health and Social Care Act 2012 suggests monitoring adherence to the technique, which we continue to do[23].

Through PDSA cycles, we recognized the importance of monitoring to assess adherence to checklist components. Even after 6 PDSA cycles, we found that material collection and port disinfection had the lowest adherence. All checklist items were dichotomous, so if all materials were not collected or if the port was not disinfected for eight full seconds, the checklist point was not achieved. Similar issues with disinfection time have been observed in studies like ours[13,16,24]. We need to explore new strategies to improve adherence to these items.

One of the main challenges in implementing improvement strategies is ensuring that the staff understands the rationale behind the changes. Initially, when aiming to reduce the CLABSI rate, the staff perceived it as an increased workload. This issue was identified during a PDSA cycle. To address this and improve adherence to the ANTT, we implemented the "let everyone know about the bacteremia" program, informing all staff when a CLABSI was diagnosed. After the program started, if a new CLABSI occurred, the nurses in the ward became concerned about why it had happened and sought help from the DHE. As described by Gould et al., it is crucial for patient safety that the staffs understand the purpose of implementing ANTT[25].

An important finding in the study was reducing the CLABSI rate since the first PDSA cycle. This reduction may have occurred for several reasons. Before implementing the "let everyone know about bacteremia" program, weekly meetings were held in the ward to identify and discuss bacteremia cases, raising awareness of the

increasing CLABSI rate in 2015. Simultaneously, preparations for ANTT implementation began, including clinic room adaptation, restricted access, a reinforced HH) program, and bacteremia prevention classes, which may have contributed to the decrease in the CLABSI rate. In addition, we observed that pediatric nursing staff generally respond quickly to changes when they understand the improvements in patient health.

Despite the initial improvement in the CLABSI rate during the first PDSA cycle, we continued with subsequent cycles due to the variability in technique adherence. Specific technique steps needed improvement to increase ANTT adherence and reduce process variability. We did not consider the initial improvement in CLABSI rates to be a success; we were aiming for increased ANTT adherence with low variability and sustained low CLABSI rates, which we achieved after 6 PDSA cycles.

The study limitations primarily stem from not measuring all variables that can increase CLABSI risks, such as total parenteral nutrition (TPN), multi-lumen devices, chemotherapy treatment, immunosuppression, prolonged use of antibiotics, prophylactic antibiotics[26-28], untrained rotating personnel, and patient comorbidities. A large percentage of the patients in that unit had gastrointestinal ailments and commonly had TPN and comorbidities. It is unlikely that patients in that unit received chemotherapy treatment, as they are in other hospital units. The rest of the risk factors were not measured because they were beyond the scope of the study, yet the CLABSI rate decreased after ANTT implementation.

Another limitation was the initial 7-day period where ANTT was not followed for medication preparation. This was due to resistance to change and inadequate nursing staff. The nursing staff, with the union, filed complaints as they felt an increased workload. After addressing these issues with the union, they supported the change and helped emphasize its importance for patient care.

Adherence to ANTT was only measured during the morning shift, potentially overestimating it. There was not enough staff to measure the evening and night shifts. However, despite the lack of measurement in other shifts, the CLABSI rate decreased.

Conclusion

The ANTT was a valuable practice to prevent CLABSIs in our institution. Its implementation was possible through PDSA cycles, identifying and addressing problems. Innovative strategies tailored to the context are necessary for sustained adherence with low variability. While our study may not be universally applicable, it supports the effectiveness of this strategy, emphasizing continuous monitoring and training to maintain ANTT adherence.

Conflicts of interest

The authors declare no conflicts of interest.

Funding

None.

Acknowledgments

We especially thank the nurses for their availability to implement this technique. We also thank Adalberto Vázquez for his collaboration in capturing the database information.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author has this document.

Use of artificial intelligence for generating text. The authors declare that they have not used any type of generative artificial intelligence for the writing of this manuscript or for the creation of images, graphics, tables, or their corresponding captions.

References

1. Rosenthal VD, Desse J, Maurizi DM, Chaparro GJ, Orellanno PW, Chediack V et al. Impact of the international nosocomial infection control consortium (INICC)'s Multidimensional approach on rates of central line-associated bloodstream infection in 14 intensive care units in 11 hospitals of 5 cities in Argentina. Infect Control Hosp Epidemiol. 2018;39:445-51.
2. Dudeck MA, Edwards JR, Allen-Bridson K, Gross C, Malpiedi PJ, Peterson KD, et al. National healthcare safety network (NHSN) report, data summary for 2013, device-associated module. Am J Infect Control. 2015;43:206-21.
3. Al-Abdely HM, Alshehri AD, Rosenthal VD, Mohammed YK, Banjar W, Orellano PW, et al. Prospective multicentre study in intensive care units in five cities from the Kingdom of Saudi Arabia : Impact of the international nosocomial infection control consortium (INICC) multidimensional approach on rates of central line-associated bloodstream. J Infect Prev. 2017;18:25-34.

4. Yokoe DS, Anderson DJ, Berenholtz SM, Calfee DP, Dubberke ER, Ellingson KD, et al. A compendium of strategies to prevent healthcare-associated infections in acute care hospitals: 2014 updates. Infect Control Hosp Epidemiol. 2014;35:967-77.
5. Mermel LA, Allon M, Bouza E, Craven DE, Flynn P, O´Grady NP, et al. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 Update by the infectious diseases society of America. Clin Infect Dis. 2009;49:1-45.
6. Marwick C, Davey P. Care bundles : the holy grail of infectious risk management in hospital? Curr Opin Infect Dis. 2009;22:364-9.
7. Agency for Healthcare Research and Quality. Tools for Reducing Central Line-Associated Blood Stream Infections. United States: Agency for Healthcare Research and Quality; 2013.
8. Blot K, Bergs J, Vogelaers D, Blot S, Vandijck D. Prevention of central line-associated bloodstream infections through quality improvement interventions: a systematic review and meta-analysis. Clin Infect Dis. 2014;59:96-105.
9. Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. N Engl J Med. 2006;355:2725-32.
10. Bion J, Richardson A, Hibbert P, Beer J, Abrusci T, McCutcheon M, et al. 'Matching michigan': a 2-year stepped interventional programme to minimise central venous catheter-blood stream infections in intensive care units in England. BMJ Qual Saf 2013;22:110-23.
11. Rowley S, Clare S. Aseptic non touch technique (ANTT): reducing healthcare associated infections (HCAI) by standardising aseptic technique with ANTT across large clinical workforces a successful state and county public health department collaboration model for mandated. Am J Infect Control. 2011;39:E90.
12. Pratt RJ, Pellowe CM, Wilson JA, Loveday HP, Harper PJ, Jones SR, et al. Epic2: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. J Hosp Infect. 2007;65 Suppl I: S1-64.
13. Shettigar S, Aradhya AS, Ramappa S, Reddy V, Venkatagiri P. Reducing healthcare-associated infections by improving compliance to aseptic non-touch technique in intravenous line maintenance : a quality improvement approach. BMJ Open Qual. 2021;10:e001394.
14. Rowley S, Clare S, Macqueen U, Molyneux R. ANTT v2: an updated practice framework for aseptic technique. Br J Nurs. 2010;19:S5-11.
15. Christoff P. Running PDSA cycles. Curr Probl Pediatr Adolesc Health Care. 2018;48:198-201.
16. Balla KC, Rao SP, Arul C, Shasshidhar A, Prashantha YN, Nagaraj S, et al. Decreasing central line-associated bloodstream infections through quality improvement initiative. Indian Pediatr. 2018;55:753-8.
17. Ullman AJ, Marsh N, Mihala G, Cooke M, Rickard CM. Complications of central venous access devices : a systematic review. Pediatrics. 2015;136:e1331-44.
18. Weiner-Lastinger LM, Abner S, Benin AL, Edwards JR, Kallen AJ, et al. Antimicrobial-resistant pathogens associated with pediatric healthcare-associated infections : summary of data reported to the national healthcare safety network, 2015-2017. Infect Control Hosp Epidemiol. 2020;41:19-30.
19. Dick A, Perencevich EN, Pogorzelska-maziarz M, Zwanziger J, Larson EL, Stone PW. A decade of investment in infection prevention: a cost-effectiveness analysis. Am J Infect Control. 2015;43:4-9.
20. De La Rosa-Zamboni D, Ochoa SA, Laris-González A, Cruz-Cordova A, Escalona-Venegas G, Pérez-Avendaño G et al. Everybody hands-on to avoid ESKAPE: effect of sustained hand hygiene compliance on healthcare-associated infections and multidrug resistance in a paediatric hospital. J Med Microbiol. 2018;67:1761-71.
21. Sonoiki T, Young J, Alexis O. Challenges faced by nurses in complying with aseptic non-touch technique principles during wound care: a review. Br J Nurs. 2020;29:28-35.
22. World Health Organization. Guidelines on Core Components of Infection Prevention and Control Programmes at the National and Acute Health Care Facility Level; 2016. Available from: https://apps.who.int/bookorders
23. Expert Participation. Health and social care Act 2012. Available from: https://www.legislation.gov.uk/ukpga/2012/7/contents
24. Khurana S, Saini SS, Sundaram V, Dutta S, Kumar P. Reducing healthcare-associated infections in neonates by standardizing and improving compliance to aseptic non-touch techniques: a quality improvement approach. Indian Pediatr. 2018;55:748-52.
25. Gould DJ, Chudleigh J, Purssell E, Hawker C, Gaze S, James D, et al. Survey to explore understanding of the principles of aseptic technique: qualitative content analysis with descriptive analysis of confidence and training. Am J Infect Control. 2018;46:393-6.
26. Alshahrani KM, Alhuwaishel AZ, Alangari NM, Asiri MA, Al-Shahrani NA, Alasmari AA, et al. Clinical impacts and risk factors for central line-associated bloodstream infection : a systematic review. Cureus. 2023;15:1-12.
27. Lafuente Cabrero E, Terradas Robledo R, Civit Cuñado A, García Sardelli D, Hidalgo López C, Giro Formatger D, et al. Risk factors of catheter-associated bloodstream infection: systematic review and meta-analysis. PLoS One. 2023;18:1-24.
28. Sellamuthu R, Nair S, Chandrasekar J, Kesavan S, Shivam V. Risk factors of central line-associated bloodstream infection (CLABSI): a prospective study from a paediatric intensive care unit in South India. Cureus. 2023;15:e43349.