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RESEARCH

Compliance with nursing interventions for central venous catheter maintenance in pediatric patients

Cumplimiento de intervenciones de enfermería para el mantenimiento del catéter venoso central en pacientes pediátricos

Adesão às intervenções de enfermagem para manutenção do cateter venoso central em pacientes pediátricos

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Resumen

Introducción: El catéter venoso central, es necesario en los cuidados pediátricos, sin embargo, es una causa importante de bacteriemia nosocomial, con 25% de mortandad. El profesional de enfermería es responsable del mantenimiento del catéter venoso central con el propósito de evitar complicaciones locales y sistémicas como la endocarditis y la bacteriemia relacionadas al tratamiento endovenoso. **Objetivo:** Describir las intervenciones de enfermería para el mantenimiento del catéter venoso central en pacientes pediátricos de un hospital especializado. **Metodología:** Diseño observacional, descriptivo, transversal, muestra conformada por 85 profesionales de enfermería que otorgaron cuidados directos a niños hospitalizados y recibieron capacitación, muestreo no probabilístico, el instrumento utilizado fue una lista de verificación de mantenimiento del catéter venoso central y se recolectaron datos con la técnica de observación. El estudio cumple con los aspectos éticos de la ley general de salud en materia de investigación. **Resultados:** Las intervenciones de enfermería se realizaron con un cumplimiento global de 90.1%, se enfatiza que el 70.6% efectuaron lavado de manos antes de manipular el dispositivo. La limpieza y mantenimiento del sitio de inserción la realizaron 98.8%, desinfectaron puertos y conexiones, identificaron lúmenes 92.9%. **Conclusión:** Los profesionales de enfermería realizan las intervenciones para el mantenimiento del catéter venoso central con un cumplimiento bueno. Sin embargo, las intervenciones con menor cumplimiento que requieren mejora son la higiene de manos, los tiempos para cambios de equipo y soluciones, la desinfección de puertos y conexiones; esenciales para disminuir las infecciones del torrente sanguíneo. Además de estudios futuros acerca de los factores profesionales e institucionales asociados al cumplimiento.

Palabras clave: Enfermería; Catéteres; Mantenimiento; Pediatría (DeCS).

Abstract

Introduction: The central venous catheter is necessary in pediatric care; however, it is an important cause of nosocomial bacteremia, with 25% mortality. The nursing professional is responsible for the maintenance of the central venous catheter, in order to prevent local and systemic complications such as endocarditis and bacteremia related to intravenous treatment. **Objective:** To describe the nursing interventions for the maintenance of the central venous catheter in pediatric patients of a specialized hospital. **Methodology:** Observational, descriptive, cross-sectional design, sample made up of 85 nursing professionals who provided direct care to hospitalized children and received training, non-probabilistic sampling; the instrument used was a central venous catheter maintenance checklist, and data were collected with the observation technique. The survey complies with the ethical aspects of the general health law on research. **Results:** Nursing interventions were performed with an overall compliance of 90.1%; it is emphasized that 70.6% washed their hands before handling the device. Cleaning and maintenance of the insertion site was carried out by 98.8%, ports and connections were disinfected, and 92.9% lumens were identified. **Conclusion:** Nursing professionals performed interventions for the maintenance of the central venous catheter with a good compliance. However, the interventions with lower compliance that require improvement are hand hygiene, times for changing equipment and solutions, disinfection of ports and connections, which are essential to reduce infections in the bloodstream. In addition to future surveys about the professional and institutional factors associated with compliance.

Keywords: Nursing; Catheters; Maintenance; Pediatrics (DeCS).

Abstrato

Introdução: O cateter venoso central é necessário no atendimento pediátrico, porém, é uma importante causa de bacteremia nosocomial, com mortalidade de 25%. O profissional de enfermagem é responsável pela manutenção do cateter venoso central para evitar complicações locais e sistêmicas como endocardite e bacteremia relacionadas ao tratamento intravenoso. **Objetivo:** Descrever as intervenções de enfermagem para manutenção do cateter venoso central em pacientes pediátricos de um hospital especializado. **Metodologia:** Delineamento observacional, descritivo, transversal, amostra composta por 85 profissionais de enfermagem que prestavam assistência direta à criança hospitalizada e receberam treinamento, amostragem não probabilística, o instrumento utilizado foi um checklist de manutenção de cateter venoso central e os dados foram coletados com o técnica de observação. O estudo atende aos aspectos éticos da lei geral de saúde em relação à pesquisa. **Resultados:** As intervenções de enfermagem foram realizadas com uma adesão global de 90,1%, destaca-se que 70,6% lavaram as mãos antes de manusear o aparelho. A limpeza e manutenção do sítio de inserção foi realizada por 98,8%, as portas e conexões foram desinfetadas, os lúmens foram identificados por 92,9%. **Conclusões:** Os profissionais de enfermagem realizam as intervenções para manutenção do cateter venoso central com boa adesão. No entanto, as intervenções com menor adesão que requerem melhoria são a higienização das mãos, tempos de troca de equipamentos e soluções, desinfecção de portas e conexões; essencial para reduzir as infecções da corrente sanguínea. Além de estudos futuros sobre os fatores profissionais e institucionais associados à adesão.

Palavras-chave: Enfermagem; Cateteres; Manutenção; Pediatria (DeCS).

Introduction

The central venous catheter (CVC) allows access to the intravascular compartment at the central level, the use of these plastic devices is of clinical benefit, therefore, inadequate maintenance leads to associated mechanical and infectious complications, risks to health and life of user[1].

Complications of the CVC use are early or late. The early ones include: improper placement, displacement and fracture of the device, while the late incidents are: local and systemic infection, venous thrombosis and catheter occlusion. Central venous catheter related bacteremias are complications caused by microorganisms that originate in the skin[2].

Hospitalized children are increasingly vulnerable to invasive procedures such as the installation of central venous lines that increase the risk of infection. Patients with CVC are at increased risk of bloodstream infections (STIs), with increased disease and death, due to prolonged periods of hospitalization[3]. However, the advantages for the patient with the use of the CVC center on the reduction of trauma related to intravenous infusion procedures, lower bleeding risk, in addition that the installation is cheaper and its maintenance becomes easier, also providing greater comfort[4].

An estimated 250,000 cases of STIs (BLASI by its English name) associated to central line or catheters occur annually in United States hospitals, with an estimated 12 to 25% attributable mortality. STI rates in intensive care units reported by the Centers for Disease Control range between 4.9 and 11.9 cases per 1,000 catheter days[5].

In Mexico, according to the latest RHOVE annual report, STIs ranked first in the frequency of infections[6]. STIs cause high morbidity, mortality, increases the days of hospital stay and costs of care[7]. Since 2012, the National Institute of Pediatrics of Mexico has carried out a verification package with five basic points: hand hygiene, skin asepsis, use of maximum barrier precautions, evaluating CVC removal and avoiding the femoral site for insertion of the catheter, with favorable results in the infection rates of the pediatric intensive care unit, in 2013 it was 2.9 STIs per 1,000 catheter-days, and in 2014 it decreased to 1.1 STIs per 1,000 catheter-days, which has been maintained until 2017[8]. In Southeast Mexico and specifically in the *Hospital Regional de Alta Especialidad del Niño* (Children High Specialty Regional Hospital), according to the report of the national catheter clinic platform, STIs associated to CVC have reported a significant reduction of a 4.8 rate per 1,000 catheter-days in 2021 to 0.8 per 1,000 catheter-days in 2022.

Implementing the intervention pack for prevention reduces STI rates and improves the quality of care and safety for patients[9]. In accordance with the evidence-based recommendations for CVC maintenance, the nursing professional should perform the following essential elements for the care of the child with CVC in the context of a pediatric hospital: assessment of the site and device, care using aseptic techniques, dressing change, visualization of the site, prevention of intraluminal contamination, catheter pulsatile flushing technique, and device functionality[10]. Strategies to reduce the risk of STI related to catheter or catheter-related bloodstream infection (CRBSI due to its acronym in English), are focused in skin protection and monitoring, allowing the reduction of damage associated to adhesives or medical adhesive related skin injury (MARSI), fundamental principles to prevent and control infections through hand hygiene, use of barrier equipment, use of sterile/non-sterile gloves, antiseptics, transparent adhesive dressings with

antimicrobial, active-passive disinfection and continuous analysis[11]. However, there is a gap in knowledge about compliance of nursing interventions with CVC maintenance in the pediatric field, in the regional context of Southeastern Mexico that allows identifying those that require continuous improvement for the prevention of STIs. Therefore, the following research question arises: What is the compliance of nursing interventions for the maintenance of the CVC in the prevention of STIs in a pediatric public hospital?

This research is based on Orem's self-care deficit theory in relation to nursing interventions in the maintenance of the CVC, because pediatric patients need caregivers to improve their health status, are dependent people, and cannot perform the activities by themselves. Orem defines that "therapeutic self-care requirements are made up of care actions at certain times to meet a person's needs (universal, developmental, and health deviation)" [12], as in pediatric patients. The nursing professional establishes a continuous interpersonal relationship with the patient, more than other members of the health team, during their hospital stay, is responsible for specialized care, when the person is unable to do it on its own (nursing agency), executes interventions for maintenance of the CVC, such as administering medications and performing the correct healing of the device and insertion site, for this reason he becomes responsible for assessing the evolution and possible complications. The importance lies in proper management by the professional, to prevent STIs, as well as other adverse effects such as pneumothorax, bleeding, arrhythmias, pulmonary emboli, among others[13].

Compliance is defined as the evaluation of adherence to recommendations and their implementation based on the best available scientific evidence, as well as expert recommendations for the maintenance of the CVC[14].

Nursing interventions "are the treatments, based on knowledge and clinical judgment, carried out by a nursing professional to favor the expected outcome of the patient"[15]. Nursing interventions include both direct and indirect care, directed to the person, the family and the community, as treatments initiated by nursing professionals, physicians, and other care providers.

Central venous catheter maintenance "is the healing of the insertion site. It is the aseptic technique that is performed to keep the catheter insertion site free of pyrogens"[16].

CVCs are necessary invasive procedures in the care of critically ill patients during their hospital process, therefore, it is necessary to know the standardized operation and management, contributing to essential safety actions and the continuous improvement of the quality of care in pediatric patients[14]. The objective of the research was to determine the compliance of interventions that the nursing professional performs for the maintenance of the CVC in pediatric patients of a regional and public hospital.

Methodology

Quantitative research, observational design, of descriptive and cross-sectional type. The universe was made up of 95 nursing professionals who performed interventions for the maintenance of the CVC, in pediatric patients in a specialized hospital; the sample was estimated with the formula of finite populations, with a confidence level of 95% and estimated error of 5%, a sampling was obtained from 85 nursing professionals, who worked in the institution and provided care directly to pediatric patients (administration of drugs, blood derived products, parenteral nutrition, closed-circuit changes and healing) hospitalized with CVC in pediatric services of oncology, surgery, emergencies and internal medicine, Neonatal Intensive Care Unit (NICU), Pediatric Intensive Care Unit (PICU), nurses who received training or courses on CVC maintenance during June to July 2021. Sampling was non-probabilistic. Nursing professionals with administrative functions, who did not perform direct care, nor did they participate in training on CVC maintenance, were excluded.

A survey was applied to obtain sociodemographic data of the professionals: age, sex, academic level, years of seniority and work shift, received training for CVC care by the catheter clinic, and compliance, nursing interventions and CVC maintenance. In addition, structured observation took place in order to observe and record the behavior of nurses, with a CVC maintenance checklist, adapted in 2018[17] from the manual for standardized nursing care to persons with intravascular infusion therapy in the Mexican Ministry of Health, which contains 9 questions with dichotomous answer options, where "complies" is equal to 1 point, and

"does not comply" is equal to 0. In the adaptation, question 6 is excluded because it is not executed and evaluated in an isolated manner but rather implicitly in another intervention. The percentage of overall compliance with nursing interventions for CVC maintenance and each of the 8 questions was estimated with the following formula: Number of observations of compliance with nursing interventions for CVC/Total-number-of-observations-made) maintenance = compliance %. The classification of compliance was performed taking as a reference the standard of quality indicators of nursing care, from the national system (INDICAS) of the General Directorate of Quality and Health Education,[17] which classifies compliance: less than 75% deficient, from 76 to 90% regular, and from 90 to 100% good.

Informed consent was requested from the nursing professionals, where the benefits, anonymity and confidentiality of the data were explained, with the authorization of the participants, the collection of data was started. The methods used to measure the research variables were: The survey to obtain the sociodemographic data of the professionals, in addition to the structured observation in order to see and record the behavior of the nurses.

The survey complied with the ethical aspects of the General Health Act for Research, Chapter I, Articles 13, 14, 15 and 16, which establishes that in every research carried out on human beings, dignity and protection of their rights must prevail, safeguarding their life and well-being[18]. It was carried out in accordance with the ethical research guidelines of the Official Mexican Standard NOM-012-SSA3-2012[19], which establishes the criteria for the execution of research health projects in human beings, the Helsinki's Declaration, and was approved by the Institutional Research Ethics Committee with number CIE-091-07-2022.

In the data processing, the statistical package for social sciences (SPSS) version 22, in Spanish, was used. A matrix was designed prior to coding the survey variables. Data analysis was performed with descriptive statistics, nominal variables with frequencies and percentages, and numerical variables with measures of central tendency.

Results

The socio-occupational characteristics of participants showed a mean age of 39.4 (±10) years and a range of 23 to 64 years, 94.1% female, 75.6% with a bachelor's degree, 21.2% specialists, and 3.5% with master's degrees. 23.5% worked in the PICU, 22.4% in oncology, 16.5% in emergencies and NICU respectively, 11.8% in surgery, and 9.4% in internal medicine. The distribution by shifts showed that 32.9% of the nurses worked in the morning shift, 30.6% mixed shifts, 28.2% in the evening shift and 8.3% in the night shift. The average job seniority was 13.1 (±9.9) years and a range of 1 to 38 years, (Table 1). One hundred percent of the professionals reported having received training on interventions for CVC management.

Table 1. Socio-occupational characteristics of the nursing personnel, 2019. (n=85)

Services	*F*	*%*
Emergencies	14	16.5
Surgery	10	11.8
Internal Medicine	8	9.4
Oncology	19	22.4
NICU	14	16.5
PICU	20	23.5
Shifts	*f*	*%*
Morning	28	32.9
Evening	24	28.2
Night A	7	7.1
Night B	1	1.2
Mixed	26	30.6
Academic Level	*f*	*%*
Bachelor's degree with technical code	9	10.6
Bachelor's degree	55	64.7
Specialty	18	21.2
Master's degree	3	3.5
Sex	*f*	*%*
Feminine	80	94.1
Masculine	5	5.9

Source: Self-development.

The recommendations for the prevention of CVC-associated STIs in the maintenance stage focus on reducing the risk of catheter colonization. Table 2 shows that 97.6% of the participants correctly identified the patient, corroborated the data in the clinical nursing records, and verbally rectified the patient's name. They performed hand hygiene before handling the CVC, 70.6% complied including the 5 moments,

maintaining sterility related to CVC care, and 29.4% did not perform aseptic technique during the continuous CVC care.

The verification of CVC patency (permeability) and the assessment of venous access conditions found that 90.6% of the nursing staff complied with the review during the application of medications, change of circuits and TPN administration, as well as in the cleaning or healing of the CVC. In the maintenance of the insertion site consistent with the protocol of the institution, it was obtained that 98.8% of nurses met the criteria to perform antisepsis or healing of the insertion site every 7 days with sterile technique, and the connection of the infusion system was maintained at all times in patients with CVC. On the other hand, in the change of solutions and equipment, the withdrawal of solutions every 24 hours, parenteral fluid infusion equipment (vacoset, metriset) heparin seals every 3 days or 72 hours were applied; when they were used with blood or lipid products (NPT), immediate replacement of the infusion equipment was performed, each one of them was identified with a letterhead, finding that 89.4% implemented this intervention, while 10.6% did not comply.

Regarding the disinfection of the injection ports with 70% alcohol before handling them, they carried out the change of the connection ports, such as three-way valves and central venous pressure equipment, using an aseptic technique, in accordance with the provisions of the standards for the prevention of SITs, 85.9% adopted the necessary measures in the management of CVC, in contrast, 14.1% failed to comply with the measure to avoid contamination and reduce the risk of infections in the patient.

The letterhead and recording of the data in nursing note formats that identified the date, time and name of the person who placed it in the established formats, reached 95.3% in the application, consequently 4.7% did not have the necessary information in the clinical records. In compliance with each of the eight interventions, it is observed that the lowest frequency was in hand hygiene prior to handling the CVC with 70.6% (Table 2).

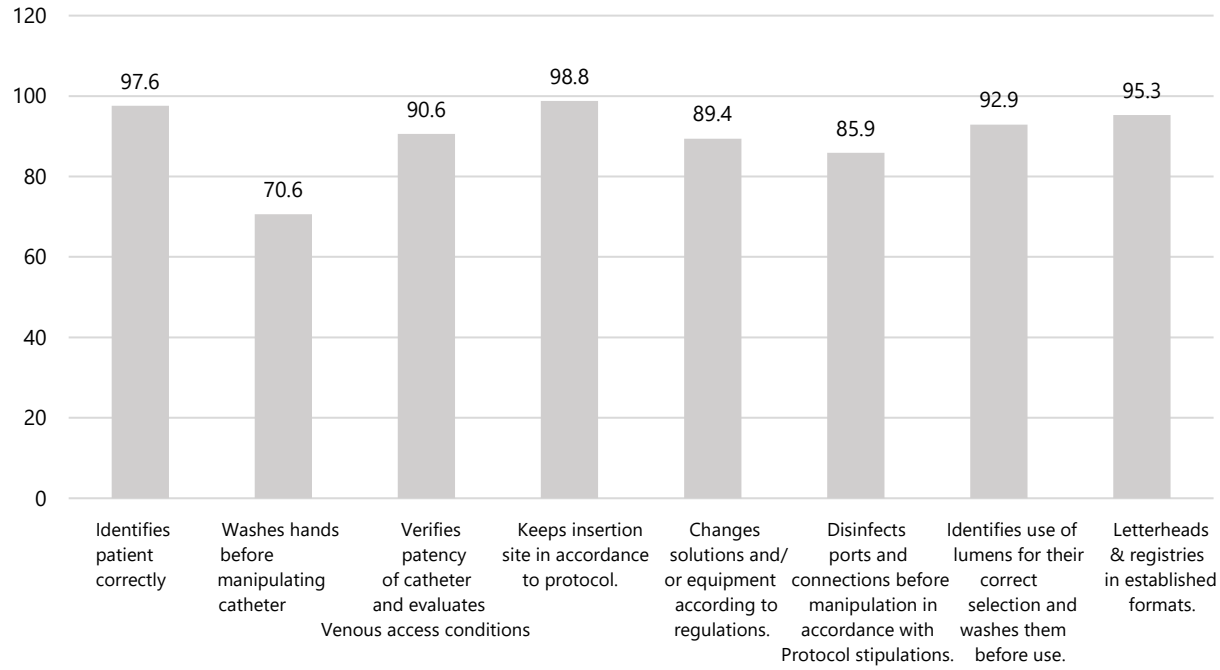
Table 2. Percentage of compliance with nursing interventions for CVC maintenance, 2019 (n=85).

Interventions	Complies			
	Yes		No	
	f	%	f	%
1.-Identifies patient correctly	83	97.6	2	2.4
2.-Performs hand hygiene before handling the catheter	60	70.6	25	29.4
3.-Verifies catheter patency and assesses venous access conditions	77	90.6	8	9.4
4.-Maintains the insertion site according to the protocol.	84	98.8	1	1.2
5.-Changes solutions and/or equipment in accordance with regulations.	76	89.4	9	10.6
6.-Disinfects ports and connections before handling them, in accordance with protocol	73	85.9	12	14.1
7.-Identifies use of lumens for their correct selection and washes them after use	79	92.9	6	7.1
8.-Letterheads and registries in established nursing note formats.	81	95.3	4	4.7

Source: Self-development.

The overall sum of the eight interventions was 721 points, the result was divided by the number of interventions, with a compliance percentage of 90.1 (Graph 1).

Graph 1. Percentage of compliance with nursing interventions for CVC maintenance, 2019. (n=85).



Source: Self-development.

Discussion

Based on the objective of describing nursing interventions for CVC maintenance in pediatric patients at a specialized hospital, it was identified that in relation to the socio-occupational characteristics of participants, 9 out of 10 were women with a mean age of 39 years, four fifths were nursing graduates (11% with technical

category) and one fifth had specialty and master's degrees. Of the various hospital services, a third of the nurses worked in the morning shift; a third in the mixed one, and a third in the evening and night shifts. The job seniority obtained an average of 13.1, all the participants were trained to manage CVC in accordance with the regulations[20]. Similar findings were reported in one survey[21], while another one differs[22] after finding a third of nursing assistants. In the clinical practice of pediatric nursing, of the specialized hospital of the public health system, care is assumed, with a group of nurses who have a heterogeneous academic training, an institutional factor that can be modified to integrate 100% of professional nurses and specialists, who count with the clinical competencies of university training and job satisfaction, with a safety culture to care for children with CVC. This has implications for future research investigating professional and institutional factors associated with compliance.

Identifying patient is an essential safety action[9], prior to carrying out any procedure carried out by 9 out of 10 nurses, nurses are required to verify the data and record the full name and date of birth, date and time of installation and full name of the person who installed the device. In the event that the patient is unconscious or with any type of disability that impedes communication, the data must be validated before performing any procedure, in agreement[21] with the parent or tutor, who reported a 97% compliance.

Likewise, hand hygiene is a set of methods, techniques that remove, destroy and reduce the number and proliferation of microorganisms; accordingly with the above, 8 out of ten nursing professionals washed hands before handling the CVC. Previous studies[22, 23, 24] reported similar results in Italian health professionals of public hospitals, implementation of guidelines for infection prevention with hand washing prior to CVC maintenance. Compliance in highly specialized hospitals with a maximum percentage of 100% compliance achieved by nurses from the National Institute of Cancerology in the Pediatric Bone Marrow Transplant Unit[23], allows differentiating the rigor of adherence to the infection prevention package in central lines when children present immunosuppression, together with the fact that the transplant unit counts with characteristics of design, isolation and highly trained professionals.

Regarding the rest of interventions, the verification of CVC patency and assessment was observed, which was carried out by 9 out of 10 nurses through the administration of medications, TPN, change of circuits and blood products. Congruent with the results[21] which reported 97% compliance. In contrast, with the findings[14] which reported that half of the professionals performed regular care and a third of the CVC site care was good. Regarding the cleaning and maintenance of the insertion site, it was identified that 100% of the nurses performed the care based on good practices, because not all the patients required cleaning on the day of data collection, handling was only observed on a single occasion, so it may be unnecessary due to standard time. Similar to this finding, researchers[23] found 97% compliance. In contrast, another survey[24] reported less than 50% of intervention execution. A possible explanation for this difference is due to a matter of the sample that corresponded to second level public hospitals.

In the disinfection of ports and connections, and in the identification of lumens and washing, 9 out of 10 complied with the intervention, respectively. The nursing professionals carried out the intervention of medication administration, TPN, change of circuits and blood products. These findings agree with a survey where they reported 97% compliance[25]. Results that differ[21] in a survey of adult population in a regional hospital, where 69% execution was observed. The completion of letterheads and records in established nursing note formats was complied with in 95.3%, similar to the results[21] that reported 92.5%.

The compliance in interventions for the maintenance of CVC was of 90.1%, which corresponds to a good quality standard, it can be concluded that the interventions of the nursing professional for the maintenance of the CVC, were carried out favorably, but it represents an opportunity for improvement in the prevention of infections associated to health care in pediatric patients. Similar to the survey of a Regional hospital in Colima, Mexico, with a sample of 67 nurses, a 91% of compliance in CVC care[22] was reported. In this survey, the performance may reflect the joint effort of the catheter clinic leaders, who with a decade of permanent actions of sensibilization (awareness), education and training in collaboration with those responsible for quality management and patient safety of the institution have promoted the training of all nursing

professionals with a favorable trend in the evolution when applying the STI prevention package for patients with CVC. It also offers a basis for future surveys on the effect of educational interventions on the application of clinical standards and guidelines that strengthen the culture of safety and contribute to improving care processes.

It is pertinent to emphasize that, although good compliance was found, in the analysis of the individual interventions that were evaluated, three results were identified with a higher percentage of non-compliance; hand hygiene, times for changing equipment and solutions, and disinfection of ports and connections; essential to reduce STIs associated with CVCs, similar to what was reported in a research [21].

Hand washing was carried out in almost a third part of the nursing staff during the survey period, despite the fact that it is an elementary technique for the maintenance of CVC, it is also the foundation of infection control, its execution limits the infections associated to health care. Likewise, it represents a protection measure for the health team[26,27].

The disinfection of ports and connections prior to their manipulation showed that just over a tenth of them failed to comply with the intervention, there is scientific evidence showing that to omit it favors the reproduction of infectious agents, in addition to the fact that it constitutes a frequent intervention for the administration of medication in pediatrics[28, 29]. Therefore, future studies are suggested to identify knowledge, attitudes and practices related to compliance with nursing interventions for CVC maintenance. Once the nursing interventions for the maintenance of CVCs have been implemented for the prevention of STIs, the systematic evaluation of compliance is recommended in clinical practice, which makes it possible to identify areas of opportunity in both structural and process aspects, in nursing care to pediatric patients of contexts similar to ours, knowledge that will serve as the basis for the design of educational interventions in clinical practice to increase the quality of care, establish goals and indicators of patient safety and the user satisfaction.

The findings of this survey should be taken with caution, further studies are required to answer questions related to generalization to other populations. Replications of the survey in several hospitals, especially if they differ in important aspects. Another limitation is non-probability sampling, since the people that are available could be outliers of the population. Also due to the observation method that includes the possible reactivity of the participant, when the observer is evident and there is vulnerability of the observations to biases. The bias was tried to be reduced with training and careful observer assessment.

Conclusions

According to the results, it can be concluded that it is shown that the nursing professionals performed good interventions for the maintenance of the CVC, in the pediatric patients of a specialized hospital. The contribution of the results makes it possible to strengthen nursing science in the clinical setting, making the use of findings useful in nursing practice to improve the care of pediatric patients with CVC. Likewise, it clarifies the contribution of the nursing discipline in the implementation of multidisciplinary action packages to reduce STIs.

During the handling of the CVC, hand hygiene and the use of antiseptics must be carried out in order to avoid the development of bacteremia associated with the CVC handling. In addition to the factors above described, it is recommended that future surveys investigate the factors related to the practice of hand hygiene, which may be affected by professional or institutional factors.

Also, the lack of identification in the CVC lumens, by nursing professionals when administering medications, should be improved, and improper handling should be eliminated, allowing the permanence of the central venous catheter, as well as safeguarding the life and safety of user.

The nursing professional executes interventions based on the best available evidence and, essentially, training and continuous education for CVC maintenance care in the hospital unit, the implementation of a set of actions is indispensable to improve health results with maximum benefits for the patient, due to the reduction of complications related to this device.

Conflicts of interest

The authors stated that they have no scientific or financial conflicts of interest..

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