

# Risk factors for infiltration in children and adolescents with peripheral intravenous catheters

*Fatores de risco para infiltração em crianças e adolescentes com cateteres intravenosos periféricos*  
*Factores de riesgo para infiltración en niños y adolescentes con catéteres intravenosos periféricos*

**Luciano Marques dos Santos<sup>LM</sup>**

ORCID: 0000-0001-7866-6353

**Irlane Batista Figueredo<sup>IB</sup>**

ORCID: 0000-0002-9088-2996

**Cleonara Sousa Gomes e Silva<sup>CSG</sup>**

ORCID: 0000-0002-4827-8306

**Uliana Oliveira Catapano<sup>UC</sup>**

ORCID: 0000-0002-0461-4531

**Bianka Sousa Martins Silva<sup>BSM</sup>**

ORCID: 0000-0003-0199-1451

**Ariane Ferreira Machado Avelar<sup>AFM</sup>**

ORCID: 0000-0001-7479-8121

<sup>I</sup>Universidade Estadual de Feira de Santana. Feira de Santana, Bahia, Brazil.

<sup>II</sup>Universidade Federal de São Paulo. São Paulo, São Paulo, Brazil.

## How to cite this article:

Santos LM, Figueredo IB, Silva CSG, Catapano UO, Silva BSM, Avelar AFM. Risk factors for infiltration in children and adolescents with peripheral intravenous catheters. Rev Bras Enferm. 2022;75(4):e20210176. <https://doi.org/10.1590/0034-7167-2021-0176>

## Corresponding author:

Luciano Marques dos Santos

E-mail: [lucmarxenfo@yahoo.com.br](mailto:lucmarxenfo@yahoo.com.br)



EDITOR IN CHIEF: Álvaro Sousa  
ASSOCIATE EDITOR: Priscilla Valladares Broca

**Submission:** 06-08-2021    **Approval:** 11-03-2021

## ABSTRACT

**Objectives:** to estimate the incidence of infiltration and the factors associated with its occurrence in children and adolescents in the operative period and with peripheral intravenous catheters. **Methods:** a longitudinal and prospective study with children and adolescents using peripheral intravenous catheters, conducted at the surgical clinic unit of a pediatric hospital in Feira de Santana, State of Bahia, from April 2015 to December 2016. The study used Pearson's chi-square and Fisher's exact test for the analysis. It also applied multiple analyses using Poisson regression with robust variance. **Results:** the incidence of infiltration was 31.2% and was associated with female sex (RR=0.53; CI=[0.30-0.96]), non-eutrophic children (RR=2.27; CI=[1.25-4.20]), who used non-irritating and non-vesicant drugs (RR=1.72; CI=[1.03-2.87]), vesicant drugs (RR=1.84; CI=[1.05-3.22]) and irritating/vesicant electrolytes (RR=2.35; CI=[1.38-3.97]). **Conclusions:** the study suggests the development of strategies that will help in the prevention of this adverse event through the knowledge of the associated factors.

**Descriptors:** Pediatric Nursing; Child Hospitalization; Catheterizations, Peripheral; Infusion, Intravenous; Adverse Effects.

## RESUMO

**Objetivos:** estimar a incidência de infiltração e os fatores associados à sua ocorrência em crianças e adolescentes no período operatório e com cateteres intravenosos periféricos. **Métodos:** estudo longitudinal e prospectivo, realizado na unidade de clínica cirúrgica de um hospital pediátrico de Feira de Santana, Bahia, de abril/2015 a dezembro/2016, com crianças e adolescentes em uso de cateteres intravenosos periféricos. Para a análise, realizaram-se os testes qui-quadrado de Pearson e teste exato de Fisher. Aplicou-se análise múltipla mediante a Regressão de Poisson com variância robusta. **Resultados:** a incidência de infiltração foi de 31,2% e foi associada ao sexo feminino (RR=0,53; IC=[0,30-0,96]), crianças não eutróficas (RR=2,27; IC=[1,25-4,20]), que utilizaram medicamentos não irritantes e não vesicantes (RR=1,72; IC=[1,03-2,87]), medicamentos vesicantes (RR=1,84; IC=[1,05-3,22]) e eletrólitos irritantes/vesicantes (RR=2,35; IC=[1,38-3,97]). **Conclusões:** sugere-se o desenvolvimento de estratégias que auxiliarão na prevenção desse evento adverso por meio do conhecimento dos fatores associados.

**Descritores:** Enfermagem Pediátrica; Criança Hospitalizada; Cateterismo Periférico; Infusões Intravenosas; Efeitos Adversos.

## RESUMEN

**Objetivos:** estimar incidencia de infiltración y factores relacionados a su ocurrencia en niños y adolescentes en el período operatorio y con catéteres intravenosos periféricos. **Métodos:** estudio longitudinal y prospectivo, realizado en la unidad quirúrgica de un hospital pediátrico de Feira de Santana, Bahia, de abril/2015 a diciembre/2016, con niños y adolescentes en uso de catéteres intravenosos periféricos. Para el análisis, se realizaron las pruebas chi-cuadrado de Pearson y exacta de Fisher. Aplicado análisis múltiple mediante la Regresión de Poisson con variancia robusta. **Resultados:** la incidencia de infiltración fue de 31,2% y fue relacionada al sexo femenino (RR=0,53; IC=[0,30-0,96]), niños no eutróficos (RR=2,27; IC=[1,25-4,20]), que utilizaron medicamentos no irritantes y no vesicantes (RR=1,72; IC=[1,03-2,87]), medicamentos vesicantes (RR=1,84; IC=[1,05-3,22]) y electrolitos irritantes/vesicantes (RR=2,35; IC=[1,38-3,97]). **Conclusiones:** se sugiere el desarrollo de estrategias que auxiliarán en la prevención de ese evento adverso por medio del conocimiento de los factores relacionados.

**Descriptorios:** Enfermería Pediátrica; Niño Hospitalizado; Cateterismo Periférico; Infusiones Intravenosas; Efectos Adversos.

## INTRODUCTION

During the hospitalization process of children and adolescents with surgical demands, especially in the postoperative period, peripheral intravenous catheterization (PIVC) will be required for the predominant infusion of drugs and solutions, as well as for the use of parenteral nutrition and blood products<sup>(1)</sup>, being one of the most commonly performed procedures for implementing intravenous therapy in pediatric units<sup>(2)</sup>.

However, research<sup>(1)</sup> conducted in 47 countries with data from 4,206 children who were in 278 hospitals located in Africa, Asia, Australia/New Zealand, Europe, the Middle East, North America, South America, and South Pacific observed that 11.4% of the peripheral intravenous catheter insertion sites had some sign of complication.

According to results of a systematic review with meta-analysis<sup>(3)</sup>, in the pediatric population, infiltration is the most common individual reason for failure due to the use of peripheral intravenous catheters, with a combined incidence of 10%. It is the accidental outflow of non-vesicant fluids (solutions and/or medicines) from the inside of the blood vessel to tissues adjacent to the insertion site<sup>(4-5)</sup>. Infiltration differs from extravasation because, even presenting similar mechanisms of occurrence, in extravasation the drugs or solutions that leave the intravascular space to the extravascular are irritating and/or vesicant in nature<sup>(4-5)</sup>.

The diagnosis of infiltration presents local edema, erythema or discoloration, leakage through the insertion site of the intravenous device, slow infusion, insignificant or absent blood reflux, cold skin, local tension, or pain<sup>(5)</sup>.

In addition, after the diagnosis of infiltration, further attempts at PIVC will be required, resulting in additional financial implications associated with the use of new intravenous devices, delays in the administration of the prescribed therapy, tissue damage associated with repeated attempts at catheterization<sup>(3-6)</sup> symptoms, stress and pain for the child<sup>(7)</sup>.

Thus, permanent efforts of health care providers are necessary concerning reducing the incidence of infiltrations in children through the early identification of probable predictors of this complication and safe, respectful, and evidence-based care. It should occur both during the insertion of catheters and in maintenance so that the withdrawal of this intravenous device occurs at the end of treatment and without complications at its insertion site for children and adolescents in the operative period.

The selection of children and adolescents in the operative period is justified because they are, in the vast majority, patients who have a short hospitalization time with lower therapeutic demand and without chronic conditions. Therefore, the risks for the occurrence of complications of intravenous therapy peripherally are minimal; and precisely because such problems are not recurrent in everyday practice, it is necessary to know the associated factors to draw preventive measures of patient safety.

By consulting the National Library of Medicine (PubMed) and identifying the production of knowledge about the incidence of infiltration and factors associated with this complication in the pediatric public, using descriptors of the Medical Subject Headings - MESH (Child Hospitalized; Catheterizations; Peripheral,

Infusion; Intravenous; and Adverse Effects), the study found that, in the last five years, these factors were little explored in the literature of the area, and it is necessary to clarify them, to verify whether they corroborate the findings available at international level<sup>(1,8-13)</sup>.

Therefore, the question is: what is the incidence of infiltration in children and adolescents in the operative period? What factors are associated with this incidence?

## OBJECTIVES

To estimate the incidence of infiltration and the factors associated with its occurrence in children and adolescents in the operative period and with peripheral intravenous catheters.

## METHODS

### Ethical aspects

The research followed the ethical aspects set out in Resolution 466/12, obtaining a favorable opinion from the Research Ethics Committee.

### Design, period and place of study

This was a longitudinal<sup>(14)</sup> and prospective study, conducted in the surgical clinic unit of a pediatric hospital located in Feira de Santana, State of Bahia (BA), from April 2015 to December 2016. The State Children's Hospital had 154 active beds during the study, with 58 beds in a surgical clinic unit for the care of children undergoing low, medium, and high complexity surgery.

This article has been prepared following STROBE's recommendations (Strengthening the reporting of observational studies in epidemiology statement)<sup>(15)</sup>.

### Population or sample; criteria of inclusion and exclusion

The study was conducted with children and adolescents hospitalized in a surgical clinic unit and needed intravenous therapy through the peripheral route.

In the sample, the study included: children aged between 29 days and 16 incomplete years because the hospital serves children and adolescents with these ages; in need of intravenous therapy and drug therapy through the peripheral venous catheter; with a stable and conscious clinical picture. It did not include children hospitalized in wards that needed some precautionary measure, those using a peripheral and central intravenous catheter, and those in need of PIVC in emergency or emergency conditions. No child included in the survey was excluded from the final sample.

The sample was of the type "for convenience" and estimated at 62 PIVC, considering the occurrence of infiltration in 16%<sup>(8)</sup>, with a 5% margin of error and 95% confidence interval. With an estimate of 20% of losses of children followed, the study decided to include 109 peripheral intravascular devices in the survey, a number recorded at the end of the data collection.

## Study protocol

Five trained collaborating researchers collected the data in the period from Monday to Friday, in the morning and afternoon, that is, there was no collection at the end of weeks, holidays, and night shift due to the administrative routine of the Institution surveyed. Through the eligibility criteria, the nursing team communicated to the collaborating researchers about the children who were indicated for intravenous therapy by the peripheral route, following the evaluation of the medical records for age and clinical picture. Therefore, the researchers approach the participants' tutors to clarify the research regarding its objectives, risks, and benefits. When they accepted, they signed the Informed Consent Form (TCLE); and children older than seven years, the Informed Consent Term (TCLA).

During this period, nursing technicians from the investigated unit performed the IPC of the selected children and adolescents, and this procedure was observed by the researchers. Then, they obtained additional information from an interview with the family members present during the PIVC and from a consultation with the child's medical records. They recorded this information in a structured instrument.

The exposure variables were classified as: demographic characteristics (age, sex, and race/color), clinical characteristics (history of prematurity, nutritional condition, and length of hospitalization), related to previous intravenous therapy (history of difficulty for PIVC, prolonged peripheral intravenous therapy, history of complications, history of phlebitis, infiltration, extravasation, and obstruction), current PIVC (location of PIVC, vein visibility, vein palpability, catheter caliber, catheter material, puncture method, and stabilization of the catheter) and intravenous therapy used in the collection period (use of irritant, vesicant, non-irritant and non-vesicant drugs, vesicant electrolyte and time of use of PIVC in hours). The outcome variable was called "occurrence or not of intravenous therapy -related infiltration".

For the variable "nutritional condition," the study evaluates the patient biotype and the nutritional record in the medical records of hospitalized children and adolescents. The age for characterization was grouped according to the age group of the developmental phases of the child and adolescent, according to the Ministry of Health. The study adopted the age group considered in the studies on intravenous therapy to carry out statistical associations.

The therapy in use was classified as follows: electrolytes, non-steroidal anti-inflammatory drugs, anticonvulsants, antipyretic, antibiotics, opioids, antiemetics, gastric protector, analgesics, 1:1 solution, 1:4 solution, glycated serum, and physiological serum. The drugs and solutions were classified into irritants, vesicants, and non-irritant/vesicant, according to the Brazilian Infusion Nurses Society standards<sup>(5)</sup>. The use of anesthetics was not evaluated, only the medications of continuous use since the first seem to be the ones that most influence the occurrence of intravenous therapy complications.

The introduction of peripheral intravenous catheters took place in surgical clinic units in the preoperative period. The researchers evaluated the insertion site at the company of the nurses on duty daily until the intravenous device was withdrawn due to

the end of the prescribed therapy, discharge from treatment, or the occurrence of some complication associated with the use of intravenous therapy by the peripheral route.

## Data analysis and statistics

The data were double-typed in the Statistical Package for the Social Sciences (SPSS), version 22.0. For the definition of the numerical variables, the study used measures of central tendency (median) and dispersion (interquartile range) due to non-adherence to the normal distribution verified by the Shapiro Wilk test. In the description of categorical variables, it used measurements of relative and absolute frequencies.

In the univariate analysis, the research used Pearson's chi-square test and Fisher's exact test to verify the association between dependent and independent variables, adopting as significance level of 5%. The relative risks (RR) and their respective 95% confidence intervals were estimated. For the multiple analysis, Poisson regression with robust variance was performed, including in the final model the variables with  $p\text{-value} \leq 0.20$  in the univariate analysis. In this step, 5% was considered as significance level.

## RESULTS

This study evaluated 109 peripheral intravenous catheters inserted in 97 participants, 59 children, and 38 adolescents, with an incidence of infiltration of 31.2%. Most of the intravenous catheters were inserted in adolescents (39.2%) and preschool children (25.8%), male (56.7%), self-declared non white (89.7%), eutrophic (88.7%), with no history of prematurity (71.8%), and with less than seven days of hospitalization (78.4%) (Table 1). The median age was 107 months (the interquartile range was 111 months) and the median hospitalization time was three days (the interquartile interval was five days).

In the univariate analysis of the demographic and clinical characteristics of children (Table 2), the incidence of infiltration was statistically associated with sex ( $p = 0.038$ ) and nutritional status ( $p = 0.033$ ). The other characteristics were not associated with the outcome studied.

Among the characteristics of previous intravenous therapy (Table 3), in the univariate analysis, the incidence of infiltration was associated with the history of difficulty for the insertion of PIVC ( $p = 0.003$ ) and history of intravenous therapy complications ( $p = 0.027$ ). The characteristics of the current PIVC were not associated with the incidence of infiltration in the studied sample (Table 3).

Regarding the characteristics of the current intravenous therapy used, the incidence of infiltration was statistically associated with the use of irritating and vesicant electrolytes ( $p = 0.010$ ). The other characteristics were not associated with the investigated complication.

The modeling of the variables confirmed that female sex, malnourished nutritional condition, use of vesicant drugs, non-irritating, and non-vesicant drugs, and irritating electrolytes/vesicant were associated with the incidence of infiltration in children/adolescents hospitalized in the surgical clinic unit (Table 5).

**Table 1** - Incidence, demographic and clinical characteristics of children/adolescents admitted to pediatric surgical clinic units in the interior of Bahia, Feira de Santana, Bahia, Brazil, 2015-2016

|                                 | n  | %    |
|---------------------------------|----|------|
| Infiltration                    | 34 | 31.2 |
| Age in months (n = 97)          |    |      |
| Up to 35 (infant)               | 14 | 14.4 |
| From 36 to 83 (preschool)       | 25 | 25.8 |
| From 84 to 131 (school)         | 20 | 20.6 |
| ≥ 132 (adolescent)              | 38 | 39.2 |
| Sex (n = 97)                    |    |      |
| Female                          | 42 | 43.3 |
| Male                            | 55 | 56.7 |
| Race/color (n = 97)             |    |      |
| White                           | 10 | 10.3 |
| Not white*                      | 87 | 89.7 |
| History of prematurity (n = 97) | 8  | 8.2  |
| Nutritional condition (n = 97)  |    |      |
| Eutrophic                       | 86 | 88.7 |
| Malnourished                    | 10 | 10.3 |
| Obese                           | 1  | 1    |
| Hospitalization length (n = 97) |    |      |
| Up to 7 days                    | 76 | 78.4 |
| ≥ 8 days                        | 21 | 21.6 |

\*In this category, black and brown are included.

**Table 2** - Incidence of infiltration according to demographic and clinical characteristics of children/adolescents, Feira de Santana, Bahia, Brazil, 2015-2016

| Variables                       | Yes (n = 34)<br>n (%) | No (n = 75)<br>n (%) | p value | RR <sup>§</sup> | CI (95%) <sup>‡</sup> |
|---------------------------------|-----------------------|----------------------|---------|-----------------|-----------------------|
| Age                             |                       |                      | 0.072*  | 1.76            | 0.95-2.89             |
| Up to 6 years (up to 83 months) | 18 (40.9%)            | 26 (59.1%)           |         |                 |                       |
| ≥ 7 years (84 months or more)   | 16 (24.6%)            | 49 (75.4%)           |         |                 |                       |
| Sex                             |                       |                      | 0.038*  | 0.53            | 0.28-0.99             |
| Female                          | 10 (20.8%)            | 38 (79.2%)           |         |                 |                       |
| Male                            | 24 (39.3%)            | 37 (60.7%)           |         |                 |                       |
| Race / color                    |                       |                      | 1.000** | 0.86            | 0.31-2.36             |
| White / red                     | 03 (27.3%)            | 08 (72.7%)           |         |                 |                       |
| Black / brown                   | 31 (31.6%)            | 67 (68.4%)           |         |                 |                       |
| History of prematurity          |                       |                      | 1.000** | 0.79            | 0.23-2.7              |
| Yes                             | 02 (25%)              | 06 (75%)             |         |                 |                       |
| No                              | 32 (31.7%)            | 69 (68.3%)           |         |                 |                       |
| Nutritional condition           |                       |                      | 0.033** | 2.09            | 1.19-3.65             |
| Non-eutrophic                   | 8 (51.1%)             | 6 (42.9%)            |         |                 |                       |
| Eutrophic                       | 26 (27.4%)            | 69 (72.6%)           |         |                 |                       |
| Hospitalization length (days)   |                       |                      | 0.172*  | 1.47            | 0.85-2.56             |
| 8 days or more                  | 15 (39.5%)            | 23 (60.5%)           |         |                 |                       |
| Up to 7 days                    | 19 (26.8%)            | 52 (73.2%)           |         |                 |                       |

\*Chi-Pearson's square; \*\*Fisher's exact test; §Relative Risk; ‡95% confidence interval.

**Table 3** - Incidence of infiltration according to characteristics of previous intravenous therapy and current peripheral intravenous catheterization, Feira de Santana, Bahia, Brazil, 2015-2016

| Variables                                | Yes (n = 34)<br>n (%) | No (n = 75)<br>n (%) | p value | RR <sup>§</sup> | CI (95%) <sup>‡</sup> |
|--|-----------------------|----------------------|---------|-----------------|-----------------------|
| Difficulty history for PIVC <sup>ε</sup> |                       |                      | 0.003*  | 2.44            | 1.29-4.61             |
| Yes                                      | 24 (44.4%)            | 30 (55.6%)           |         |                 |                       |
| No                                       | 10 (18.2%)            | 45 (81.8%)           |         |                 |                       |
| Prolonged peripheral intravenous therapy |                       |                      | 0.172*  | 1.47            | 0.85-2.56             |
| Yes                                      | 15 (39.5%)            | 23 (60.5%)           |         |                 |                       |
| No                                       | 19 (26.8%)            | 52 (73.2%)           |         |                 |                       |
| History of complications <sup>†</sup>    |                       |                      | 0.027*  | 2.25            | 1.02-4.95             |
| Yes                                      | 27 (37.5%)            | 45 (62.5%)           |         |                 |                       |
| No                                       | 06 (17.1%)            | 30 (82.9%)           |         |                 |                       |
| History of phlebitis                     |                       |                      | 0.803*  | 0.92            | 0.49-1.72             |
| Yes                                      | 10 (35.7%)            | 18 (64.3%)           |         |                 |                       |
| No                                       | 17 (38.6%)            | 27 (61.4%)           |         |                 |                       |

To be continued

Table 3 (concluded)

| Variables                     | Yes (n = 34)<br>n (%) | No (n = 75)<br>n (%) | p value  | RR <sup>§</sup> | CI (95%) <sup>‡</sup> |
|-------------------------------|-----------------------|----------------------|----------|-----------------|-----------------------|
| History of infiltration       |                       |                      | 0.945*   | 1.02            | 0.52-2.03             |
| Yes                           | 20 (37.7%)            | 33 (62.3%)           |          |                 |                       |
| No                            | 07 (18.9%)            | 12 (63.2%)           |          |                 |                       |
| History of extravasation      |                       |                      | 0.161**  | 1.77            | 0.96-3.27             |
| Yes                           | 06 (60%)              | 04 (40%)             |          |                 |                       |
| No                            | 21 (33.9%)            | 41 (66.1%)           |          |                 |                       |
| History of obstruction        |                       |                      | 0.430*   | 0.73            | 0.33-1.64             |
| Yes                           | 05 (29.4%)            | 12 (70.6%)           |          |                 |                       |
| No                            | 22 (40%)              | 33 (60%)             |          |                 |                       |
| Location of PIVC <sup>‡</sup> |                       |                      | 1.000**  | 0.96            | 0.34-2.58             |
| MMII <sup>‡</sup>             | 03 (30%)              | 07 (70%)             |          |                 |                       |
| MMSS <sup>‡</sup>             | 31 (31.3%)            | 68 (68.7%)           |          |                 |                       |
| Vein visibility               |                       |                      | 0.436*   | 1.25            | 0.71-2.21             |
| Not visible                   | 13 (36.1%)            | 23 (63.9%)           |          |                 |                       |
| Visible                       | 21 (28.8%)            | 52 (71.2%)           |          |                 |                       |
| Palpability of the vein       |                       |                      | 0.930*   | 0.96            | 0.32-2.59             |
| Not palpable                  | 07 (30.4%)            | 16 (63.9%)           |          |                 |                       |
| Palpable                      | 27 (31.4%)            | 59 (71.2%)           |          |                 |                       |
| Catheter gauge                |                       |                      | 0.6948** | 1.49            | 0.59-3.75             |
| 20 G <sup>§</sup>             | 03 (42.9%)            | 04 (57.1%)           | > 0.99** | 1.18            | 0.43-3.26             |
| 24 G <sup>§</sup>             | 08 (36.4%)            | 14 (63.6%)           |          |                 |                       |
| 22 G <sup>§</sup>             | 23 (28.8%)            | 57 (71.3%)           |          |                 |                       |
| Catheter Material             |                       |                      | 0.360*   | 0.76            | 0.43-1.35             |
| Teflon                        | 22 (28.6)             | 55 (71.4%)           |          |                 |                       |
| Polyurethane                  | 12 (37.5%)            | 20 (62.5%)           |          |                 |                       |
| Puncture method               |                       |                      | 0.145**  | 2.04            | 0.700-9.60            |
| Direct                        | 31 (34.1%)            | 60 (65.9%)           |          |                 |                       |
| Indirect                      | 03 (16.7%)            | 15 (83.3%)           |          |                 |                       |
| Catheter stabilization        |                       |                      | 0.440*   | 1.31            | 0.68-2.54             |
| No                            | 7 (38.9%)             | 11 (61.1%)           |          |                 |                       |
| Yes                           | 27 (39.7%)            | 64 (70.3%)           |          |                 |                       |

\*Chi-Pearson's square; \*\*Fisher's exact test; §Relative Risk; †95% confidence interval; ‡peripheral intravenous catheterization; †In two children/adolescents, it was not possible to collect this information; ‡Lower limbs; †Upper members; §Gauge.

Table 4 - Incidence of infiltration according to characteristics of the current intravenous therapy, Feira de Santana, Bahia, Brazil, 2015-2016

| Variables  | Yes (n = 34)<br>n (%) | No (n = 75)<br>n (%) | p value | RR <sup>§</sup> | CI (95%) <sup>‡</sup> |
|--|-----------------------|----------------------|---------|-----------------|-----------------------|
| Use of irritating drugs <sup>§</sup>                     |                       |                      | 0.678*  | 0.88            | 0.48-1.60             |
| Yes  | 22 (39.3%)            | 53 (70.7%)           |         |                 |                       |
| No   | 11 (33.3%)            | 22 (66.7%)           |         |                 |                       |
| Use of vesicant drugs <sup>§</sup>                       |                       |                      | 0.135*  | 1.58            | 0.89-2.80             |
| Yes  | 11 (42.3%)            | 15 (57.7%)           |         |                 |                       |
| No   | 22 (26.8%)            | 60 (73.2%)           |         |                 |                       |
| Use of non-irritating and non-vesicant medicinal product |                       |                      | 0.060*  | 0.57            | 0.31-1.04             |
| Yes  | 12 (22.2%)            | 42 (77.8%)           |         |                 |                       |
| No   | 21 (38.9%)            | 33 (61.1%)           |         |                 |                       |
| Use of irritant / vesicant electrolyte <sup>§</sup>      |                       |                      | 0.010*  | 2.26            | 1.32-3.84             |
| Yes  | 09 (60%)              | 06 (40%)             |         |                 |                       |
| No   | 25 (26.6%)            | 69 (73.4%)           |         |                 |                       |
| PIVC <sup>‡</sup> usage time <sup>‡</sup> (hour)         |                       |                      | 0.215** | 0.61            | 0.26-1.41             |
| Greater than or equal to 72                              | 05 (20.8%)            | 19 (79.2%)           |         |                 |                       |
| Less than 72   | 29 (34.1%)            | 56 (65.9%)           |         |                 |                       |

\*Chi-Pearson's square; \*\*Fisher's exact test; §Relative Risk; †95% confidence interval; ‡It was not possible to verify the type of drug and electrolyte used by a child; §peripheral intravenous catheterization.

Table 5 - Poisson regression with robust variance of variables related to demographic and clinical variables child/adolescent, current intravenous therapy used for infiltration in Pediatric Surgical Clinic unit in the countryside of Bahia, Feira de Santana, Bahia, Brazil, 2015-2016

| Variables | p value | Occurrence of infiltration<br>RR <sup>§</sup> | CI (95%) <sup>‡</sup> |
|-----------|---------|---|-----------------------|
| Sex       | 0.038   | 0.53  | 0.30-0.96             |
| Female    |         |   |                       |
| Male      |         |   |                       |

To be continued

Table 5 (concluded)

| Variables   | p value | Occurrence of infiltration<br>RR <sup>§</sup> | CI (95%) <sup>¶</sup> |
|---|---------|---|-----------------------|
| Nutritional condition                                 | 0.008   | 2.27  | 1.25-4.20             |
| Malnourished  |         |   |                       |
| Eutrophic   |         |   |                       |
| Use of vesicant medicines                             | 0.039   | 1.72  | 1.03-2.87             |
| Yes   |         |   |                       |
| No  |         |   |                       |
| Use of non-irritating/non-vesicant medicinal products | 0.034   | 1.84  | 1.05-3.22             |
| Yes   |         |   |                       |
| No  |         |   |                       |
| Use of irritating/vesicant electrolytes               | 0.002   | 2.35  | 1.38-3.97             |
| Yes   |         |   |                       |
| No  |         |   |                       |

<sup>§</sup>Relative Risk; <sup>¶</sup>95% confidence interval.

## DISCUSSION

The findings of this study are following the results of other Brazilian and international studies, in which the incidence of infiltration varies from 1.8% to 78%<sup>(1,8-9,12,16-22)</sup>. This leads to the reflection that there may be similarities between the groups of children, even in places different from the studies presented above, correlating the confirmation of the data regarding the possibility of the proximity of the risk factors for the incidence of this complication in the Pediatric Public.

In the present study, being female was a protective factor for the occurrence of infiltration. Girls had a 47% lower risk for the occurrence of infiltration compared to boys. However, research shows that sex did not statistically influence in the occurrence of this clinical outcome<sup>(10,13,18)</sup> or other complications associated with the use of intravenous therapy in children<sup>(15,17,23)</sup>.

It is thought that female children tend to be more collaborative during the care provided by the nursing team and move the catheterized limb less, compared to male children, minimizing the occurrence of mechanical infiltration by less intravenous mobilization of the catheter cannula.

In the present study, non-eutrophic children and adolescents (obesity, overweight, and malnutrition) had twice the risk of infiltration compared to eutrophic ones. Children with low weight presented a higher chance for the occurrence of this complication, according to data from international research<sup>(10,24)</sup>.

Malnutrition generates "capillary fragility and decreased tissue turgor" in children. Such alterations in the structure of the capillary endothelium can allow the occurrence of rupture of blood vessels, thereby developing infiltration<sup>(25)</sup>. Also, the decrease in tissue turgor increases the mobility of the catheterized vessel, making it difficult to stabilize the intravenous catheter and, thus, instability influences the displacement of the device with the possibility of rupture and infiltration of fluids out of the vein.

Also, it is more complex to obtain peripheral venous access in obese children since, in this population, two or more attempts are required, in addition to the likelihood of not having visible and palpable veins<sup>(26)</sup>.

Thus, the association of infiltration in obese children may be due to the difficulty of obtaining venous access since the insertion of the peripheral venous catheter into veins that are often not visible or palpable for the excessive presence of adipose

tissue can cause the displacement of the tip of the device inside the vessel and consequent displacement of its tip to adjacent tissues more easily.

Data from Chinese research pointed out that, among the risk factors for extravasation, the infusion of drugs with high osmolarity and poor condition of the veins stood out<sup>(20)</sup>. Also, another study that investigated the principal causes of infiltration and extravasation in hospitalized children verified the high osmolarity of fluids in use as a cause of infiltration<sup>(13)</sup>. When drugs leave the range of hydrogen ionic potential from 5 to 9, the risk of inflammation and vascular injury increases significantly<sup>(5,27)</sup>, with the potential to cause complications associated with intravenous therapy<sup>(5)</sup>. The current guideline of the Infusion Nurses Society highlights the need to avoid the infusion of drugs and solutions of irritant or vesicant nature by the peripheral route<sup>(4)</sup>.

Research shows that high-risk drugs and solutions have osmolarity higher than 600 mOsm/L, pH less than 4 or greater than 9, and most is classified as vesicants, while those of moderate risk have osmolarity ranging from 450 to 600 mOsm/L or pH between 4 and 9 or 7.5 to 9, classified as non-vesicant<sup>(28)</sup>.

Hyperosmolar substances, like those with osmolarity higher than 900 mOsm/L<sup>(4)</sup>, extract water from cells, resulting in cell death by dehydration<sup>(29)</sup>, potentiating the occurrence of infiltrations of a chemical nature. Other international studies indicate that the use of drugs such as phenytoin, ampicillin, vancomycin, and electrolytes have been associated with the occurrence of infiltration<sup>(10-11)</sup>.

The use of isotonic, hypotonic, or hypertonic solutions was statistically associated with the occurrence of complications in peripheral intravenous catheter insertion sites, while the type of treatment used (drugs or solutions) and the types of drugs (antibiotics and other drugs) did not influence the occurrence of these events in children<sup>(22)</sup>.

Longitudinal research, conducted in a hospital in the countryside of Bahia, found that, in the multivariate analysis, the use of irritant/vesicant drugs and vesicant solutions was associated with the manifestation of intravenous therapy complications in children and adolescents with cancer<sup>(30)</sup>.

Considering all that, it is essential that the pediatric nurse adequately plan the infusion of drugs and solutions intravenously, respecting the osmolarity and hydrogen ionic potential of the prescribed fluids, the type of vascular access device (central or peripheral), vein with more adequate conditions (caliber, blood

flow and distant regions of joints) and the time of use of therapy, thinking about health promotion and vascular protection.

From this perspective, it is observed that the failure of one of these issues directly contributes to the occurrence of complications in peripheral intravenous catheter insertion sites, which increases the contact of risk fluids with the vascular endothelium, leaving it more vulnerable to damage to its anatomical structure.

Therefore, considering that children in the operative period present acute conditions, even having a short period of hospitalization, the adequate use of intravenous therapy by peripheral route may result in reduced damage. This is because the therapy is not prolonged, despite the use of drugs of irritating and vesicant characteristics. Therefore, knowing the risk factors and, in turn, applying preventive measures can minimize the occurrence of infiltration.

### Study limitations

This research has some limitations. The convenience sample limits the generalization of the results to other pediatric populations; and, because it is a unicentric study, the data can only represent the peculiar reality of the Surgical Clinic unit of the hospital in question.

Another limitation was the lack of classification of the degree of infiltration employing a scale appropriate for children, during the development of this research, there was no clinical tool validated and cross-culturally adapted for the Brazilian pediatric population

### Contributions to the field of Nursing, Health or Public Policy

The study presents contributions to the theoretical, practical, and social fields. In theory, it can contribute to the production of scientific evidence on the subject, as well as assist in undergraduate and graduate teaching.

Regarding the practice, knowing the risk factors for infiltration can imply the development of care based on preventive actions

and focused on such factors, generally susceptible to modifications. Thus, nurses can implement the actions able to contribute to the reduction of the infiltration in the unit studied, including investment in professional training, development of algorithms for the selection of the optimal route for administration of fluids and medications as prescribed, and acquisition of technologies, such as appropriate catheters and coverage, care during intravenous device maintenance, and the recognition of the risk factors for the occurrence of this complication.

Regarding the social issue, the knowledge produced by the research can help in the promotion of patient safety and in the reduction, for children and their families, of psychological damage linked to the pain caused by the complication and the trauma resulting from the various PIVC attempts.

### CONCLUSIONS

The findings of this research warn of the high incidence of infiltration in children and adolescents who reside in a city in the State of Bahia and present surgical conditions. Being female was a protective factor for the occurrence of the event, while non-eutrophic children, using non-irritating and non-vesicant drugs, vesicants, and irritating/vesicant electrolytes were risk factors related to the occurrence of infiltration.

These independent risk factors can guide nursing professionals as to the interventions that contribute to better care outcomes for hospitalized children and adolescents, given the possibility of reflection on the implementation of care based on scientific evidence that can promote and sustain safe and quality intravenous therapy, reducing the risk of infiltration development. It demonstrates the importance of transferring the investigated knowledge to clinical practice, strengthening the practice of nursing professionals in scientifically proven actions, free of empirical procedures and without scientific foundations, with consequent promotion of patient and family safety.

### REFERENCES

1. Ullman AJ, Takashima M, Kleidon T, Ray-Barruel G, Alexandrou E, Rickard CM. Global pediatric peripheral intravenous catheter practice and performance: a secondary analysis of 4206 catheters. *J Pediatr Nurs*. 2020;50:e18-e25. <https://doi.org/10.1016/j.pedn.2019.09.023>
2. Gerçeker GÖ, Kahraman A, Yardimci F, Bilsin E, Binay Ş, Özdemir HNÇ, et al. Infiltration and extravasation in pediatric patients: a prevalence study in a children's hospital. *J Vasc Access*. 2018;19(3):266-71. <https://doi.org/10.1177/1129729817747532>
3. Indarwati F, Mathew S, Munday J, Keogh S. Incidence of peripheral intravenous catheter failure and complications in paediatric patients: systematic review and metaanalysis. *Int J Nurs Stud*. 2020;102:103488. <https://doi.org/10.1016/j.ijnurstu.2019.103488>
4. Infusion Nurse Society. Infiltration and extravasation. In: *Infusion nursing standards of practice: 8th edition*. Norwood (MA): INS. 2021;44(15):S142-76.
5. Infusion Nurses Society Brasil. *Diretrizes práticas para a terapia infusional*. 3th ed. São Paulo: INS Brasil; 2018. p. 45-94.
6. Kleidon TM, Cattanaçh P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: a quality improvement initiative. *J Paediatr Child Health*. 2019;55(10): 1214-23. <https://doi.org/10.1111/jpc.14384>
7. Sanchez Cristal N, Staab J, Chatham R, Ryan S, Mcnair B, Grubenhoff JA. child life reduces distress and pain and improves family satisfaction in the pediatric emergency department. *Clin Pediatr (Phila)*. 2018;57(13):1567-75. <https://doi.org/10.1177/0009922818798386>
8. Jeong IS, Park SM, Park KJ. Effect of observation window at peripheral intravenous catheter site on early recognition of infiltration among hospitalized children. *J Korean Acad Nurs*. 2016;46(4):534-41. <https://doi.org/10.4040/jkan.2016.46.4.534>
9. Park SM, Jeong IS, Kim KL, Park KJ, Jung MJ, Jun SS. The effect of intravenous infiltration management program for hospitalized children. *J Pediatr Nurs*. 2016;31(2):172-8. <https://doi.org/10.1016/j.pedn.2015.10.013>

10. Park SM, Jeong IS, Jun SS. Identification of risk factors for intravenous infiltration among hospitalized children: a retrospective study. *PLoS One*. 2017;11(6):e0158045. <https://doi.org/10.1371/journal.pone.0158045>
11. Jeong IS, Jeon RG, Lee MS, Shin BJ, Kim Y-J, Park SM, et al. Intravenous infiltration risk by catheter dwell time among hospitalized children. *J Pediatr Nurs*. 2017;32:47-51. <https://doi.org/10.1016/j.pedn.2016.08.008>
12. Lin S-W, Chen S-C, Huang F-Y, Lee M-Y, Chang C-C. Effects of a clinically indicated peripheral intravenous replacement on indwelling time and complications of peripheral intravenous catheters in pediatric patients: a randomized controlled trial. *Int J Environ Res Public Health*. 2021;18(7):3795. <https://doi.org/10.3390/ijerph18073795>
13. Litao H, Yuxuan R, Yongxia S. Infiltration and extravasation of intravenous infusions in children-value of high-quality care on outcome. *J Pak Med Assoc*. 2021;71(4):1181-3. <https://doi.org/10.47391/JPMA.02-194>. PMID: 34125767
14. Bonita R, Beaglehole R, Kjellström T. *Epidemiologia básica*. 2. ed. São Paulo: Santos. 2010. 213p.
15. Malta M, Cardoso LO, Bastos FI, Magnanini MMF, Silva CMFP. STROBE initiative: guidelines on reporting observational studies. *Rev Saude Publica*. 2010;44(3):559-65. <http://doi.org/10.1590/S0034-89102010000300021>
16. Förberg U, Unbeck M, Wallin L, Johansson E, Petzold M, Ygge B-M, et al. Effects of computer reminders on complications of peripheral venous catheters and nurses' adherence to a guideline in paediatric care-a cluster randomised study. *Implement Sci*. 2016;11:10. <https://doi.org/10.1186/s13012-016-0375-9>
17. Jacinto AKL, Avelar AFM, Pedreira MLG. Predisposing factors for infiltration in children submitted to peripheral venous catheterization. *J Infus Nurs*. 2011;34(6):391-8. <https://doi.org/10.1097/NAN.0b013e3182306491>
18. Laudenbach N, Braun CA, Klaverkamp L, Hedman-Dennis S. Peripheral i.v. stabilization and the rate of complications in children: an exploratory study. *J Pediatr Nurs*. 2014;29(4):348-53. <https://doi.org/10.1016/j.pedn.2014.02.002>
19. Abdelaziz RB, Hafsi H, Hajji H, Boudabous H, Chehida AB, Mrabet A, et al. Peripheral venous catheter complications in children: predisposing factors in a multicenter prospective cohort study. *BMC Pediatr*. 2017;17(1):208. <https://doi.org/10.1186/s12887-017-0965-y>
20. Yan Y-M, Gong M, Chen J-L, Li D, Xu T-T, Zou H, et al. Incidence, risk factors and treatment outcomes of drug extravasation in pediatric patients in China. *Turk J Pediatr*. 2017;59(2):162-8. <https://doi.org/10.24953/turkjped.2017.02.008>
21. Unbeck M, Förberg U, Ygge B-M, Ehrenberg A, Petzold M, Johansson E. Peripheral venous catheter related complications are common among paediatric and neonatal patients. *Acta Paediatr*. 2015;104(6):566-74. <https://doi.org/10.1111/apa.12963>
22. Abusafia BMR, Boztepe H. Evaluation of peripheral intravenous catheter-induced local complications in pediatrics. *J Clin Nurs*. 2017;26(17-18):2818. <https://doi.org/10.1111/jocn.13730>
23. Fonzo-Christe C, Parron A, Combescure C, Rimensberger PC, Pfister RE, Bonnabry P. Younger age and in situ duration of peripheral intravenous catheters were risk factors for extravasation in a retrospective paediatric study. *Acta Paediatr*. 2018;107(7):1240-46. <https://doi.org/10.1111/apa.14280>
24. Danski MTR, Migorance P, Johann DA, Vayego SA, Lind J. Incidence of local complications and risk factors associated with peripheral intravenous catheter in neonates. *Rev Esc Enferm USP*. 2016;50(1):22228. <https://doi.org/10.1590/S0080-623420160000100003>
25. Negri DC, Avelar AFM, Andreoni S, Pedreira MLG. Predisposing factors for peripheral intravenous puncture failure in children. *Rev Latino-Am Enfermagem*. 2012;20(6):1072-80. <https://doi.org/10.1590/S0104-11692012000600009>
26. Nafiu OO, Burke C, Cowan A, Tutuo N, Maclean S, Tremper KK. Comparing peripheral venous access between obese and normal weight children. *Pediatric Anaesth*. 2010;20(2):172-6. <https://doi.org/10.1111/j.1460-9592.2009.03198.x>
27. Beall V, Hall B, Mulholland JT, Gephart SM. Neonatal extravasation: an overview and algorithm for evidence-based treatment. *Newborn Infant Nurs Rev*. 2013;13(4):189-95. <https://doi.org/10.1053/j.nainr.2013.09.001>
28. Manrique-Rodríguez S, Heras-Hidalgo I, Pernia-López MS, Herranz-Alonso A, Del Río Pisabarro MC, Suárez-Mier MB, et al. Standardization and chemical characterization of intravenous therapy in adult patients: a step further in medication safety. *Drugs Rev D*. 2021;21(1):39-64. <https://doi.org/10.1007/s40268-020-00329-w>
29. Phillips LD, Gorski L. *Manual of IV therapeutics: evidence-based practice for infusion therapy*. 6th ed. Philadelphia: F. A. Davis Company; 2014.
30. Santos LM, Silva CSG, Machado ES, Almeida AHV, Silva CAL, Silva BSM, et al. Risk factors for site complications of intravenous therapy in children and adolescents with cancer. *Rev Bras Enferm*. 2020;73(4):e20190471. <https://doi.org/10.1590/0034-7167-2019-0471>