Factors associated with the disinfection of devices attached to peripheral intravenous catheters performed by the nursing team in pediatric units

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FACTORS ASSOCIATED WITH THE DISINFECTION OF DEVICES ATTACHED TO PERIPHERAL INTRAVENOUS CATHETERS PERFORMED BY THE NURSING TEAM IN PEDIATRIC UNITS

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ABSTRACT

Background: peripheral intravenous catheterization, as well as drug administration through it, represents one of the most performed procedures by the Nursing team and, for that, precautions need to be adopted to offer harm-free care. **Objective:** to verify the association of Nursing professionals' work shift and training time with proper disinfection of intravenous catheter devices in pediatric units. **Methods:** a cross-sectional and analytical study conducted between June and August 2021 in three hospitalization units of a Pediatric Hospital. The inclusion criterion was drug administration via peripheral intravenous catheters performed by Nursing professionals. The data were analyzed according to inferential statistics, adopting $p \leq 0.05$ as significance level. **Results**: there was a total of 385 observations of drug administration procedures. The device was not disinfected in 60.3% of the cases, there was no friction at the suitable time in 86.3%, and the disinfectant was not allowed to dry in 72.5%. The work shift exerted no influence on performance of the disinfection procedure ($p=0.376$). However, longer training time was associated with a lower rate in performing such procedure ($p<0.001$). **Conclusion:** performing friction below the recommended time can cause a false sense of prevention of catheter-associated bloodstream infection; therefore, training sessions and strategies for adherence to the disinfection procedures should be considered, mainly for professionals with more training time.

Keywords: Disinfection, Peripheral Catheterization, Bloodstream Infection, Patient safety, Pediatrics.

BACKGROUND

Preventable infections resulting from health care still represent a major concern for health institutions (Fiorino et al., 2021; Reynolds et al., 2022). Peripheral intravenous catheterization is the invasive procedure most performed in hospitalized pediatric patients and the harms caused either by incorrect insertion or by inadequate maintenance and handling jeopardize the safety of these patients (Ullman et al., 2020; Berger et al., 2021). A multicenter study carried out in five pediatric units evidenced that 51.9% of the peripheral intravenous catheters (PIVCs) presented some type of complication (Abdelaziz et al., 2017).

The following can be mentioned among the main complications resulting from PIVC use: leakage, phlebitis and catheter-associated bloodstream infection (CABSI) (Berger et al., 2021). CABSI is defined as a bloodstream infection due to the use of PIVCs or central vascular access devices (CVADs) (Gorski et al, 2021). CABSI is associated with an increase in hospitalization times and with worsening of children's health status, even with a potential evolution to death (Berger et al., 2021; Shettigar et al*.,* 2021).

However, CABSI can be prevented by adopting preventive actions both during catheter insertion and for its maintenance, among which is disinfecting devices, such as connectors and extenders, used in intravenous catheters before administering medications (Cooney et al., 2020). These orientations and procedures are commonly employed in hospitals as part of structured bundles (Lutwick et al, 2019). Furthermore, globally recognized research groups have elaborated standards and guidelines specifically for intravenous therapy (O'Grady et al, 2011; Loveday et al, 2014; Gorski et al, 2021).

The scarcity of studies on the impacts caused by PIVC use, especially in children hospitalized in pediatric units, confirms its undervaluation in relation to CVAD, a factor that can be crucial for non-adherence to prevention measures for CABSI due to PIVC (Berger et al., 2021).

Failure to perform basic care activities can be characterized as care omission, with inadequate staffing, occurrence of some emergency situation, work shift schedule, number of patients and non-availability of materials or equipment among the main reasons (Ball et al., 2016; Dutra et al., 2019).

In view of the above and the need to exercise safe care, especially in relation to CABSI prevention through disinfection of PIVC devices, the following question was formulated: Which is the association of Nursing professionals' work shift and training time with proper disinfection of peripheral intravenous catheter devices to prevent bloodstream infection in pediatric units? Thus, the study aimed at verifying the association of Nursing professionals' work shift and training time with proper disinfection of intravenous catheter devices in pediatric units.

METHODS

The study design corresponded to a cross-sectional, analytical and exploratory research, carried out in three pediatric inpatient units of a public hospital specialized in

Pediatrics from Santa Catarina, southern Brazil. The Strengthening the Reporting of Observational studies in Epidemiology (STROBE) recommendations (Von elm et al., 2007) were followed for the reporting stage.

Data collection and research instrument

Data collection took place from June to August 2021 by means of a non-participant observation of the Nursing team during its care practice. The observation was in charge of one of the researchers, systematically and without exerting any influence on the study events (Zangirolami-Raimundo et al., 2018).

During the observations, the researcher accompanied the professional from the Nursing station to the patients' rooms, keeping an approximate distance of two meters. To measure friction time of the devices attached to the PIVC and the drying time of the antiseptic, the researcher used a digital stopwatch. In all, there were nearly 120 observation hours.

To reduce bias in the observation, such as the change in the participants' behavior, there was no interference from the researcher in their actions; in addition, the data collection instrument was not presented to the participants. In addition to that, the number of observations was divided by the number of professionals who agreed to participate so that each professional was observed on more than one occasion.

An instrument was prepared in REDCap® for data collection, based on the recommendations set forth in Infusion Therapy: Standards of Practice (Gorski et al, 2021). The instrument was divided into two parts: the first was related to characterization of the professional and contained nine variables: gender, age, professional category, training time, work shift, weekly hour load, other employment contract, working time in the sector and additional training. The second part consisted of 40 variables related to the disinfection of devices used in PIVCs. The variables were sample and exposure characterization, work shift and training time. In turn, the outcome variables were performance or non-performance of the disinfection procedure, friction time, and disinfectant drying time.

In the context of our study, we used as a reference The Infusion Therapy: Standards of Practice (Gorski et al, 2021). In this manner, the reference for performing adequate disinfection was friction for 5 to 15 seconds, using 70% Isopropyl Alcohol or

alcohol-based Chlorhexidine Gluconate <0.5%, allowing to dry for at least 5 seconds when using 70% Isopropyl Alcohol and for at least 20 seconds in the case of alcohol-based Chlorhexidine Gluconate <0.5% (Gorski et al, 2021).

Study sample

The sample was non-probabilistic and intentional, consisting in 385 observations of drug administrations performed by Nursing professionals. Sample size calculation was performed based on a previous survey, during seven days, of the number of medications prescribed in all three units to establish the estimate of the number of medications administered in a period of one year, calculated in the SEstaNet® Statistical Software-UFSC. The minimum sample size was 382 observations, considering a 95% significance level, with a 5% error margin.

The inclusion criterion established was drug administration via PIVCs performed by Nursing professionals. In turn, the non-inclusion criteria were drug administration performed by professionals on holidays or leave during beginning of the observation, even if they had returned to work during collection; and, as exclusion criteria: interruption of drug administration to perform another activity and withdrawal from participation in the study during the observation.

A pilot test of the instrument was conducted, in which 23 observations were carried out, representing 6% of the total sample, in order to verify if it was clear and coherent with the study objective (Canhota, 2008). The observations performed in this pilot test were not part of the final sample.

Recruitment

Before initiating data collection, contacts were made with the heads of the units and, consecutively, with the Nursing team of the units in order to explain the study objective. The professionals who agreed to participate in the study signed the Free and Informed Consent Form.

Data analysis

The data were organized and analyzed by means of the Statistical Package for the Social Sciences (SPSS) software, version 22. Data analysis was performed by means of inferential statistics; in addition, the association between the variables (work shift and

training time) and the procedure observed was performed. The inferential method used was the Chi-Square test, adopting a 95% confidence interval.

Ethical approval

The study was approved by the Ethics Committees in Research with Human Beings of the University to which the study was linked and of the Hospital where the research was conducted, submitting the following Presentation Certificates for Ethical Consideration: No. 40124620.0.0000.0121 in Opinion No. 4,646,384 and No. 40124620.0.3001.5361 in Opinion No. 4,807,211.

RESULTS

There were 385 observations of drug administrations performed by 58 Nursing professionals, with a mean of 6.6 observations per professional. Such being the case, 89 (23.1%) observations were made in the Orthopedics unit, 187 (48.6%) in Unit D, and 109 (28.3%) in Unit E. It is worth noting that all three units had a total of nine nurses and 63 nursing technicians, distributed between two work shifts.

Of the 63 nursing technicians, three (4.7%) were on holidays, two (3.2%) were on medical leave during the data collection period, and one (1.6%) showed no interest in participating; therefore, six nursing technicians were not included in the study. All the nurses agreed to participate in the study; however, during data collection, only one nurse administered medications via PIVCs.

Most of the observations were carried out in Unit D, in the daytime and with nursing technicians, who were between 31 and 50 years of age, with 21 to 30 years of training and no additional training (Table 1).

In 153 (39.7%) of the 385 observations, the professionals performed some type of disinfection procedure. In relation to the disinfectant, 70% Ethanol was used in all the procedures observed. As for the material on which the disinfectant was used for the disinfection procedure, 135 (83.7%) corresponded to non-sterile gauze and 26 (16.3%) to cotton.

In most of the observations, the friction time was below the recommended value, as well as the disinfectant drying time. There was low adherence to hand hygiene at all

three moments observed: before preparation, before administration, and after administration of the medication (Table 2).

Gloves were used in 12.2% of the drug administrations. After drug administration via three-way stopcock or double lumen extension, replacement of the protective cap with a new sterile cap only occurred in 7.5% of the observations.

When the association of work shift and training time with performance of some type of disinfection procedure, it was verified that work shift exerts no influence on disinfection of the devices ($p=0.376$). However, it was evidenced that the professionals with 10 or more years of training were the ones who least performed disinfection of the devices before administering the medications ($p<0.001$) (Table 3).

In the association of work shift and training time with performance of the disinfection technique, friction and drying time, it was again verified that work shift exerts no influence on performance of adequate friction and drying time. No association was observed between the exposure and outcome variables either (Table 4).

DISCUSSION

Despite the efforts of international organizations to disseminate best practices for intravenous therapy, proper disinfection of devices before drug administration is not part of the professionals' care routine (Oliveira et al., 2018). A study carried out in Australia on the disinfection of PIVC connectors in units for the care of adults presented high disinfection rates, where 99% of the nurses performed some type of disinfection procedure, but only 47.2% applied friction for more than 5 seconds and 80% allowed drying for more than 5 seconds (Slater et al., 2020).

In turn, in a study carried out in a Neonatal Intensive Care Unit, before adopting and implementing and operational protocol for the maintenance of intravenous catheters, an alarming result was identified in relation to the disinfection of devices before administering medications, as disinfection of the devices was not performed by any professional (Shettigar et al*.,* 2021).

Among the possible reasons for not performing some health care measure, work shift is considered a possible influencing factor (Ball et al., 2016; Lake et al., 2016), with the day shift presenting the highest number of omission cases (Ball et al., 2016). The study evidenced that disinfection of the perforating and healing disk of the saline vial before introducing the equipment presented a higher compliance rate during the night shift and that disinfection of the lateral injector of the equipment or the three-way stopcock showed better compliance during the daytime period (Oliveira et al*.,* 2018).

In this study, the participants' work shift did not exert any influence on performance of the disinfection procedures or on the friction and drying times. Thus, other factors can be associated with low adherence to procedures that contribute to patient safety, such as fatigue, long working hours, few hours of sleep and increased workload (Tubbs-Cooley et al*.,* 2019; Cochran, 2021).

In addition to that, when comparing the results of this study with a similar one (Slater et al., 2020), behavioral knowledge-related factors inherent to the professionals on the topic can be though about, being necessary to investigate in order to propose appropriate interventions.

It is noted that the participants' training time emerged as an influential factor for proper performance of the disinfection procedures for the venous devices. A number of studies show that the professionals with less training time have better theoretical knowledge in different contexts (Guskuma et al., 2019; Rocha et al., 2019), such as about multidrug-resistant bacteria (Rocha et al., 2019). However, further studies are necessary to understand this behavior fully, and to ascertain if this pattern repeats in different contexts.

In order to be successful in elimination of the microorganisms, in addition to the appropriate friction action, the use of some associated antiseptic is necessary. A randomized pilot trial evidenced that, after adhering to a protocol for disinfecting CVAD devices, when using 70% Isopropyl Alcohol, incidence of CABSI was 2% and, when using 2% Chlorhexidine Gluconate based on 70% Isopropyl Alcohol, incidence was 0% (Rickard et al*.,* 2021).

It is worth mentioning that an important factor in this context is availability of resources, which makes practices be based on what is available rather than on what is recommended (Ullman et al., 2020). In this study, all the disinfection procedures were

performed using 70% Ethanol. Using antiseptics other than those recommended presents challenges for the clinical practice: the use of 70% Ethanol can lead to changes in integrity of the catheter and the drying time of povidone-iodine is too long; therefore, its use is not recommended, even showing effectiveness in combating bacterial growth (Gorski et al, 2021).

To apply the antiseptic, non-sterile gauze was the material most used by the participants of this study (83.7%), despite what is indicated by Infusion Therapy: Standards of Practice, which recommends using disinfectant-impregnated swabs (Gorski et al, 2021). It is important to note that swabs are sterile single-use compresses impregnated with antiseptic. If they are not available, an equally sterile material, such as sterile gauze, should be used.

The Infusion Therapy: Standards of Practice (Gorski et al, 2021) also presents other measures to prevent CABSI due to PIVC, namely: replacement of the previous connection area protection cover of the three-way stopcock or double lumen extension with a new sterile cap after administering the medication (Paparella, 2017; Gorski et al, 2021) and hand hygiene before administering the medication, as one of the ways to acquire CABSI is through intraluminal contamination, which is caused by the dissemination of microorganisms by health professionals when inappropriately handling connectors and devices of intravenous catheters (Hankins et al., 2019).

A number of studies show that, despite being widely publicized, adherence to the hand hygiene practice is still not within the expected standards (Oliveira et al., 2018; Slater et al., 2020; Ben fredj et al., 2020). In this study, low adherence to hand hygiene stands out, mainly before administering medications. It is worth noting that this study was carried out during the COVID-19 pandemic and that frequent hand hygiene, mainly with soap and water, is one of the recommendations for preventing transmission of the virus (Rundle et al., 2020).

This study showed the context of a single hospital, thus precluding generalization of the results, as other hospitals may have institutional specificities, such as work structure, availability of materials and different training procedures. Such factor also represents a study limitation. However, the low adherence to disinfection and hand hygiene found in this study serves as an alert for health institutions and as a reference for

new studies in other contexts, as they are factors of attention for a possible increase in the number of CABSI cases.

CONCLUSION

This study showed that the longer the professional's training time, the lower the adherence to the practice of disinfection of devices attached to PIVCs in the pediatric units analyzed; this result can assist in planning training sessions and strategies for adherence to disinfection performed by these professionals. Furthermore, there was no significant relationship between the work shift variable and the procedures observed, from which other factors should be researched in order to identify possible reasons for the low adherence to this CABSI prevention measure.

In addition to that, performing friction below the recommended time can cause a false sensation in the professionals that they are protecting the patient from potentially dangerous microorganisms; as well as the use of materials without proof of effectiveness in eliminating microorganisms, such as non-sterile gauze and cotton, in addition to the use of Ethanol, which can compromise integrity of the device.

DECLARATION OF CONFLICTING INTERESTS

The authors declare that there is no conflict of interest.

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