● **Original article**

EDUCATIONAL ACTION FOR STANDARDIZATION IN THE MANAGEMENT OF HICKMAN CATHETERS®

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ABSTRACT: Objective: to enable the nursing team of a hematopoietic stem cell transplantation service to manage Hickman® catheters. **Method**: descriptive and quantitative research. Data collection took place between January and March 2017, in a public hospital in the South of Brazil, using questionnaires that were analyzed through descriptive statistics. **Results**: Forty-four participants were enrolled. Of the issues addressed, the ones with better results after the guidelines were: definition of a short-term central venous catheter (79.55% for 93.18% of correct answers); material and position of the catheter (75% to 88.64%); characteristics of the catheter (54.55% to 65.91%); immediate procedures after catheter insertion (2.27% to 18.18%); flushing, positive pressure and syringe-induced reflux (72.73% to 97.73%); catheter lock (84.09% to 97.73%); and priming volume (22.73% to 54.55%). **Conclusion**: the educational process developed allowed the instrumentalization of professionals to a more homogenous knowledge in the management of Hickman® catheters.
DESCRIPTORS: Evidence-based nursing; Central venous catheters; Hematopoietic stem cells transplantation; In-service training.

AÇÃO EDUCATIVA PARA A PADRONIZAÇÃO NO MANEJO DO CATETER DE HICKMAN®

RESUMO: Objetivo: habilitar a equipe de Enfermagem de um serviço de transplante de células-tronco hematopoiéticas no manejo do cateter de Hickman®. **Método:** pesquisa descritiva e quantitativa. A coleta de dados ocorreu entre janeiro e março de 2017, em um hospital público do Sul do Brasil, por meio de questionários que foram analisados mediante estatística descritiva. **Resultados:** habilitaram-se 44 participantes. Das questões abordadas, tiveram melhor resultado após as orientações: definição de cateter venoso central de curta permanência (79,55% para 93,18%de acertos); material e posição do cateter (75% para 88,64%); características do cateter (54,55% para 65,91%); procedimentos imediatos à inserção do cateter (2,27% para 18,18%); lavagem, pressão positiva e refluxo induzido pela seringa (72,73% para 97,73%); bloqueio do cateter (84,09% para 97,73%); volume do *priming*(22,73%para 54,55%). **Conclusão:** o processo educativo desenvolvido possibilitou a instrumentalização dos profissionais para um conhecimento mais homogêneo no manejo do cateter de Hickman®.
DESCRITORES: Enfermagem baseada em evidências; Cateteres venosos centrais; Transplante de células-tronco hematopoiéticas; Capacitação em serviço.

ACCIÓN EDUCATIVA PARA ESTANDARIZAR EL MANEJO DEL CATÉTER DE HICKMAN®

RESUMEN: Objetivo: Capacitar al equipo de Enfermería de un servicio de trasplante de células madre hematopoyéticas en el manejo del catéter de Hickman®. **Método:** Investigación descriptiva, cuantitativa. Datos recolectados entre enero y marzo de 2017 en hospital público delo Sur de Brasil, mediante cuestionarios, que fueron analizados por estadística descriptiva. **Resultados:** Recibieron capacitación los 44 participantes. Las cuestiones abordadas obtuvieron mejores resultados después de las indicaciones: definición de catéter venoso de corta permanencia (79,55% al 93,18% de aciertos); material y posición del catéter (75% al 88,64%); características del catéter (2,27% al 18,18%); higiene, presión positiva y reflujo inducido por jeringa (72,73% al 97,73%); bloqueo del catéter (84,09% al 97,73%) volumen del *priming* (22,73% al 54,55%). **Conclusión:** El proceso educativo desarrollado permitió el desarrollo por parte de los profesionales de un conocimiento más homogéneo en el manejo del catéter de Hickman®.
DESCRIPTORES: Enfermería Basada en la Evidencia; Catéteres Venosos Centrales; Trasplante de Células Madre Hematopoyéticas; Capacitación en Servicio.

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INTRODUCTION

Hematopoietic stem cell transplantation (HSCT) is a therapeutic modality used for malignant and non-malignant hematological diseases that attempts to exchange deficient bone marrow. This treatment is translated into the intravenous infusion of hematopoietic stem cells (HSCs), providing the reconstitution of the recipient's hematopoietic and immune systems. This exchange may be autologous, in which the cells derive from the patient, or allogeneic, when the donor and the recipient are genetically different persons, but with some degree of human leukocyte antigens matching, and can be consanguineous or not[1].

After hospitalization, in the pre-transplantation phase, the recipient is submitted to the implantation of a vascular catheter that should remain permeable throughout the treatment regimen, which requires a skilled and qualified nursing team. This is an intrinsic factor for the success of HSCT[2].

Hematopoietic stem cell transplantation is a therapy that requires intense parenteral infusion for hydration, infusion of medications, blood components, and hematopoietic stem cells, as well as access to blood samples for daily exams, which determines the use of a semi-implanted (SI), or tunneled long-term central venous catheter (LTCVC) to ensure adequate parenteral treatment[3].

Hickman® catheters are a type of LTCVC-SI or tunneled, non-valved catheter, produced with radiopaque, hemocompatible and biocompatible silicone[4]. Inserted in a surgical environment under general anesthesia or sedation[5], it can remain for one to two years[3]. It is called semi-implantable or tunneled because its insertion occurs in a central vein through a subcutaneous tunnel, made by the surgeon, whose preferred sites are the subclavian or internal jugular vein[6]. In these cases, the catheter insertion ostium is located in the anterior thoracic region, below the hemiclavicular line, maintaining part of the catheter exposed through which intravenous therapy is performed[7].

Although widely used, central venous catheters (CVC) are subject to several complications including occlusion, which is responsible for 14% to 36% of complications related to LTCVC within one to two years of its placement[8]. It is also characterized as one of the main complications related to Hickman® LTCVC-SI[9-10] often requiring withdrawal and exposing the patient to a new surgical procedure.

Proper management of this vascular device is decisive to ensure its permeability, avoiding, among other intercurrences, occlusion[3,11]. The occlusion of Hickman® catheters or of another CVC is the impossibility of infusing solution and/or suctioning blood from the catheter lumen[12]. To ensure this device functionality, as important as the solution chosen to maintain intraluminal permeability, the standardization of the management actions of this device is required, as well as the correct flushing and locking technique.

For the standardization of Hickman® LTCVC-SI handling for permeability, the concept of permanent education, which presumes learning at work, was considered. Thus, based on real difficulties, and respecting the knowledge and previous experience of those involved in the educational process, we seek to modify practices, and the appropriation of technical-scientific knowledge and work organization. In-service education is a relevant tool for implementing new and better practices[13-15].

Hickman® LTCVC-SI care assessment consisted of the first step in the development of a triple blind randomized clinical trial aimed at evaluating the effectiveness of two locking solutions in preventing occlusion of Hickman® LTCVC-SI, and due to the need to reduce bias in the research. The purpose of this study was to evaluate the educational activity developed to enable the nursing team of an HSCT service for the standardization of Hickman® catheter management for the prevention of occlusion.

METHODOLOGY

This is a descriptive study of a quantitative approach, performed as an initial step in the development of a randomized triple-blind trial. This stage was specifically characterized as a study to evaluate the knowledge of professionals through a questionnaire applied immediately before and shortly after the completion of the educational action.

The educational action was performed to standardize the management of Hickman® catheters in order to reduce possible biases of data collection procedures. A total of 44 nursing professionals participated in the study, including nurses, and nursing technicians and aides from a referral service for HSCT located in the city of Curitiba, state of Paraná. Data collection took place between January and March 2017.

It is important to emphasize that according to the Law of Professional Practice, activities of high complexity can only be performed by nurses, and nursing professionals manipulate the Hickman® catheter according to their legal technical competence.

All participants completed a registration form with professional and academic information. The following inclusion criterion was considered: being a full-time nursing professional in the HSCT service - hospitalization unit and responsible for handling and maintaining Hickman® LTCVC-SI. All professionals met the inclusion criterion defined.

The educational action was carried out in three stages: first, a questionnaire consisting of ten questions with three alternatives each, of which only one was correct. The questions addressed knowledge about LTCVC characteristics, care for maintenance and prevention of occlusion of Hickman® catheters. After the application of the questionnaire and identification of the knowledge gaps on this subject, an expositive-dialogic class was presented, addressing the themes:

a) Definition of CVC permeability and types of occlusion;

b) Evaluation and prevention of catheter occlusion (permeability check);

c) Description of a Hickman® catheter;

d) Positive pressure technique for catheter flushing and locking;

e) Pulsatile or start-stop technique;

f) Sufficient volume (in mL) of 0.9% isotonic saline solution to flush the lumens after infusion of drugs or blood products and blood collection;

g) Protocol for catheter locking;

h) Sequence for unlocking the catheter, as per protocol;

i) Important topics about catheter permeability to be approached in the nursing reports;

j) Demonstration of the start-stop or pulsatile technique, and positive pressure technique for catheter flushing and locking.

This stage lasted an average of one hour and thirty minutes. The procedures were updated according to the existing literature. There were 11 lectures distributed in the morning, afternoon and evening shifts to reach the whole nursing team (Table 1). In all classes, the questions raised by the professionals were clarified. The classes were conducted exclusively by the main researcher, a nurse from the Bone Marrow Transplant Service for eight years. The questionnaire was also developed and applied by the main researcher.

Table 1 - Distribution of the professionals who participated in the meetings. Curitiba, PR, Brazil, 2017

Date	Period	Number of participants
January 10, 2017	Morning	04
	Afternoon	08
	Evening	04
January 12, 2017	Evening	02
January 13, 2017	Afternoon	05
	Evening	03
January 18, 2017	Morning	08
	Evening	04
January 29, 2017	Evening	02
January 31, 2017	Morning	03
March 8, 2017	Afternoon	05

Immediately after completing the educational activity, the questionnaire was reapplied to evaluate learning after the recommendations on the theme. The data collected were typed, organized into tables, and the quantified answers were later analyzed with the help of the Microsoft Excel® software. Descriptive statistics using absolute frequency and percentage was used for the analysis.

The research was approved by the Human Research Ethics Committee of the institution where it was carried out under report no. 1.967.302.

● RESULTS

Of the total 48 participants, two did not complete the pre- and post-qualification questionnaire and two did not answer the post-qualification questionnaire. Thus, the final sample consisted of 44 participants who answered the questionnaire at both times.

The mean age of participants was 40.09 ± 10.31 years. Further information on gender, academic background, and professional experience are presented in table 1.

Table 1 - Characterization of participants regarding gender, academic background, and professional experience (n = 44). Curitiba, PR, Brazil, 2017. (continues)

Variable	n	%
Gender		
Female	41	93.18
Male	3	6.82
Undergraduate degree		
Yes	41	93.18
No	2	4.55
In progress	1	2.27
University (n = 41)		
Public	24	58.54
Private	17	41.46

Length of study (n = 41)		
0 ≥ 5 years	1	2.44
5 ≥ 10 years	19	46.34
10 ≥ 15 years	7	17.07
15 ≥ 20 years	6	14.63
20 ≥ 25 years	0	0
25≥ 30 years	4	9.76
> 30 years	4	9.76
Specialization		
Yes	33	75
No	11	25
Area of specialization (n = 33)		
Health audit and management	6	18.18
Worker's health	5	15.15
Intensive care	4	12.12
Pediatric and neonatal intensive care	2	6.06
Medical-surgical nurse	2	6.06
Hematology and oncology	2	6.06
Community/public health	2	6.06
Family health	2	6.06
Woman's health/obstetrics	2	6.06
Health informatics	1	3.03
Mental health	1	3.03
Pediatrics	1	3.03
Geriatrics	1	3.03
Urgency and emergency	1	3.03
Teaching	1	3.03
Master's degree		
Yes	6	13.64
No	30	68.18
In progress	8	18.18
Time of experience in the hospital area		
0 ≥ 5 years	8	18.18
5 ≥ 10 years	13	29.55
10 ≥ 15 years	9	20.45
15 ≥ 20 years	4	9.09
20 ≥ 25 years	3	6.82
25≥ 30 years	4	9.09
> 30 years	3	6.82
Length of work at the BMTS*		
<1 year	5	11.36
>1 year to 5 years	23	52.27
> 5 years to 10 years	5	11.36
> 15 years to 20 years	2	4.54
> 20 years to 25 years	4	9.09
> 25 years	5	11.36
Work position		
Nurse	35	79.55
Nursing Technician	7	15.91
Nursing Aide	2	4.55
Work shift		
Morning	15	34.09
Afternoon	13	29.55
Evening	16	36.36

*Bone marrow transplantation service

The participants' answers for the questions 1 to 10, in the pre- and post-educational period, are presented on table 2.

Table 2 - Proportion of correct answers to the questionnaire in the pre- and post-training period (n=44). Curitiba, PR, Brazil, 2017

	Pre-training		Post-training	
Question theme	**n**	**%**	**n**	**%**
1. Short-term CVC*				
Correct answer	35	79.55	41	93.18
Incorrect answer	9	20.45	3	6.82
2. Long-term CVC*				
Correct answer	41	93.18	42	95.45
Incorrect answer	3	6.82	2	4.55
3. Hickman catheter (material and position)				
Correct answer	33	75	39	88.64
Incorrect answer	11	25	5	11.36
4. Hickman catheter (characteristics)				
Correct answer	24	54.55	29	65.91
Incorrect answer	20	45.45	15	34.09
5. Catheter permeability				
Correct answer	41	93.18	41	93.18
Incorrect answer	3	6.82	3	6.82
6. Occlusion				
Correct answer	36	81.82	36	81.82
Incorrect answer	8	18.18	8	18.18
7. Care with catheter after insertion				
Correct answer	1	2.27	8	18.18
Incorrect answer	43	97.73	36	81.82
8. Flushing, positive pressure, reflux induced by the syringe and locking				
Correct answer				
Incorrect answer	32	72.73	43	97.73
	12	27.27	1	2.27
9. Catheter locking				
Correct answer	37	84.09	43	97.73
Incorrect answer	7	15.91	1	2.27
10. Catheter priming volume (flushing and locking)				
Correct answer				
Incorrect answer	10	22.73	24	54.55
	34	77.27	20	45.45

* Central venous catheter; Priming-lumen internal volume.

● DISCUSSION

At the end of the educational action, participants understand that the venous catheter should be selected according to the patient's needs, such as the venous network condition, the regimen and treatment time, as well as the technical domain of the team that manipulates the device[12].

It was possible to establish the knowledge that the CVC is any catheter, the tip of which is positioned in a central vessel, that is, the superior vena cava or inferior vena cava[16]. CVCs are divided into short-term and long-term, with LTCVCs being indicated for patients requiring treatment for more than 21 days[12,17]. Hickman® catheter is a semi-implanted or tunneled LTCVC installed surgically, which can remain in the body for one to two years[3].

The participants had the opportunity to discuss the process of manufacturing of Hickman® LTCVC-SI in which hemocompatible and biocompatible radiopaque silicone is used[4]. Silicone is a material with thermal, chemical and enzymatic stability, but it has low resistance to pressure. It is resistant, flexible and presents greater stability in the long term [17] This catheter has a cuff for its fixation in the subcutaneous tissue and, in each lumen, there is a female luer locking adapter(s)[18].

The reliable Hickman® LTCVC-SI is a fundamental prerequisite for the care of severely ill patients, such as those submitted to HSCT, since it allows the administration of intravenous fluids, medicines, blood components and blood products, parenteral nutrition and monitoring of the hemodynamic status[11].

Regarding its location, it was reaffirmed that the tip of the catheter should be located in the lower third of the superior vena cava near the cavo-atrial junction (Figure 1), or in the inferior vena cava above the level of the diaphragm for femoral insertion [4,7,12,16].

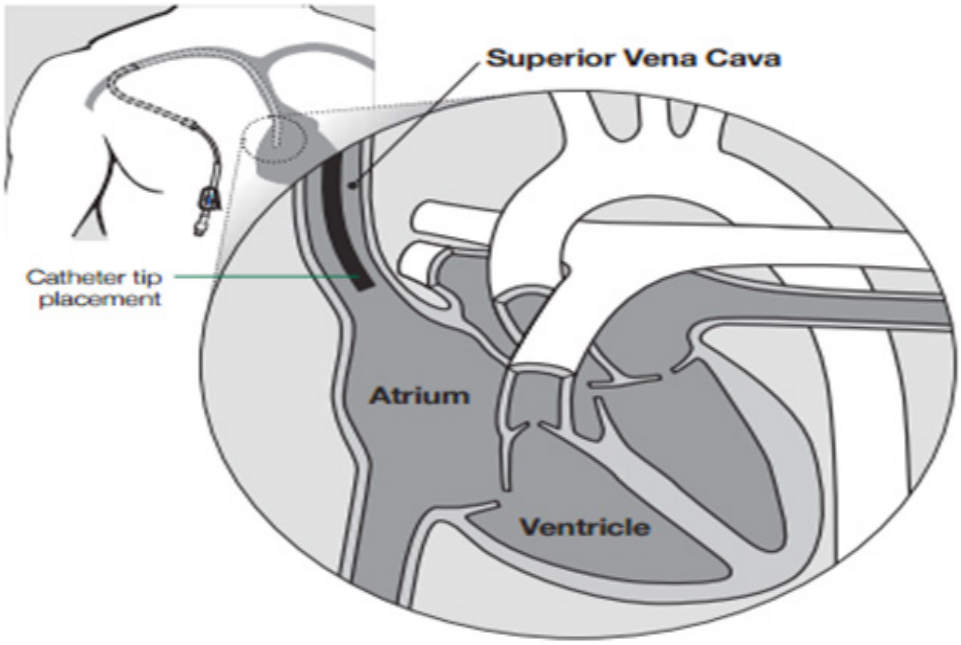

Figure 1 - Position of the catheter tip in the superior vena cava. Tempe, AZ, USA, 2016

Regarding the characteristics of Hickman® catheters, participants understood that the catheter caliber is called French size and ranges from 7 to 12.5F. The total length is the original catheter size, which is measured at the time of insertion. It was also argued that to keep the tip of the catheter in the central vessel, about four centimeters below the furcula are considered and the excess part of the catheter is cut[10,18].

Regarding the permeability of the catheter, there were no alterations in the answers of the second phase of the application of the questionnaire compared to the first phase. 93.18% (n = 41) of correct answers were maintained. Participants demonstrated that the objective of correct catheter flushing and locking is to maintain permeability of the device during treatment. They recognize that permeability consists of infusing fluids and collecting blood from the CVC with no resistance, but it can be affected by chemical, physical or thrombotic occlusion[16].

Occlusion is defined as the inability to infuse solution into the lumen of a catheter, the inability to aspirate blood from the catheter, or both[12], which was categorized into three degrees of occlusion as follows: partial, no reflux and complete[16].

Partial occlusion is defined as the resistance to flush, or a slow reflux in the CVC; occlusion with no reflux – there is no blood reflux from the catheter, but the infusion has no resistance, and complete occlusion is defined as the impossibility of infusion and aspiration into the catheter[16].

Regarding the causes of CVC occlusions, these may have a mechanical, chemical or thrombotic origin. The mechanical is related to internal or external catheter problems. The chemical is related to medication or precipitated drug. The thrombotic is characterized by thrombus formation within or around the CVC. It is also advised that, when it is impossible to determine the type of occlusion, it should be conducted as thrombotic. There are four subdivisions of thrombotic occlusion: intraluminal, fibrin tail, fibrin sheath, and mural[16].

The contact of incompatible solutions results in chemical occlusion. Thrombotic occlusions derive from fibrin deposition in the lumen of the catheter or in a surrounding vessel. Both can be avoided by performing correct flushing and locking techniques[17]. Researchers corroborate this assertion when they state that obstructions, or thrombi, result from failures in catheter maintenance[3,5].

Furthermore, fibrin residue within the catheter lumen, in addition to progressing to catheter occlusion, favors the risk of Staphylococcus coagulase-negative infections[19].

For the catheter care immediately after insertion, it was stated that a radiographic evaluation should be the first step to be taken. It is only after the release based on the image analysis that the reflux and flow test can be performed and any kind of infusion initiated[20]. With this assertion, participants understood the need to follow this sequence in the procedure for evaluating the permeability of the catheter and to ensure safety of its use.

In the course of the discussions, during the lessons, the need to create a quality indicator related to the first evaluation after insertion of the catheter was highlighted; this corroborates a practice already in force in the service that notifies its events. There were 28 correct notes, after the educational action, for this question: "c) catheters that, after being inserted and in the first test, present some type of permeability difficulty (reflux or flow) should be reported."

With regard to flushing, positive pressure and syringe-induced reflux, there was an increase in the number of correct answers of 25% after the educational action. Thus, it was stated that, in order to ensure the permeability of the catheter, the correct flushing and locking technique on the device should be performed. Flushing, the act of moving fluids into the lumen of the catheter, has the purpose of removing fibrin and residual medicines. The correct technique for flushing is called pulsatile or start-stop, which consists of slowly infusing the washing solution. This technique causes turbulence within the lumen of the catheter generating effective cleaning, and should be performed between infusions and prior to catheter locking[12].

Flushing should be performed with 0.9% isotonic saline solution (SSI), except when administering medications that are incompatible with this solution. In such cases, the lumen should be flushed with 5% glucose solution (5% GS) and then washed with SSI before being locked. For lumen flushing, a syringe of 10mL or larger is used, because smaller syringes generate more pressure than larger syringes. Infusion pressure greater than 25 psi (172 kPa) should not be performed due to the risk of blood vessel damage[7].

In Hickman® LTCVC-SI, SSI should be used for flushing by closing the clamp before withdrawing the hand from the plunger of the syringe. When injecting the locking solution, a small amount of solution should be kept in the (traditional) syringe, between 0.5 and 1 ml, closing the clamp before withdrawing the hand from the plunger of the syringe and thus avoiding the return of the blood to the lumen of the catheter[12].

With respect to catheter locking, it is defined as the filling of the catheter lumen when it is not being used, to keep its functionality and to reduce the risk of infection until the next use. It should be preceded by SSI flushing[12].

The most common locking solutions are SSI and heparin solution[21]. To lock the Hickman® LTCVC-SI, it was noted that the internal diameter of the lumens of this catheter is different from each other and that it is possible to calculate the exact volume for each path, which makes this practice safer.

Regarding the volume of catheter priming, flushing and locking, there was a 31.82% increase in the number of correct answers. It was considered that the exact value of priming depends on the actual value of the catheter inserted in the patient. The excess part that has been cut from the catheter should be disregarded. For the LTCVC-SI locking, i.e. the adequate volume for filling the catheter priming, the catheter French should be considered, along with the caliber of the catheter and the portion of the catheter that was cut after insertion. After considering these three requirements, it is possible to determine the exact volume of locking solution required[10]. Thus, 20% more is added to this value due to the higher density of the blood relative to that of the locking solutions[12].

The educational action at work consists of developing and/or improving knowledge, skills, and attitudes that aim at professional qualification and improvement in the work process[22]. To train the nursing team to handle Hickman® LTCVC-SI, with the objective of avoiding the occlusion of this device in patients submitted to HSCT, it is fundamental to guarantee the safety and the improvement in the nursing care process, and to contribute to the better development of the proposed clinical trial.

According to the results of this study, there was a greater number of correct answers after the educational action, which shows that the appropriation of scientific and technical knowledge should reflect on the quality of care provided to Hickman® LTCVC-SI.

As a limitation of the study, there is the fact that the educational actions were given during the working hours of the participants, which possibly caused apprehension due to the need to be absent from patient care for some time.

● CONCLUSION

Maintaining the permeability of Hickman® LTCVC-SI throughout the HSCT process is a crucial task for the success of this therapeutic modality. After insertion, performed in a surgical environment, the role of keeping it functional is the sole responsibility of the nursing team that assists the patient. To do so, specialization is needed for the best practice, thus ensuring adequate safety and treatment.

The results of this research demonstrate that the educational action developed instrumentalized the nursing team for a more homogeneous practice in the management and maintenance of Hickman® catheter permeability. During the development of this research, there was a need to prepare a protocol on safe nursing procedures immediately after catheter insertion. A service quality indicator was also generated with the participants, which is the mandatory notification of any abnormality identified in the first evaluation of the catheter after insertion.

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