



Adherence to central venous catheter insertion bundle in neonatal and pediatric units

Adesão ao *bundle* de inserção de cateter venoso central em unidades neonatais e pediátricas
Adhesión al *bundle* de inserción de catéter venoso central en unidades neonatales y pediátricas

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ABSTRACT

Objective: To describe the observed behavior of professionals in two neonatal and pediatric intensive care units regarding the use of central venous catheter insertion bundle, and the clinical and birth profile of neonates and children who received the devices. **Method:** A quantitative descriptive exploratory study was conducted in two intensive care units of a public hospital in Belo Horizonte with neonates and children, between February and September 2016. **Results:** The sample consisted of 59 observed implants of central venous catheter. Most patients were male preterm infants, of cesarean delivery and proper weight according to the gestational age. Among all procedures observed, only three followed all recommendations for the central venous catheter insertion bundle. Incorrect techniques were observed while performing surgical antisepsis and inadequate use of chlorhexidine, an antiseptic. **Conclusion:** The findings highlight the importance of more investment in continuous training of the team on the prevention of bloodstream infection caused by central venous catheter to reduce the number of adverse events related to intravenous therapy.

DESCRIPTORS

Catheter-Related Infections; Catheterization, Central Venous; Patient Safety; Neonatal Nursing; Pediatric Nursing.

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INTRODUCTION

The technical and scientific advances related to invasive procedures have led to reduced infant mortality and increased survival rate of preterm newborns, which has changed the profile of care, raising the demand for increasingly complex care required for the survival of this population⁽¹⁻³⁾. The adoption of central venous catheters (CVC) in clinical practice was an important advance in the care to preterm newborns, ensuring safe venous access with less invasive, simple and low-cost techniques.

The types of CVC commonly used in pediatrics and neonatology are peripherally inserted central catheters (PICC), central insertion catheters, and umbilical venous catheters (UVC). These devices allow continuous administration of intravenous fluids and medications, parenteral nutrition, hemodynamic monitoring, and in some cases transfusion of blood products, depending on the catheter caliber and the patient's age^(2,4).

Despite the advantages of CVC, there are risks of complications associated with their use, such as venous thromboembolism, hemorrhage, infiltration, rupture, phlebitis and infection, with primary bloodstream infections (PBSI) being the most frequently related to health care⁽⁵⁻⁷⁾. PBSI can lead to clinical complications for patients, longer hospital stay, increased morbidity and mortality, and a significant increase in health care costs⁽⁸⁾. Planning and adopting PBSI prevention measures is essential for reducing morbidity and mortality rates, improving the quality and safety of health care, and reducing hospitalization costs^(7,9-10).

Strategies have been developed to reduce the incidence of PBSI associated with central venous catheters, for instance, the guidelines proposed by the Centers for Disease Control and Prevention (CDC), called Guidelines for the Prevention of Intravascular Catheter-Related Infections⁽¹⁰⁾. This is a group of care (bundle) that should be applied in a systematized manner by the healthcare team at each stage of care⁽⁷⁾.

The proposed care in the bundle is: hand hygiene, maximum barrier precautions (hand hygiene, cap, mask, coat, sterile gloves, and large sterile fields), skin preparation with chlorhexidine 2%, insertion site selection, and daily review of CVC need⁽¹⁰⁾.

To achieve good results, it is critical to incorporate the proposed steps into the care practice, which requires training and awareness of the teams involved. However, obstacles are observed to the full compliance with recommendations, leading to increased PBSI and complications associated with the use of CVC. This situation may compromise the quality of care and patient safety, with serious, immediate and late consequences⁽⁸⁾.

The objectives of this study were to describe the behavior of the professionals of the team working in the neonatal and pediatric intensive care units in terms of the proposed items in the CVC insertion bundle, and the clinical and birth profile of neonates and children submitted to these implants.

METHOD

A quantitative descriptive exploratory study was conducted in two intensive care units (a neonatal unit with 20 beds and a pediatric unit with 10 beds) of a large hospital in Belo Horizonte.

The population was made up of 188 neonates and children admitted between February and September 2016, and submitted to CVC insertion. For the purpose of sample calculation, the OpenEpi software was used, considering 95% as anticipated frequency for bundle adherence⁽¹⁰⁾, 5% margin of error, 95% significance level, and 20% estimated sample loss. The sample size was 54 patients, and five of them were submitted to more than one procedure, totaling 59 observations.

The inclusion criteria applied were: neonates, nursing infants and children aged 0 to 16 years admitted to the neonatal and pediatric intensive care units and submitted to CVC implant during the study period. Patients submitted to CVC insertion in emergency situations, hospitalized in care units other than those selected for the study, and with unsuccessful insertion procedures were excluded.

The patients' parents or legal guardians signed an informed consent form (ICF) after receiving clarifications about the study. All professionals (nurses, physicians, and surgeons) responsible for the central venous catheterization were informed about the study and authorized the observation by signing an ICF too.

Before data collection, the researchers were trained to reduce data bias. The training consisted of a theoretical module that introduced the CVC bundle, the objectives, the inclusion and exclusion criteria, and ethical considerations. In the second module, an equivalence method was used, through the observation of the same CVC insertion by the main investigator and other researchers, with records of the observations and comparison of the results obtained by each evaluator. This method evaluates the reliability of the recorded data⁽¹¹⁾.

Data collection was conducted by observing the insertion of central venous catheters and checking the patient's chart of the selected neonates and children. To record the data obtained, an instrument was developed using the recommendations of the Centers for Disease Control and Prevention, comprising items related to patient identification and characterization, and a catheter insertion technique.

The variables analyzed for sample characterization were gender, weight, gestational age at birth and corrected gestational age, gestational age classification in relation to weight, type of delivery, neonatal resuscitation, admission diagnosis, and catheter indication. The diagnoses: apnea, infant respiratory distress syndrome, acute fetal distress, early respiratory discomfort, and transient tachypnea of the newborn were categorized under Respiratory issues. The diagnoses of presumed sepsis and early sepsis were categorized under Sepsis.

Regarding insertion, the variables analyzed were: use of pain control measures, catheter type, insertion site and

site change, events during the procedure, use of ventilation devices, number of professionals in charge and their respective categories, and catheter position on the x-ray.

The variables regarding the central venous catheter insertion bundle⁽¹⁰⁾ were recorded as dichotomous variables (performed/not performed or used/not used), as follows: surgical antisepsis (steps of brushing, drying and rinsing), use of maximum protection barriers (sterile glove, coat, cap, mask, large sterile fields), protection of circulating professionals (mask and cap), antisepsis with chlorhexidine in a degerming solution (correct and complete technique), antisepsis with alcoholic chlorhexidine (correct and complete technique), antisepsis with degerming chlorhexidine (correct and complete technique). Any contamination during the procedure was also observed.

Data were entered and analyzed in the Statistical Package for the Social Sciences (SPSS®), version 22.0. All study variables were classified as categorical, and for their evaluation, absolute and relative frequencies were used.

The study project was approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais under protocol number: 1.288.258.

RESULTS

During the study period, 54 neonates and children were submitted to CVC insertion. The age of the children included in the study was between 0 and 12 years. Regarding the unit in which the procedures were performed, most procedures (n=44, 81.5%) were performed in the neonatal ICU and the others (n=10, 18.5%) in the pediatric ICU. The use of one CVC was predominant, and only five patients (9.3%) used two CVCs, totaling 59 inserted catheters.

Table 1 shows that the use of PICC as a device to ensure central venous access was predominant in the Neonatal Intensive Care Unit (NICU), while the central insertion CVC was more used in the Pediatric Intensive Care Unit (PICU).

Table 1 – Distribution of types of central venous catheters inserted in neonates and children according to the intensive care unit – Belo Horizonte, Minas Gerais, Brazil, 2016.

Intensive care unit	Types of central venous catheter			
	PICC* n(%)	CVC† n(%)	UVC‡ n(%)	Total n(%)
NICU§	40 (81.6)	3 (6.1)	6 (12.3)	49 (100.0)
PICU¶	4 (40.0)	6 (60.0)	0	10 (100.0)
Total	44 (74.6)	9 (15.2)	6 (10.2)	59 (100.0)

Note: *PICC – Peripherally inserted central catheter, †CVC – Central venous catheter, ‡UVC – Umbilical venous catheter, §NICU – Neonatal intensive care unit, ¶PICU – pediatric intensive care unit.

Regarding the newborns' birth profile, most patients were male (n=30, 55.6%), with predominant cesarean delivery

(n=18, 33.3%); most were born with adequate weight for their gestational age (n=41, 75.9%), and more than half (n=38, 70.4%) were preterm neonates.

More than half (n=31, 57.4%) received the diagnosis of prematurity. The categories of respiratory issues (n=2, 46.3%), malformations (n=11, 20.4%), sepsis (n=8, 14.8%), neurological diseases, and hypoglycemia (n = 1, 1.9%) were also diagnosed in the studied sample.

While observing the CVC insertion procedures, most neonates and children (n=36, 66.7%) had ventilation devices, predominantly mechanical ventilation (n=20, 33.9%) followed by CPAP (Continuous positive airway pressure) (n=13, 22.0%) and HOOD (n=3, 5.1%), which is an acrylic device that increases the concentration of oxygen without pressure. Of the patients on mechanical ventilation, two were tracheostomized.

The indication of CVC insertion was mostly for the administration of antibiotics for long periods (more than 7 days) (n=25, 42.4%), followed by the use of antibiotics and parenteral nutrition (n=15, 25.4%), and parenteral nutrition alone (n=6, 10.2%). The use of some measure for prevention and relief of pain was observed in more than half of the procedures evaluated (n=38, 64.4%). Of these, most received oral glucose solution (n=18, 47.4%), fentanyl associated with midazolam (n=8, 21.1%), or fentanyl alone (n=7, 18.4%).

In relation to the catheter insertion site, the veins of the upper limbs predominated (n=23, 39.6%), followed by veins located in the head (n=9, 15.5%), veins of the lower limbs and neck (n=7, 12.1%), umbilical vein (n=6, 10.3%), and subclavian vein (n=4, 6.9%). Only one (1.7%) dissection was performed in the lower limb vein. The insertion site changed during the procedure in 10 (16.9%) cases observed.

Regarding the catheter position on the x-ray, the central position was found in 22.0% of the cases, and non-central position in 49.1% of the cases – nine in peripheral and 18 intracardiac position. Of the six inserted umbilical catheters, two were in the intrahepatic position and the catheter was drawn in 47.5% of the procedures.

Nurses were responsible for PICC insertions (n=44, 74.6%), surgeons for the CVC insertions (n=9, 15.2%), and pediatricians for UVC insertions (n=6, 10.2%). In 66.1% of the observations, the catheters were inserted by two professionals. Nursing technicians were the circulating professionals in 89.8% of the insertions.

The complications observed during insertion were bleeding (n=19, 32.2%), difficult progression (n=15, 25.4%), and saturation fall (n=9, 15.3%) of patients.

In most insertions (n=31, 52.5%), an error was observed while performing the degerming procedure of the patient's skin. Technical inadequacies while using alcoholic chlorhexidine on the patient's skin (n=22, 37.3%) was higher than its recommended use (n=17, 28.8%). Contamination of the procedure was observed in 27.1% of the insertions. Among all procedures observed, in 5.1%, no breach was observed in any of the central venous catheter insertion bundle stages (Table 2).

Table 2 – Data from CVC insertion bundle observation in neonates and children in ICU – Belo Horizonte, Minas Gerais, Brazil, 2016.

Parameters	n	%	% valid**
Surgical antisepsis - first professional			
Did not perform the procedure	2	3.4	3.4
Performed it using the correct technique	15	25.4	25.4
Performed it using the incorrect technique	42	71.2	71.2
Total	59	100.0	100.0
Maximum protection barriers – first professional			
Incomplete preparation	2	3.4	3.4
Complete preparation	57	96.6	96.6
Total	59	100.0	100.0
Surgical antisepsis - second professional*			
Did not perform the procedure	3	6.7	7.0
Performed it using the correct technique	13	28.9	30.2
Performed it using the incorrect technique	27	60.0	62.8
Total	43	95.6	100.0
Maximum protection barriers – second professional*			
Incomplete preparation	1	2.2	2.9
Complete preparation	33	73.3	97.1
Total	34	75.5	100.0
Protection barriers - circulating professional			
Incomplete preparation	6	11.3	11.3
Complete preparation	47	88.7	88.7
Total	53	100.0	100.0
Skin antisepsis with degerming chlorhexidine 2%			
Did not perform the procedure	1	1.7	1.7
Performed it using the correct technique	27	45.8	45.8
Performed it using the incorrect technique	31	52.5	52.5
Total	59	100.0	100.0
Insertion site antisepsis with alcoholic chlorhexidine*			
Did not perform the procedure	15	25.4	25.9
Did not use it due to low weight	4	6.8	6.9
Performed it using the correct technique	17	28.8	29.3
Performed it using the incorrect technique	22	37.3	37.9
Total	58	98.3	100.0

Variables with lost data; **Percentage of valid data. Note: (n=59).

DISCUSSION

Most patients submitted to CVC insertion were male, and the main admission diagnosis was prematurity. In 2011, 11.8% of the children born in Brazil were preterm infants. Complications associated with prematurity account for more than 70% of annual neonatal deaths in neonates without malformations, which constitutes a health problem in this population⁽²⁾.

In this study, prematurity as the main admission diagnosis does not differ from the national context, and the immediate implications of this fact are the prevalence of respiratory diseases due to pulmonary immaturity and the need for interventions to support life for this population, with emphasis on safe central venous access for the administration of antibiotics, nutrition and supporting electrolytes. Preterm patients present specificities that significantly differentiate them from other age groups. For this reason, technical and scientific improvements, specialized equipment and skilled workforce are essential for their survival^(2,12).

In this study, the most frequent central catheter insertion sites were the upper limb veins, in agreement with the

specific literature^(2,13). In these limbs, factors such as easy positioning, the lower number of valves when compared to lower limb veins, the greater caliber and the favorable anatomy of the vessels, as well as the easily changed dressing contribute to having the basilic and cephalic veins as the primary option. The selection of the axillary vein should take into account the high risk of bleeding, especially in thrombocytopenic patients. It is a vein of larger caliber, lower number of valves, but the puncture positioning requires a skilled professional. The external jugular vein should be avoided due to the difficult positioning and lower vagal reflex threshold in preterm infants, as well as the risk of carotid artery puncture, which may cause hematoma, pneumothorax and gas embolism⁽¹⁴⁻¹⁵⁾. Tortuous veins with many valves and long routes to the heart tend to make the procedure more difficult and place the catheter in undesired anatomical positions⁽¹⁵⁾. The selection of the appropriate vein for the puncture should consider, besides the condition of the venous network and prior access, the age, diagnosis, type and duration of therapy⁽²⁾.

The adequate position of the catheter tip was observed in a small portion of the population, unlike the results

obtained in another study performed at an NICU in Belo Horizonte⁽¹³⁾. Incorrect catheter position is considered an adverse event related to CVC, and it is necessary to evaluate the possible causes of this finding. Among them, the technique used for catheter measurement and the patient position during catheter insertion should be investigated⁽²⁾. One study⁽¹⁵⁾ highlighted difficult catheter progression as a factor of significant influence on the catheter position. In addition, venous valves, excessive bleeding during insertion, and anatomical variation may lead the catheter to other venous branches⁽¹⁵⁾. Confirming the central position of the catheter tip on the x-ray is the gold standard and should be performed before the infusion of substances and it is a safety measure when using this device. This correct position is near the cardiac silhouette, preferably in the vena cava⁽¹⁶⁾. One study demonstrated the applicability of ultrasonography as an additional tool to ensure a successful CVC insertion procedure and highlighted its main benefits, including absent exposure to radioactivity, convenience, low cost, and the fact that it is not an invasive technique, minimizing risks related to infection and pain⁽¹⁷⁾. It should be noted that, in the city where the study was conducted, no neonatal unit uses ultrasonography as a strategy to evaluate central catheter position in clinical practice, except for research purposes⁽¹⁷⁾.

In this study, a considerable percentage of the sample was submitted to central venous catheterization without any control of pain intervention. Central venous catheterization is an invasive procedure and, for this reason, causes pain of variable intensity⁽¹⁸⁾. Submitting a patient to multiple untreated painful events alter the final brain architecture of preterm infants, resulting in immediate and late impairment of the patients⁽¹⁹⁻²⁰⁾. Therefore, the adoption of pain control measures is recommended, which should be defined by the team for each specific case.

This study showed that many professionals are resistant to conducting hand hygiene, which in some moments was not performed or performed inadequately. These results differ from the findings of a study conducted at a NICU in the Netherlands, which found a greater adherence to proper hand hygiene before events requiring this procedure by all professionals⁽²¹⁾. This finding points to the need to adopt team awareness measures because it is a simple but very important procedure to reduce infection rates and complications in patients using CVC.

Antisepsis of the insertion site before puncture was not performed in approximately 25% of the procedures. A similar result was found in another study conducted in Rio de Janeiro⁽²²⁾. In a study conducted in an ICU in Porto Alegre,

Brazil, the CVC insertion bundle adherence rate ranged from 36.1 to 78.3% in the study period, values that are much higher than those found in this study⁽²³⁾.

Despite the measures recommended by the CDC and even though all professionals from the investigated units had been previously trained, this study showed non-compliance with any step of the CVC insertion process in most observed procedures. One possible explanation is the great turnover of professionals in the studied units, work overload, and multiple employments, a factor that exposes professionals to long working hours, which compromise the quality of the care provided.

The relevance of this study is the collection of data that can be identified in different units in Brazil. Obstacles to the adherence to simple and effective measures to improve the quality of care should be identified and properly addressed in neonatal and pediatric intensive care units, resulting in longer survival and reduced complications associated with CVC use.

The limitations of this study refer to unavailable information in the literature regarding the implementation of CVC bundles in neonatal and pediatric units, and its reduced sample. The researchers opted for the interruption of data collection due to the findings and the need for educational interventions in the units where the study was conducted.

CONCLUSION

Central venous catheterization is a technology that has significantly contributed to the survival of neonates and children in critical health situations. Despite its benefits, the failure to comply with the steps to ensure a contamination-free procedure by professionals in charge of it puts the health of patients at risk.

This study showed that almost all healthcare professionals at some moment during the observed procedures did not follow important steps of the CVC insertion bundle, in particular, incorrect techniques while performing surgical antisepsis and using degerming chlorhexidine and alcoholic chlorhexidine.

The authors emphasize the importance of adopting permanent training on the CVC insertion bundle in the units that perform this procedure to minimize the risks of contamination and, consequently, hospital infection associated with the use of CVC. The adoption of these practices may contribute to reduce the number of adverse events related to intravenous therapy, reducing risks and increasing safety of the care practices related to the insertion and maintenance of central catheters in pediatrics.

RESUMO

Objetivo: Descrever o comportamento observado dos profissionais da Unidade de Terapia Intensiva Neonatal e Pediátrica segundo os itens do *bundle* de inserção de cateter venoso central, bem como o perfil clínico e de nascimento de neonatos e crianças que receberam os dispositivos. **Método:** Estudo descritivo-exploratório, de abordagem quantitativa, realizado em duas Unidades de Terapia Intensiva de um hospital público de Belo Horizonte com neonatos e crianças, entre fevereiro e setembro de 2016. **Resultados:** A amostra foi constituída por 59 oportunidades de observação de implantes de cateter venoso central. A maior parte dos pacientes era do sexo masculino, com nascimento prematuro, de parto cesáreo e com peso adequado para a idade gestacional. Entre todos os procedimentos observados, em apenas três não houve ruptura de nenhuma recomendação do *bundle* de inserção de cateter venoso central. Destacaram-se as técnicas incorretas na realização da antisepsia cirúrgica e o uso inadequado do antisséptico clorexidina. **Conclusão:** Os achados reforçam a importância de maior investimento na educação permanente da equipe referente às ações de

prevenção de infecção da corrente sanguínea relacionada à cateter venoso central, a fim de reduzir a ocorrência de eventos adversos relacionados à terapia intravenosa.

DESCRITORE

Infecções Relacionadas a Cateter; Cateterismo Venoso Central; Segurança do Paciente; Enfermagem Neonatal; Enfermagem Pediátrica.

RESUMEN

Objetivo: Describir el comportamiento observado de los profesionales de la Unidad de Cuidados Intensivos Neonatales y Pediátricos según los componentes del *bundle* de inserción de catéter venoso central, así como el perfil clínico y de nacimiento de neonatos y niños que recibieron los dispositivos. **Método:** Estudio descriptivo exploratorio, de abordaje cuantitativo, realizado en dos Unidades de Cuidados Intensivos de un hospital público de Belo Horizonte con neonatos y niños, entre febrero y septiembre de 2016. **Resultados:** La muestra estuvo constituida de 59 oportunidades de observación de implantes de catéter venoso central. La mayor parte de los pacientes era del sexo masculino, con nacimiento prematuro, de parto cesárea y con peso adecuado para la edad gestacional. Entre todos los procedimientos observados, en solo tres no hubo ruptura de ninguna recomendación del *bundle* de inserción de catéter venoso central. Se destacaron las técnicas incorrectas en la realización de la antisepsia quirúrgica y el empleo inadecuado del antiséptico clorhexidina. **Conclusión:** Los hallazgos refuerzan la importancia de mayor inversión en la educación permanente del equipo referente a las acciones de prevención de infección de la corriente sanguínea relacionada con el catéter venoso central, a fin de reducir la ocurrencia de eventos adversos relacionados con la terapia intravenosa.

DESCRIPTORES

Infecciones Relacionadas con Catéteres; Cateterismo Venoso Central; Seguridad del Paciente; Enfermería Neonatal; Enfermería Pediátrica.

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