*Arch Health Sci Res*. 2024;11(2):117-121
DOI: 10.5152/ArcHealthSciRes.2024.23178

**Original Article**

# The Prevalence of Infiltration in Pediatric Patients and Affecting Factors

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This article was presented as an abstract at the 4th International Mediterranean and 3rd International 8th National Pediatric Nursing Congress.

**Cite this article as:** Sarıalioğlu A, Başkurt F. The prevalence of infiltration in pediatric patients and affecting factors. *Arch Health Sci Res.* 2024;11(2):117-121.



## ABSTRACT

**Objective:** The aim of the study was to define the infiltration in pediatric patients and the affecting variables.

**Methods:** The study had an observational and descriptive study design. The population comprised pediatric patients who stayed at a state hospital pediatrics clinic in the east of Türkiye between March and August 2022. The time prevalence method was used in the study. The sample size was 300 pediatric patients. The "Questionnaire Form" and the "Pediatric Peripheral Intravenous Infiltration Scale" were utilized.

**Results:** It was determined that infiltration developed in 30% of pediatric patients. A total of 16% of the patients with infiltration had first-degree, 8.3% had second-degree, 4.7% had third-degree, and 1% had fourth-degree infiltration. Variables such as the child's age, number of catheters, body part where the catheter was inserted, serum set type, infusion pump use, and hydration status affected the infiltration in pediatric patients.

**Conclusion:** The prevalence of infiltration was high in pediatric patients. Intravenous infiltration is a preventable complication in children. Pediatric patients should be evaluated with a scale to prevent infiltration. It is suggested to plan the required nursing interventions to prevent infiltration.

**Keywords:** Infiltration, pediatrics, prevalence

## Introduction

Some local complications such as phlebitis, infiltration, extravasation, hematoma, and infection might develop during the insertion and monitoring of peripheral intravenous catheters (PIC).[1] In addition to hospital and patient-related factors, the characteristics of fluids and medications also play roles in the development of these complications.[2] It is stated that complications of PIC are more common in children than adults. In addition to the complications in PIC applications, the physical and behavioral characteristics of children also cause difficulties in the management of PIC.[3] Among these difficulties, there are small vessel diameter, inability to express or localize the signs of complications, limited communication skills, underdevelopment of their immune systems, and children's inability to control their behaviors because of their developmental characteristics and being more physically active.[4,5] A total of 95% of the peripheral venous catheters are removed because of obstruction, leakage, and infiltration. The most common complication detected in most patients is infiltrations.[6,7]

Intravenous infiltration is the situation where the irritant and non-vesicant drug given intravenously leaks out of the vein. Infiltrates often cause redness, swelling, and bullae in the area, and no tissue loss develops.[1,8] Separation of the intravenous fluid from the localization and leakage under the fixation are also among the infiltration findings. However, complications may be more in some cases, with skin swelling, pallor, prolongation of capillary filling time, and tissue necrosis.[1]

It is the nurse's responsibility to insert, control, and monitor the peripheral intravenous catheter, maintain intravenous therapy, prevent complications, and ensure the safety of the patient.[9-11] These complications in the PIC process cause prolongation of hospital stay, increase in medical

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Received: December 11, 2023
Revision Requested: January 9, 2024
Last Revision Received: February 13, 2024
Accepted: March 14, 2024
Publication Date: June 7, 2024

expenses, and morbidity.[12] For this reason, it is extremely important to prevent the development of such complications. To prevent intravenous infiltrates and reduce complications, hourly monitoring of vascular access must be noted, and signs of fluid removal in the infusion pump must be recorded. In the observation of the infusion area, findings such as redness, pain, swelling, color change, pallor, edema, and the leakage must be observed and evaluated systematically with the help of a scale. Various scales and guidelines are used to define intravenous infiltrations.[8,13]

When the literature on infiltration complications in pediatric patients was reviewed, it was reported as 72% in the study by Abusafia,[12] 54.1% in the study byOlgun et al.,[14] 2.9% by Gerçeker et al.,[15] and 8.7% by Karaoğlan et al.[16]

It is considered that determining the prevalence of infiltration will contribute to the increasing awareness of nurses and to planning and implementing of interventions to prevent infiltration. For this reason, the aim of the study was to define the infiltration in pediatric patients and the variables that affect it.

**Research Questions**

1. What is the grade of infiltration in pediatric patients?
2. What are the variables affecting the infiltration in pediatric patients?



## Methods

**Design**

The study had an observational and descriptive study design. The study was carried out at a state hospital pediatrics clinic in the east of Türkiye between March and August 2022.

**Sample and Setting**

The population comprised pediatric patients who stayed at a state hospital pediatrics clinic in the east of Türkiye. It was attemptedto reach the maximum possible number of pediatric patients without using any sampling method because the time prevalence method was employed in the study. The sample of the study comprised of 300 pediatric patients who met the inclusion criteria and were in the clinic for the specified time. Posthoc power analysis was performed using the G.Power 3.1.9.7 program to determine that the sample size was sufficient. Goodness-of-fit test: Contingency table was used for the $\chi^2$ test for analysis. As a result of the analysis, considering an effect size of 0.4, an α-type error estimation was 0.05, and a degree of freedom of 1, the power of the study was found to be 0.99. These values indicate that the sample size is sufficient.

**Inclusion Criteria**

- Ages ranging from 1 month to 18 years.
- Pediatric patients who completed at least 72 hours of hospitalization.
- Children undergoing peripheral intravenous catheterization.
- No previous signs of intravenous infiltration or extravasation.
- Children without circulatory disorders.

**Exclusion Criteria**

- Children who continue to receive intravenous treatment that may be toxic, such as calcium and parenteral nutrition solutions that may cause extravasation.
- Children who underwent catheter application between 4:00 AM and 8:00 AM.
- Children who are not taking similar medications.

**Data Collection Tools**

The "Questionnaire Form" and the "Pediatric Peripheral Intravenous Infiltration Scale" were used.

**Questionnaire Form**

In this form, which was prepared by the researcher based on the literature data,[13-16] there were questions about parental characteristics (age, gender, education level, economic status), and children's sociodemographic characteristics (age, gender, weight), and the factors that might affect infiltration (number of catheters, body part where the catheter was inserted, serum set type, infusion pump use, and hydration status). The questionnaire was created by taking the opinions of 3 experts working in pediatric nursing. The Content Validity Index (CVI) value for this form was found to be 0.99.

**Pediatric Peripheral Intravenous Infiltration Scale**

It was developed and validated for use in pediatric patients by Simona in 2012.[8] Temizsoy et al. conducted the Turkish validity and reliability in 2017.[13] The scale consists of a 5-level (0-1-2-3-4) scoring system. Specifically, edema measurement was evaluated as the area covered by the affected extremity as originally suggested by the scale. For example, it was evaluated as 1%-10% (first degree), 10%-25% (second degree), 25%-50% (third degree), and >50% (fourth degree). Grade 0 (no symptoms, flushes with ease), grade 1 (localized swelling 1%-10%, flushes with difficulty, pain at site), grade 2 (localized swelling 10%-25%, presence of redness, pain at site), grade 3 (localized swelling 25%-50%, pain at site, skin cool to touch, blanching, diminished pulse below site), and grade 4 (localized swelling >50%, infiltration of blood products, irritants, and/or vesicants, skin cool to touch, blanching, skin breakdown/necrosis, blistering, diminished or absent pulse, pain at site, capillary refill >4 seconds). The first level represents the lightest infiltration and the fifth level represents the most severe infiltration. How to use the infiltration scale was based on the principle that each patient receiving fluid therapy is checked for findings once an hour and the level is recorded. The higher the scale score, the higher the risk of complications. Intra-class correlation coefficient showing reliability between measurements was $r = 0.99$ ($P < .001$).[13]

**Data Collection**

The research data were collected between March and August 2022. After, explaining the purpose of the research and providing necessary information to the children and parents who met the inclusion criteria, verbal and written informed consent was obtained from the children and parents participating in the research. The questionnaire form was collected through face-to-face interviews, and the Pediatric Peripheral Intravenous Infiltration Scale was collected by grading and observing whether infiltration developed in children. The data were collected in the patient's room when the child and parent were available. Filling in the scale and questionnaire took an average of 10-15 minutes.

All clinical nurses were informed about the research and Pediatric Peripheral Intravenous Infiltration Scale, and instructions on how to use it were explained. Peripheral intravenous catheter application, medication, and fluid administration were performed by a nurse working the day shift in the clinic. The start time of PIC was recorded. Complications that developed in the patient were observed and evaluated by the researcher. Observations and evaluations during the hours when the researcher was not in the clinic were carried out by clinical nurses who were informed about the research and were trained in detail on this subject. The area where the catheter was inserted was evaluated for infiltration by clinical nurses every hour until the PIC was removed. The PIC was removed as soon as infiltration developed or, if not, after 72 hours. The removal time of PIC was recorded.

**Statistical Analysis**

The Statistical Package for Social Sciences version 20.0 software (IBM Corp.; Armonk, NY, USA) was used for the statistical analysis of the data. Numbers, percentages, chi-square test, Fisher–Freeman–Halton exact test, and Fisher's exact test were used to evaluate the data. The

statistical significance level was taken as 0.05. The level of the relationship in statistically significant data was evaluated with the "Cramer's V test."

### Ethical Considerations

The ethics committee and institutional permission were obtained to conduct the study from Erzurum Atatürk University Clinical Research Ethics Committee (Approval no: B.30.2.ATA.0.01.00/200, Date: February 2, 2022). The purpose of the study was explained to the children and their parents who met the inclusion criteria, their questions were answered, and their verbal and written consents were obtained. The ethical principles were followed in the study.

### Results

It was determined that infiltration developed in 30% of pediatric patients. A total of 16% of the patients with infiltration had first-degree, 8.3% had second-degree, 4.7% had third-degree, and 1% had fourth-degree infiltration (Table 1).

It was found that 57.8% of the parents of the pediatric patients who had infiltration were 18-29 years old, 92.2% were mothers, 28.9% were secondary school graduates, and 70% of their income was equal to their expenses. Also, 41.1% of the pediatric patients were 1-12 months old and 42.2% were 6-10 kg (Table 2).

A statistically significant relationship was detected between the presence of infiltration and the child age variables in the pediatric patients ($P < 0.05$), with the frequency of infiltration being higher in children aged 1-12 months when compared to other age groups (Table 3).

Among the pediatric patients who had infiltration, 44.4% had 24G catheters, 72.2% had infusion pumps, 71.1% had normal serum sets, 52.2% had left and 38.9% had forearm catheters, and 87.8% of them had hydration (Table 3).

Variables such as the child's age, number of catheters, body part where the catheter was inserted, serum set type, infusion pump use, and hydration status affected the infiltration in pediatric patients ($P < .05$). The frequency of infiltration was higher in children with a 24G catheter compared to other catheter numbers. It was found that the frequency of infiltration was higher in children who had a catheter inserted in the forearm compared to other body parts. The frequency of infiltration was higher in children who had a normal serum set, not an infusion pump, and who received hydration (Table 3).

**Table 1.** Infiltration Distribution of Pediatric Patients (n = 300)

| | Infiltration | |
|---|---|---|
| | n | % |
| No symptoms | 210 | 70.0 |
| First degree | 48 | 16.0 |
| Second degree | 25 | 8.3 |
| Third degree | 14 | 4.7 |
| Fourth degree | 3 | 1.0 |

### Discussion

In the study, which aimed to define the infiltration in pediatric patients and the affecting variables, the prevalence of infiltration was high in pediatric patients. It was reported that PIC complications are more common in children than adults.[3] A total of 95% of PICs were removed because of obstruction, leakage, and infiltration. The most common complication detected in most patients was infiltration.[6,7]

When the literature on infiltration complications in pediatric patients was reviewed, infiltration complications in pediatric patients was



**Table 2.** Distribution and Comparison of Sociodemographic Characteristics of Pediatric Patients According to Infiltration Results (n = 300)

| | | Without Infiltration (n = 210) | | With Infiltration (n = 90) | | Test and *P* | |
|---|---|---|---|---|---|---|---|
| | Characteristics | n | % | n | % | $\chi^2$ | *P** |
| Parent age | 18-29 age | 91 | 43.4 | 52 | 57.8 | 6.292 | .053[a] |
| | 30-39 age | 100 | 47.6 | 29 | 32.2 | | |
| | 40 age and above | 19 | 9.0 | 9 | 10.0 | | |
| Parent gender | Female | 167 | 79.5 | 83 | 92.2 | 7.314 | .061[b] |
| | Male | 43 | 20.5 | 7 | 7.8 | | |
| Parent education level | Illiterate | 5 | 2.4 | 8 | 8.9 | 8.204 | .084[a] |
| | Primary school | 44 | 21.0 | 21 | 23.3 | | |
| | Middle school | 82 | 39.0 | 26 | 28.9 | | |
| | High school | 58 | 27.6 | 25 | 27.8 | | |
| | University | 21 | 10.0 | 10 | 11.1 | | |
| Family income | Less than expenditure | 53 | 25.2 | 12 | 13.3 | 5.533 | .063[a] |
| | Equal income and expenditure | 131 | 62.4 | 63 | 70.0 | | |
| | More than expenditure | 26 | 12.4 | 15 | 16.7 | | |
| Child age | 1-12 months | 51 | 24.3 | 37 | 41.1 | 10.339 | **.035[a]** |
| | 1-3 age | 98 | 46.7 | 29 | 32.2 | Cramer's | |
| | 4-6 age | 33 | 15.7 | 10 | 11.1 | $V = 0.186$ | |
| | 7-12 age | 18 | 8.6 | 9 | 10.0 | $P = .035$ | |
| | 13-18 age | 10 | 4.7 | 5 | 5.6 | | |
| Child gender | Female | 112 | 53.3 | 52 | 57.8 | 0.502 | .561[b] |
| | Male | 98 | 46.7 | 38 | 42.2 | | |
| Child weight | 2-5 kg | 24 | 11.4 | 14 | 15.6 | 9.496 | .055[a] |
| | 6-10 kg | 63 | 30.0 | 38 | 42.2 | | |
| | 11-20 kg | 81 | 38.6 | 19 | 21.1 | | |
| | 21-30 kg | 19 | 9.0 | 8 | 8.9 | | |
| | 31 kg and above | 23 | 11.0 | 11 | 12.2 | | |

Values in bold indicate statistical significance.
[a]Fisher–Freeman–Halton exact test.
[b]Fisher's exact test.

**Table 3.** Distribution and Comparison of Features that May Affect Pediatric Patients According to Infiltration Results (n = 300)

| | | Without Infiltration (n = 210) | | With Infiltration (n = 90) | | Test and *P* | |
|---|---|---|---|---|---|---|---|
| | **Characteristics** | **n** | **%** | **n** | **%** | $\chi^2$ | ***P**** |
| Catheter number | 20G | 12 | 5.7 | 5 | 5.6 | 1.090 | **.038**[a] |
| | 22G | 38 | 18.1 | 14 | 15.6 | Cramer's *V* = 0.271 | |
| | 24G | 100 | 47.6 | 40 | 44.4 | *P* = .038 | |
| | 26G | 60 | 28.6 | 31 | 34.4 | | |
| Catheter side | Right | 105 | 50.0 | 43 | 47.8 | 0.124 | .821[b] |
| | Left | 105 | 50.0 | 47 | 52.2 | | |
| Body part where the catheter | Handheld | 77 | 36.7 | 19 | 21.1 | 16.110[a] | **.007**[a] |
| | Wrist | 42 | 20.0 | 14 | 14.4 | Cramer's *V* = 0.232 | |
| | Forearm (antecubital) Out of foot | 49 | 23.3 | 35 | 38.9 | *P* = .007 | |
| | Ankle | 17 | 8.1 | 13 | 14.4 | | |
| | Head-neck | 20 | 9.5 | 10 | 11.1 | | |
| | | 5 | 2.4 | 0 | 0.0 | | |
| Type of serum set | Normal | 185 | 88.1 | 64 | 71.1 | 28.274 | **.000**[a] |
| | Infusion pump | 16 | 7.1 | 26 | 28.9 | Cramer's *V* = 0.307 | |
| | No | 10 | 4.8 | 0 | 0.0 | *P* = .000 | |
| Using an infusion pump | Yes | 17 | 8.1 | 25 | 27.8 | 20.271 | **0.000**[b] |
| | No | 193 | 91.9 | 65 | 72.2 | Cramer's *V* = 0.260 | |
| | | | | | | *P* = .000 | |
| Hydration status | Yes | 116 | 55.2 | 79 | 87.8 | 29.321 | **.000**[b] |
| | No | 94 | 44.8 | 11 | 12.2 | Cramer's *V* = 0.313 | |
| | | | | | | *P* = .000 | |

Values in bold indicate statistical significance.
[a]Fisher–Freeman–Halton exact test.
[b]Fisher's exact test.



reported as 54.1% in the study of Olgun et al.,[14] and 72% in the study of Abusafia.[12] It is noteworthy that the infiltration results in the study were lower than the results of some studies in the literature.[12,14] On the other hand, in the studies conducted so far, Jacinto et al.[10] reported the infiltration rate as 16%, Tripi et al.[18] 13%, Karaoğlan et al.[16] 8.7%, Park et al. 7.8%,[7] and Gerçeker et al.[15] 2.9%. In the study of Laudenbach et al.,[3] it was reported that 22.5% of the patients developed PIC complications, and the most common complications were obstruction (mechanical complication) and infiltration. Also, in the study of Park et al.,[17] the infiltration rate decreased significantly after the infiltration prevention program was applied (pre-program = 4.4%, post-program = 0.9%). It was determined that the infiltration results in this study were higher than the results of some studies in the literature.[3,7,10,15-18] The reason why it was higher than the literature may be the diseases of the patients, individual characteristics of the patients, the drugs used, as well as the differences in the knowledge and practice levels of the nurses.

It was determined in the study that 16% of pediatric patients developed grade 1 infiltration, 8.3% developed grade 2, 4.7% developed grade 3, and 1% developed grade 4 infiltration. In the study conducted by Olgun et al.,[14] it was found that 54.1% of pediatric patients developed infiltration, 20.3% developed grade 1 infiltration, 16.2% had grade 2 infiltration, and 4% developed grade 3 infiltration. In the study of Simona,[8] 37.1% of the infiltrations in pediatric patients were determined as grade 1, 31.4% as grade 2, and 10.8% as grade 3. The highest level of prevalence in patients with infiltrates being grade 1 is consistent with the literature data. It is important that the first-degree infiltration turns to its former state more easily than other degrees. For this reason, it is recommended to train nurses and raise awareness of this issue.

In the study, it was found that the frequency of infiltration was higher in children aged 1-12 months than in other age groups. Age is an important risk factor for the development of infiltration.[19] In Abusafia's[12] study, it was determined that infiltration developed mostly in the age group of ≤3 years. In the studies of Park et al.[7] and Jacinto et al.,[10] no significant differences were reported between age and the incidence of infiltration. In this study, the reason for the higher infiltration rate in children aged 1-12 months can be associated with the fact that their vessels are smaller, fragile, and vulnerable to intraluminal pressure and rapid flow.

In the study, it was found that the frequency of infiltration was higher in children with a 24G catheter when compared to other catheter numbers. The smallest catheter number that will allow the flow rate of the treatment to be applied should be preferred because the complication rate decreases as the PIC number decreases.[20] In some studies, it was reported that the inability to determine the catheter number suitable for treatment affects the development of infiltration.[21,22] In the study of Karaoğlan et al.,[16] the use of 22G and 24G catheters in children was shown to be an important risk factor for the development of infiltration. In a study that examined the development of infiltration according to the PIC number, it was found that infiltration developed at the rate of 73% in 22G catheters and 72.9% in 24G catheters, and the rate of complication development decreased as the catheter number decreased.[12] In the study of Jacinto et al.[10] and Park et al.,[7] it was found that infiltration was most common in children with a 24G catheter, but no significant differences were detected between the catheter number and the incidence of infiltration. The findings of this study are consistentwith the literature data. The larger diameter of the 22-24G catheter in the patients in this study, allowing longer IV administration, might have increased the infiltration rate.

In the study, it was found that the frequency of infiltration was higher in children who had a catheter inserted in the forearm (antecubital site) when compared to other body parts. In a study, it was reported that there was a significant difference between the developing infiltration rates according to the area where PIC was inserted. A maximum of 80.8% infiltration was observed in the lower extremity/other catheters. A maximum of 68.9% infiltration was found in catheters inserted in the upper extremity.[12] One of the important factors in reducing the complications of PIC is avoiding the lower extremity, antecubital region, and wrist, which have a high risk of infiltration.[7,9,23] The reason for the higher rate of infiltration in the forearm in this study may be because of the presence of the antecubital region in the forearm and the inability of pediatric patients to adequately protect the forearm region.

In the study, it was found that the frequency of infiltration was higher in children who received IV treatment with a normal serum set and without an infusion pump. It is reported in the literature that various infusion pumps can be used to safely deliver the desired amount of intravenous fluid administration to the patient.[24] The alarming of the infusion pump in case of any folding or occlusion may have contributed to the early detection of the infiltration condition. Also, the absence of signs of infiltration in children who received fluid with a serum set may have prevented the infiltration from being noticed. It was found in the study that the frequency of infiltration was higher in children who received fluid. The infiltration rate may be high because the fluid intake of pediatric patients disrupts the structure of the vessels.

## Conclusion

It was found that the prevalence of infiltration was high in pediatric patients. Variables such as "the child's age, number of catheters, body part where the catheter was inserted, serum set type, infusion pump use, and hydration status" affected the infiltration in pediatric patients.

## Practice Implications

Intravenous infiltration is a preventable complication in children. Pediatric patients should be evaluated with a scale to prevent infiltration. Also, it is necessary not only to diagnose the infiltration situation but also to plan necessary interventions. Nurses working in pediatric clinics should be given regular training on PIC placement, follow-up, care, and complications. It is recommended to conduct studies to reduce this complication in the hospital where the study was conducted. Further studies must be conducted with a larger sample and different groups.

## Limitations and Strengths of the Study

The limitation of the study is that it was conducted only in one state hospital pediatrics clinic in the east of Türkiye. One of the most important limitations of the study is that it was not followed up by the same person (following up by more than one person). Although not all complications could be evaluated, the study is one of the few studies conducted on the subject. It is important because it prepares the ground for qualitative studies to reduce complications in the hospital where the study was conducted.

**Ethics Committee Approval:** The ethics committee and institutional permission were obtained to conduct the study from Erzurum Atatürk University Clinical Research Ethics Committee (Approval no: B.30.2.ATA.0.01.00/200, Date: February 2, 2022).

**Informed Consent:** Written and verbal informed consent was obtained from children who participated in this study and their parents.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept – A.S., F.B.; Design – A.S., F.B.; Supervision – A.S., F.B.; Resources – A.S., F.B.; Materials – F.B.; Data Collection and/or Processing – F.B.; Analysis and/or Interpretation – A.S.; Literature Search – A.S., F.B.; Writing Manuscript – A.S., F.B.; Critical Review – A.S., F.B.

**Acknowledgement:** The authors gratefully would like to thank the children, parent and nurses participating in the research.

**Declaration of Interests:** The authors have no conflict of interest to declare.

**Funding:** The authors declared that this study has received no financial support.

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