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Impact of flushing with aseptic non-touch technique using pre-filled flush or manually prepared syringes on central venous catheter occlusion and bloodstream infections in pediatric hemato-oncology patients: A randomized controlled study

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ABSTRACT

Purpose: To compare standardized flushing methods with aseptic non-touch technique; (1) Manually prepared syringes (2) Single-use prefilled flush syringes.
Method: Forty-eight PHO patients with Hickman or Port catheters were recruited to participate in a prospective, randomized study. Standardized flushing methods with aseptic non-touch technique (ANTT) using single-use pre-filled flush syringes (intervention group) or manually prepared syringes (control group) also included the pulsatile technique, use of 10-mL syringe size with 0.9% NaCl for flushing, flushing once a day, flushing training of the nurses. The effects of standardized flushing methods on occlusion and CLABSI evaluated.
Results: Of the patients in the intervention group, 8.7% (n: 2) had catheter occlusion, while this rate was 20.0% (n: 5) in the control group. Of the patients in the intervention group, 8.7% (n: 2) had CLABSI, while this rate was 36.0% (n: 9) in the control group. While there was no difference in occlusion, there was a difference between the groups in terms of CLABSI development. In the intervention group, CLABSI rate was 1.9/1000 per catheter-days, in the control group CLABSI rate was 10.1/1000 per catheter-days. In the intervention group, occlusion rate was 1.9/1000 per catheter-days, in the control group, occlusion rate was 5.6/1000 per catheter-days.
Conclusion: Standardized flushing and single-use prefilled flush syringes are effective in reducing CLABSI rates in PHO patients.

1. Introduction

The use of central venous catheters (CVCs) in healthcare is crucial to shortening the hospitalization process, increasing patient safety, and reducing costs (Heidari Gorji et al., 2015). In the treatment of cancer patients, the vascular access must be maintained (Arora et al., 2010). Health professionals have a key role to play in ensuring the safety of CVCs. If complications do not develop, CVCs can remain in pediatric hemato-oncology (PHO) patients during treatment (Gonzalez et al., 2012). Central line-associated bloodstream infections (CLABSI) are frequently seen in the hospitalization process of PHO patients and carry a risk of morbidity (Hentrich et al., 2014). Studies reveal that CLABSI rates can be controlled in PHO patients with care bundles (Choi et al., 2013; Duffy et al., 2015; Gerçeker et al., 2017; Rinke et al., 2012).

In addition to CLABSI, another complication seen in these children is catheter occlusion. It develops in CVCs due to the formation of fibrin structures at the tip of the catheter, and in this case catheter should be completely removed or replaced. This causes an interruption in the treatment (Shah and Shah, 2008). Flushing is a method that can be applied to ensure the safety of the catheter lumen and to prevent occlusion (Hadaway, 2006). Milani et al. (2017) noted that the port occlusion was associated with flushing. Little is known about the current status of flushing practice. Aseptic Non-Touch Technique (ANTT) and flushing by using both manually prepared and prefilled flush syringes can be used (Keogh et al., 2014).

In a randomized controlled study by Schallom et al. (2012) in which heparin and 0.9% sodium chloride (NaCl) efficacy was compared to maintain CVC patency, both flushing solutions had similar effects. In the guidance prepared by the Centers for Disease Control and Prevention, it was recommended that heparin should not be routinely used to reduce the risk of CLABSI in the general hospital population (Evidence II) (O'Grady et al., 2011). For this reason, 0.9% NaCl is preferred in the

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routine flushing of CVCs (Bradford et al., 2016; Schallom et al., 2012).

In a randomized controlled trial performed by Schreiber et al. (2015), once or twice daily flushing were compared in child patients, and no difference was found between these two groups. It was noted that flushing once a day is enough, reducing the manipulation while also being cost-effective. Keogh et al. (2014) compared manually prepared and single used pre-filled flush syringes in terms of total flushing time and found that the mean total flushing time was significantly less in the group of single used pre-filled flush syringes. Pre-filled flush syringes are shown to reduce the risk of catheter and solution contamination. Single-use prefilled flushing devices are cost-effective and associated with a significantly lower CLABSI rate (Rosenthal et al., 2015). Devrim et al. (2016) found that the central line bundle including split-septum needleless connector and single-use pre-filled flushing devices are effective in reducing the catheter infection. Although there are bundle studies on CLABSI control in the PHO population (Choi et al., 2013; Duffy et al., 2015; Gerçeker et al., 2017; Rinke et al., 2012), no studies on the effectiveness of the flushing were found. The purpose of this study was to investigate the effect of standardized catheter flushing with ANTT using single-use pre-filled flush syringes or manually prepared syringes on catheter occlusion and CLABSI in PHO patients with CVC.

2. Methods

2.1. Study design

This prospective randomized controlled and single-blinded study was designed to compare standardized flushing methods using aseptic non-touch technique (ANTT); (1) Manually prepared syringes (2) Single-use prefilled flush syringes (BD PosiFlush™). This study was conducted in the Ege University Pediatric Hemato-oncology Unit between July 2016–June 2017.

2.2. Intervention

In the intervention group, standardized flushing method with ANTT using single-use pre-filled flush syringes were used for the catheter flushing. In the control group, standardized flushing method with ANTT using manually prepared syringes were used for the catheter flushing. The catheter flushing steps used in the intervention and control groups are given in Table 1.

Standardized flushing methods with ANTT using single-use pre-filled flush syringes (intervention group) or manually prepared syringes (control group) included the pulsatile technique, use of 10-mL syringe size with 0.9% NaCl for flushing, flushing once a day, flushing training of the nurses.

The ANTT is based on the principle that “If the interference area is not touched, the area concerned is not contaminated.” This technique relies on the principles of efficient hand-washing, the provision and maintenance of clean spaces/materials, the use of alcohol-based solutions for decontamination, and waiting for the alcohol to dry out. The ANTT technique has been used in catheter flushing for more than 20 years, and it describes infection prevention guidelines and precautions to be followed during invasive clinical interventions (Rowley et al., 2010).

In the control group, a 10-mL syringe is manually filled with 0.9% NaCl for catheter flushing. The steps for manually preparing the syringe are given in Table 1. Single-use pre-filled flush syringes used in the intervention group were disposable and required no preparation.

The size of the syringe for flushing is also extremely important. Small-volume syringes can cause the catheter rupture due to higher pressure. Flushing should be performed with 10-mL syringe size and the flushing volume should not exceed 5–10 mL to prevent catheter rupture. 10-mL syringe size is the gold standard for CVCs (Infusion Nurses Society, 2016). Although it is sufficient to flush the catheter with 5 mL fluid before and after the drug administration, it is necessary to flush the catheter with 10 mL fluid to avoid fibrin leftovers in the catheter lumen in cases such as blood draw and blood transfusion (Goossens, 2015). For this purpose, single-use pre-filled flush syringes are found in 10 mL syringes (Rosenthal et al., 2015). In the intervention group, 10 mL of single-use pre-filled flush syringes containing 0.9% NaCl were used for flushing. In the control group, 0.9% NaCl was manually filled up to 10 mL syringes.

The quality of flushing is as important as the frequency of flushing. In the catheter flushing, the pulsatile technique should be used, and the catheter should be flushed with the pulsatile technique to prevent biofilm formation on the inner surface of the catheter (Ferroni et al., 2014). Ferroni et al. (2014) concluded that pulsatile flushing technique reduces endo-luminal colonization better compared to the continuous infusion of fluids, and especially inhibits *Staphylococcus aureus*. The pulsatile technique is a simple, effective, and inexpensive technique to reduce bacterial colonization in the catheter (Ferroni et al., 2014). For this reason, the pulsatile technique was used in this study.

Before beginning the study, nurses were trained about flushing (its necessity, frequency, quality, and size of syringes to be used) and made aware of comparative studies on flushing with heparin and saline. The ANTT and pulsatile flushing technique were explained. In routine flushing, heparin was not used. The catheter flushing was shown practically to each nurse working in the unit. The steps listed in Table 1 were fully implemented by the nurses. The researchers observed and recorded the daily flushing.

In addition, a care bundle for preventing catheter infection was applied in the unit where the study was performed. This care bundle included: 1) Catheter entries (hand hygiene, closed intravenous system); 2) Catheter site care (chlorhexidine gluconate skin antisepsis, checklist for catheter exit site care and port needle change, IV Advanced Tegaderm 3M); 3) Daily dressing/site assessment performed; 4) Catheter cap/hub/tubing care (split septum needleless connector-BD Qsyte, checklist for medication administration and infusion sets change); 5) Providing patient and family training for catheter safety.

2.3. Data collection

All children and families who volunteered to participate in the study were informed about the study, and their written consent was taken. After randomization, the investigators obtained information about the patients and their catheter characteristics through the “Patient Characteristics and Catheter Complication Evaluation Form.” Daily flushings were recorded in this form. If any occlusion developed in the patient's catheter, continuous infusion outflow and use of total parenteral nutrition (TPN) were recorded at the date of occlusion.

The blood culture results from the patients were obtained, and the CLABSI development status was recorded in the form. At the time of CLABSI and occlusion development, neutropenia, bacteremia, and septicemia were also evaluated. Catheter removal due to occlusion or CLABSI was recorded. The total length of stay of the catheter was evaluated until the patient was discharged or until the end of treatment.

2.3.1. Patient characteristics and catheter complication evaluation form

This form requests for the patient's age, gender, diagnosis, relapse status, catheter type, date of inclusion to the study-discharge from the unit, occlusion status, history of TPN and continuous infusion, blood transfusion status, intervention due to occlusion, CLABSI development status, clinical features of the patient in the case of CLABSI development (neutropenia, bacteremia, septicemia), catheter removal, and total catheter days.

2.4. Study sample

The study's population consisted of patients between 0 and 18 years of age who had a CVC inserted and were hospitalized in a PHO unit of a