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Phlebitis associated with peripheral intravenous catheters in children: study of predisposing factors

Flebite associada a cateteres intravenosos periféricos em crianças: estudo de fatores predisponentes

Flebitis asociada con catéteres venosos periféricos en niños: estudio de factores predisponentes

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ABSTRACT

Objective: To identify risk factors for phlebitis related to peripheral intravenous catheters (PIC) in children. **Methods:** A retrospective cohort study conducted in 338 children submitted to intravenous. The variables related to the children and intravenous therapy were investigated, after approval of the ethical merit. **Results:** From 338 children, nine (2.7%) developed phlebitis. None of the demographic characteristics influenced significantly the development of phlebitis. Regarding to the therapy, there were significant: the use of the PIC for more than five days ($p = 0.001$), intermittent maintenance ($p = 0.001$) and greater time permanence of the PIC ($p = 0.006$). The risk factors were: the presence of predisposing conditions to puncture failure ($p = 0.041$, OR = 4.645), history of complications ($p < 0.001$, OR = 40.666); administration of drugs or solutions with extreme pH and osmolarity ($p = 0.004$, OR = 7.700). **Conclusion:** The occurrence of the phlebitis did not showed association with demographic characteristics and therapy aspects that represent risk factors, were predisposing conditions for puncture failure, previous complications, drugs administration and solutions with pH extremes and osmolarity.

Keywords: Phlebitis; Catheterization, Peripheral; Pediatric Nursing; Patient safety.

RESUMO

Este estudo objetivou identificar fatores de risco para flebite relacionada a cateteres intravenosos periféricos (CIP) em crianças. **Métodos:** Coorte retrospectiva realizada em 338 crianças submetidas a punção venosa periférica. Foram investigadas variáveis relacionadas à criança e à terapia intravenosa, após aprovação do mérito ético. **Resultados:** Das 338 crianças, nove (2,7%) desenvolveram flebite. Nenhuma característica demográfica influenciou significativamente o desenvolvimento de flebite. Quanto às características da terapia, foram significantes: utilização do CIP por mais de cinco dias ($p = 0,001$); manutenção intermitente ($p = 0,001$) e maior tempo de permanência do CIP ($p = 0,006$). Representaram fatores de risco: presença de condições predisponentes para insucesso da punção ($p = 0,041$; OR = 4,645); antecedentes de complicações ($p < 0,001$, OR = 40,666); administração de drogas ou soluções de elevados pH e osmolaridade ($p = 0,004$, OR = 7,700). **Conclusão:** A ocorrência de flebite não apresentou associação com características demográficas, e os aspectos da terapia que representaram fatores de risco foram condições predisponentes para insucesso da punção, antecedentes de complicações, administração de fármacos e soluções com extremos de pH e osmolaridade.

Palavras-chave: Flebite; Cateterismo periférico; Enfermagem pediátrica; Segurança do paciente.

RESUMEN

Objetivo: Identificar los factores de riesgo para flebitis relacionada con catéteres venosos periféricos (CVP) en niños. **Métodos:** Estudio de cohorte, retrospectivo, realizado en 338 niños sometidos a punción venosa. Fueron investigadas variables relacionadas con los niños y con la terapia intravenosa, después de aprobación ética. **Resultados:** De los 338 niños, nueve (2,7%) tuvieron flebitis. Ninguna característica demográfica influenció significativamente el desarrollo de flebitis. Cuanto a la terapia, fueron significativas: uso de CVP por más de cinco días ($p = 0,001$); mantenimiento intermitente ($p = 0,001$); y permanencia más larga ($p = 0,006$). Representaron factores de riesgo: condiciones que predisponen el fracaso de la punción ($p = 0,041$, OR = 4,645); e histórico de complicaciones ($p < 0,001$, OR = 40,666); administración de fármacos o soluciones de pH y la osmolaridad altos ($p = 0,004$, OR = 7,700). **Conclusión:** Las características demográficas no influenciaron la ocurrencia de flebitis y los factores de riesgo fueron la presencia de condiciones predisponentes para el fracaso de la punción, complicaciones anteriores, la administración de medicamentos y soluciones con pH extremos y osmolaridad.

Palabras-clave: Flebitis; Cateterismo periférico; Enfermería pediátrica; Seguridad del paciente.

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INTRODUCTION

The intravenous therapy (IVT) is defined as a set of knowledge and techniques aimed at the administration of solutions or drugs in the circulatory system and covers various aspects of care, from the preparation of the patient, the choice and acquisition of peripheral venous access, calculation, preparation and administration of drugs and solutions, exchanges of solutions, devices and dressing, to the removal of catheters¹.

In Pediatrics, the installation of intravenous catheters represents the more invasive procedures performed during the hospitalization of children, being used for various purposes and in a variety of situations, such as in hydro-electrolyte unbalance, in cases of blood loss, in multiple organ dysfunction, infectious processes, burns, surgical procedures and in the impossibility of adequate intake of nutrients, electrolytes and fluids^{1,2}.

For the realization of IVT is required to obtain peripheral or central venous access, and among the various types of devices, the peripheral intravenous catheter (PIC) is used in approximately one third of patients admitted in hospitals³⁻⁶.

In this context, the IVT performed in children is considered a complex procedure, and may exist determinant aspects in the development of complications such as type of catheter used; the technique of insertion and catheter stabilization; the insertion site; the characteristics of the infusion solution, as pH less than 5 and greater than nine and osmolarity above 350 mOsm/L; the time of permanence of the device, among others, in addition to characteristics inherent to the patient such as skin color, sex, prematurity and certain clinical conditions such as infections, trauma, malnutrition and burns^{2,3,5,7-9}.

The complications arising from the IVT are classified into local and systemic. One of the systemic complications is sepsis, circulatory overload, pulmonary edema, air embolism, catheter embolism and shock by rapid infusion. The local complications relate to infiltration, extravasation, phlebitis, the hematoma, thrombophlebitis, in addition of thrombosis and cellulite⁸.

The phlebitis is the inflammation of the vessel, and may be classified, according to the predisposing factor, as chemistry phlebitis, when related to the administration of medications or risk solutions; mechanical phlebitis, which may result from the trauma caused by the catheter in the vessel wall and infectious phlebitis, related to contamination of the solution, the catheter insertion site and device. As signs and symptoms can be observed edema, local heat, hyperemia, fibrous cord in the path of the vessel, pain and exudate output at the puncture site. For the Infusion Nursing Society (INS) the proportion of 5% of phlebitis is considered as maximum accepted for the occurrence of this kind of complication¹⁰.

According to some researchers, the phlebitis is a frequent complication related to the use of PIC in hospitalized adults and children, and can cause discomfort for the patient, need for new peripheral venous puncture, prolonged hospitalization and consequent increased costs^{3,5,8}.

Research that evaluated 150 PIC type outside the needle in children, showed that 55.3% of the catheters were removed due to the occurrence of infiltration and 4.7% due to phlebitis¹¹.

In another study, with 654 catheters inserted in children in a pediatric intensive care unit, the occurrence of phlebitis was 13%, similar to the rate found in relation to other studies of pediatric patients, around 10%^{7,12}.

In this context, it should be noted that the pediatric patient can undergo twelve to twenty CIP insertion attempts over a period of just four weeks, demonstrating how important is the realization of IVT without complications, both for the effectiveness of therapy and for the quality of nursing care in pediatrics¹¹.

In this way, analyzing such evidence, is verify the relevance of research that guided the practice of IVT, in order to avoid adverse events during its implementation. In this scenario, based on the hypothesis that there are predisposing factors for the occurrence of phlebitis in pediatric age group, the study aims to compare the child's characteristics and the IVT related to occurrence of phlebitis and identify factors that increase the chance of occurrence of such complication, in a group of children who have used PIC and developed or not complications of intravenous therapy.

METHOD

Retrospective cohort study conducted in 338 children and adolescents undergoing IVT through the use of PIC type needle out, hospitalized in a pediatric Surgery unit with 25 beds, in a university hospital of the city of São Paulo that performs tertiary level and quaternary care by the Unified Health System, and participated in a prospective and randomized study. Literate children and adolescents were clarified about the goals, risks and benefits arising from the voluntary participation in the research, giving the possibility of exercising autonomy in its decision, constituting the assent, which offers the opportunity, when appropriate, the child from the age of seven, to participate in the decision-making process, being obligatory the request of assent to the children from 12 years of age. In these situations, the terms of consent were signed by responsible and by children.

In the study, all children and adolescents admitted in the study unit with peripheral venous puncture indication for administration of intravenous therapy were included, with the exception of children under 24 hours of life, with more than 18 years, if there was a refusal on participation in research by the child or by responsible, or if needed urgent treatment.

To the use of previous research data for the achievement of this study, the project was submitted to the ethical merit analysis by the Research Ethics Committee of the Federal University of São Paulo in the form of addend and approved as opinion N^o 402/06.

The collection of the analyzed data in this research occurred from February 28, 2007 to July 7, 2008, being held by eight nurses of the Nursing research group on patient safety, intensive

care and intravenous therapy in Pediatrics (SEGTEC) or linked to research project funded by the National Committee of Scientific and Technological Development (CNPq-4762952004-1). The nurses were trained to fill data collection instruments, implementation of the IVT, use of the PIC, realization of puncture and bandage, as well as for the administration of IVT, considering the standardization of dilution and infusion time of pharmaceuticals and institutional protocol solutions.

The outcome variable, presence of phlebitis in children undergoing peripheral IVT, was measured by nurses from the clinical evaluation of PIC insertion sites, four times a day, with the application of the rating scale of phlebitis proposed by the INS, which assesses the presence and intensity of signs and symptoms: degree 0 - without clinical signs; degree 1 - presence of erythema on the insertion of the catheter with or without pain; degree 2 - pain at the site of insertion of the catheter with erythema and/or edema; degree 3 - pain at the site of insertion of the catheter with erythema and/or edema, hardening, palpable fibrous cord; and grade 4 - presence of pain at the site of insertion of the catheter with erythema and/or edema, hardening and palpable fibrous cord greater than 1 centimeter long, with purulent drainage¹⁰.

Some features related to children and the IVT were selected to study of its prevalence among the group of children who developed phlebitis or not. The variables related to the demographic characteristics of the children were sex, skin color, age, nutrition degree and medical diagnosis categorized according to the organic system affected.

The IVT-related variables understood previous use of IVT; the presence of conditions that could predispose to failure of the puncture, as prematurity, chronic disease, prolonged surgical treatment, prolonged IVT, use of vesicant medications, psychomotor agitation, vascular disease, infection, edema, altered peripheral perfusion, skin lesion, hyperactivity, muscle spasms, refusal to IVT; history of complications of TIV (previous signs of infiltration or phlebitis); permanence time of the CIP, calculated in hours, by the difference between the date and time of the puncture and the date and time of withdrawal of the PIC; venipuncture method, whether direct or indirect, and use of Vascular Ultrasound (VU) to guide the puncture.

Other variables related to IVT analyzed were the gauge catheter, technique of repositioning and PIC installation site, use of limb immobilization splint, catheter maintenance form, method of administration of the medicine/solution and administration medicine/solution with features of risk for occurrence of complications, according to the osmolarity higher to 350 mOsm/L, pH less than five or more than nine, or description of risk for developing complications by the manufacturer.

The data were analyzed according to absolute frequencies, relative and median. For the comparison between the groups was used the test of Pearson's Chi-square, Fisher Exact Test and *t* Test, being conducted analysis of the reason of chance

(Odds Ratio: OR) with 95% confidence interval, being considered statistically significant values of descriptive levels equal to or less than 5% ($p \leq 0.05$).

RESULTS

338 children were studied, of which 247 (73.0%) did not have developed local complications of IVT, 54 (16.0%) presented infiltration, 28 (8.3%) developed further complications and nine (2.7%) phlebitis.

In Tables 1 and 2 is the comparison of demographic characteristics of children and of the IVT, respectively, among the nine children who have phlebitis and the 247 who did not present any kind of complication of IVT.

Children with phlebitis were predominantly eutrophic, school age, female, with brown skin color. When analyzed the medical diagnosis by systems, it was verified the predominance of diseases of the genitourinary system, however it has not been possible to apply statistical test for evaluation of this feature due to wide variation (Table 1).

In Table 2 we can see that children who used IVT for more than five days, had predisposing conditions to failure in PVP, had already presented complications related to the IVT, that had kept catheters intermittently for the administration of drugs or solutions with risk features and remained with the catheter for longer, showed significantly more phlebitis than children who did not possess such characteristics.

Children who had already developed phlebitis and infiltration, presented 40 times more risk for developing phlebitis, and those who received drugs or risk solutions had seven times (OR = 7.700) more chance of developing such complications. To present predisposing conditions to failure of PVP represented approximately five times (OR = 4.645) more risk for developing this complication (Table 2).

Children who have had their catheters kept intermittently presented a higher occurrence of phlebitis, when compared with children undergoing to continuous infusion ($p = 0.001$ - Chi-square Pearson Test). The method of infusion of drugs and solutions, if gravitational, in an infusion pump or in *bolus*, showed no significant influence on the occurrence of phlebitis ($p = 0.254$ - Chi-square Pearson Test).

The puncture method, the use of the US, the gauge of the catheter, the repositioning technique of the PIC, its installation site and usage of splint showed no statistically significant difference between groups ($p > 0.05$).

DISCUSSION

There are several factors, related to IVT or to the characteristics of the patient, which hamper the obtainment of peripheral venous access and influence the occurrence of complications, interfering in the quality of nursing care during its implementation^{2,3,5-8}.

Table 1. Demographic characteristics of children, according to the occurrence or not of phlebitis. São Paulo, 2008

Variables	Phlebitis		p
	Yes (n = 9) f (%)	No (n = 247) f (%)	
Age (years)			
Median	8.775	7.983	0.341 ^a
Minimum-Maximum	3.975-14.613	0.033-17.805	
Gender			
Masc	4 (44.4)	140 (56.7)	0.510 ^b
Female	5 (55.6)	107 (43.3)	
Skin color			
White	4 (44.4)	118 (47.8)	
Brown	5 (55.6)	87 (35.2)	0.466 ^c
Black	-	40 (16.2)	
Red	-	2 (0.8)	
Yellow	-	-	
Nutrition degree			
Eutrophy	8 (88.9)	206 (83.4)	1 ^b
Malnutrition and Obesity	1 (11.1)	41 (16.6)	
Medical diagnosis for organic systems			
Cardiovascular	-	9 (3.6)	
Gastrointestinal	2 (22.2)	27 (10.9)	
Genito-urinary	5 (55.6)	30 (12.2)	
Skeletal muscle	2 (22.2)	26 (10.6)	-
Respiratory	-	89 (36.0)	
Neurologic	-	5 (2.0)	
Sensorial	-	46 (18.6)	
Tegumental	-	14 (5.7)	
Others	-	1 (0.4)	

^a t test; ^b Fisher's Exact test; ^c Pearson's Chi-square test.

Epidemiological studies of local complications of IVT, focusing on phlebitis, show heterogeneity of results and are still scarce in our midst.

In literature, the incidence of phlebitis is variable, as well as the analyzed samples. The observed frequency of this complication was of 4.7% in a study with children and other with adults, identified that 43% of IVT was interrupted due to occurrence of phlebitis^{5,11}. In our study it was observed the development of phlebitis in 2.7% of children, being the maximum level of 5% considered acceptable by the INS as much for adults as for children¹⁰.

In the group of children who developed phlebitis, the variables age, gender, skin color and nutrition degree did not demonstrate different distribution between the groups, as evidenced in researches that cover the topic^{4,12,13}.

Compared with IVT-related variables, most children who developed phlebitis used IVT previously by period greater than five days; presented predisposing conditions to failure of PVP; had already developed phlebitis as antecedent of complication of IVT; was subjected to the direct method of puncture; the catheters were held intermittently, with administration of intravenous drug or solution with risk characteristics for the occurrence of complications, and remained for longer.

When considering the previous use of IVT, variable that showed statistically significant difference between the groups, it is verify that patients who receive drugs have a higher chance of complication, being that 60.8% of adult patients of general surgery unit that received the infusion of drugs developed phlebitis. Thus, infers that a child who had already previously undergone the

Table 2. Characteristics of intravenous therapy of children who presented or not phlebitis. São Paulo, 2008

Variables	Phlebitis		p	OR ^d
	Yes (n = 9) f (%)	No (n = 247) f (%)		
Previous use of IVT				
≤ 5 days	2 (22.2)	136 (55.1)	0.001 ^a	0.105
> 5 days	7 (77.8)	50 (20.2)		0.010-0.583
No	-	61 (24.7)		
Predisposing conditions for failure of PVP				
Yes	7 (77.8)	103 (41.7)	0.041 ^b	4.645
No	2 (22.2)	144 (58.3)		0.983-21.936
History of complications of IVT				
Phlebitis	2 (22.2)	-	< 0.001 ^a	40.666
Infiltration	1 (11.1)	3 (1.2)		4.255-350.042
No	6 (66.7)	244 (98.8)		
Puncture method				
Direct	5 (55.6)	89 (36.0)	0.295 ^b	-
Indirect	4 (44.4)	158 (64.0)		
US use				
Yes	2 (22.2)	115 (46.6)	0.186 ^b	-
No	7 (77.8)	132 (53.4)		
Gauge catheter				
22G	-	51 (20.7)	0.211 ^b	-
24G	9 (100.0)	196 (79.3)		
Technique of repositioning of the catheter				
Yes	-	64 (25.9)	0.117 ^b	-
No	9 (100.0)	183 (74.1)		
Instalation location of PIC				
MMII	-	2 (0.8)	1 ^b	-
Other locations	9 (100.0)	245 (99.2)		
Splint use				
Yes	5 (55.6)	155 (62.7)	0.731 ^b	-
No	4 (44.4)	92 (37.3)		
Drug administration or solution with risk characteristics				
Yes	7 (77.8)	73 (29.6)	0.004 ^b	7.700
No	2 (22.2)	174 (70.4)		1.635-36.259
Permanence time of PIC (hours)				
Median	116.8	22.83	0.006 ^c	-
Minimum and Maximum	31.75-216.42	1-188.25		

^a Chi-squar Pearson test; ^b Fisher's Exact Test; ^c t test; ^d Odds Ratio and confidence interval; IVT: Intravenous therapy; PVP: Peripheral venipuncture; US: Ultrasound; PIC: Peripheral intravenous catheter.

TIV, can be with some injury degree of vein net in relation to the properties of the drug or solution administered earlier¹³.

It was a risk factor for occurrence of phlebitis the presence of predisposing conditions for failure of PVP, as evidenced in some studies^{3,14,15}. In adults, the study concluded that individuals with immunodeficiency or chronic disease are at increased risk to develop phlebitis¹⁵. Adult and pediatric patients with infectious diseases, burns or *Diabetes Mellitus* feature up to seven times more risk of developing phlebitis, value greater than observed in our study (OR = 4.645). Other research with children and adults also revealed that the underlying disease is a risk factor for phlebitis^{3,15}.

Considering the history of complications of IVT, 22.2% of children with phlebitis had already introduced such adverse event previously. Research reveals that the history of phlebitis and the previous use of catheters, increases the chance of occurrence of this complication². In this context, the literature demonstrates that frequent peripheral intravenous catheterization, also constitute a risk factor for the occurrence of phlebitis, corroborating with the results founded in this study, in which children with a history of complications of IVT presented 40 times more risk of developing phlebitis^{15,16}.

About the maintenance of the PIC, the devices that have been held intermittently presented a higher relationship with the occurrence of phlebitis when compared to no occurrence. In clinical practice, maintaining the catheter intermittently provides its greatest manipulation, with increased chance of occurrence of complications¹³.

The administration of drugs or solutions with risk features for complications was also a variable that demonstrated statistically significant distribution among children who have phlebitis, several studies show that drugs with extremes of pH and osmolarity bring greater risks for the development of phlebitis. According to some authors, the use of antibiotics is a risk factor for such complication, in addition to other studies affirm that several drugs can be considered of risk for occurrence of phlebitis^{6,16}.

On the other hand, with adult patients in a general surgery unit, relevance was not observed regarding the type of drug administered to the occurrence of phlebitis, meanwhile, 60.8% of the individuals who received drugs developed such complication¹³. Thus, many medicines used during implementation of IVT could not be administered by PIC, due to osmolarity and pH, predisposing to the occurrence of phlebitis of chemical origin.

With respect to the time of permanence of the catheter, it was identified long time of permanence of the device in children who have phlebitis when compared to those that did not show any kind of complication. Research developed with children showed frequency of phlebitis in 8.4% of catheters that remained for up to 72 hours, while the children who remained with the catheters for longest developed phlebitis in 16.2% of cases, frequencies greater than those identified in this study¹².

In adult patients, the permanence of the catheter for more than 72 hours increases by up to four times the chance of developing phlebitis when compared to catheters to remain for less time⁵.

However, other authors showed that from the third day of permanence of the catheter, there is decrease in occurrence of phlebitis of 11.7%, on the third day to 4.8% from the fourth day of permanence of the catheter in adults¹⁴. In this way, due to reduction in the risk of developing phlebitis after the third day, it must prioritize in the service to children with IVT, the permanence of the PIC til the end of therapy, unless some complication of IVT occurs, according to the recommendation of the Centers for Disease Control and Prevention and studies that are showing positive results as the peripheral catheter withdrawal only in the validity of clinical indication^{9,17,18}.

So, it is emphasized the importance of identifying the risk factors related to child and IVT for the occurrence of complications, so that the nurse can establish the prescribed therapy with greater safety and quality.

CONCLUSIONS

From the results of the study, it was identified, in relation to other research, low occurrence of phlebitis in the studied sample.

Represent risk factors for phlebitis related to the use of PIC in children, the presence of predisposing conditions for puncture failure, a history of therapy complications, administration of drugs and solutions with extremes of pH and osmolarity.

In this way, to identify factors that have direct relationships with the occurrence of complications, we can improve the clinical practice of nursing as well as planning, prescription and IVT implementation, providing a lower rate of adverse events of this therapy in hospitalized children.

Limitation of the study

It is considered the completion of the study in one place as a possible limitation of the study, stressing the importance of the development of new research on the subject, multi-center drawing, in children and adolescents with different demographic characteristics and therapy employed.

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