

Infiltration and extravasation of intravenous infusions in children-value of high-quality care on outcome

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Abstract

Objective: To study the value of high-quality care on the outcome of infiltration and extravasation of peripheral intravenous infusions in children.

Methods: The retrospective cohort study was conducted at the Third Affiliated Hospital of Zunyi Medical University, Guizhou, China, and comprised secondary-data analysis on children aged <3 years hospitalized between January 2013 and September 2019. The sample was divided into control group A and high-quality care group B. Outcomes noted were severity of infiltration and extravasation of intravenous infusions graded using the Infusion Nurses Society score. Data was analysed using SAS software version 9.4.

Results: Of the 16,268 subjects, 2147(13%) were in control group A and 14,121(87%)were in the high-quality care group B. Group B had lower severity of infiltration and extravasation compared to group A (odds ratio: 0.75; 95% confidence interval: 0.63-0.90). The causes of infiltration and extravasation included agents with high osmolality, poor condition of veins, guardianship negligence and allergies to dressing materials ($p<0.05$).

Conclusion: High-quality care was more effective than routine care in reducing the incidence and degree of infiltration and extravasation of peripheral intravenous infusions.

Keywords: Children, Extravasation, Infiltration, Nurse, Peripheral intravenous infusions. (JPMA 71: 1181; 2021)

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Introduction

In paediatric nursing care, complications of peripheral intravenous (PIV) infusion are common and include infiltrations and extravasations.¹ The Infusion Nurses Society (INS) defines infiltration and extravasation as inadvertent administration of fluid, including vesicants, into the surrounding tissue.² Physical characteristics of children aged 0-3 years, such as small, fragile veins, irritability, and poor verbal skills, are more prominent than in adults, causing difficulties when fixing the intravenous (IV) catheter. In addition, paediatric patients often need IV therapy because of dehydration from fever, vomiting and diarrhoea.³ However, the resultant changes in vascular structure and size always result in a higher incidence of infiltration and extravasation after PIV infusion.

Complications caused by infiltration and extravasation of infusion not only cause unnecessary suffering for the patient, but also increases the length of hospital stay and nursing cost for additional treatment. It also causes permanent injuries and physical limitations in paediatric patients.⁴ To some extent, under-treatment of infiltration and extravasation by nurses is a consequence of management

deficits.⁵ Inpatient paediatric units are increasingly aware that providing safe patient-centred quality of care can reduce pain and improve the well-being of sick children.⁶ With the establishment of the bio-psychosocial models, a patient-centred care (PCC) medical model was proposed⁷ based on the concept of continued care and holistic nursing.⁸ Under this model, high-quality care is widely used in the medical field in line with institutional guidelines.⁹ In brief, nurses are expected to provide PCC through a series of measures, such as clarifying responsibilities and workflow, meeting the basic needs of patients during hospitalisation, ensuring the safety and comfort of patients, effectively implementing a variety of diagnostic and therapeutic measures, and continuously improving professional skills.¹⁰

The current study was planned to explore if the PCC model can effectively reduce the incidence and severity of infiltration and extravasation in paediatric infusions.

Patients and Methods

The retrospective observational study was conducted at the Third Affiliated Hospital, Zunyi Medical University, Guizhou, China, and comprised data of infants aged <3 years hospitalised between January 2013 and September 2019. Those who had received IV injections before hospitalisation and cases with incomplete data were excluded. The study protocol was approved by the institutional review committee, and the condition of informed patient consent was waived in view of the retrospective design of the study.

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The sample was divided into control group A and high-quality care group B. Both groups received routine care. In addition to routine care, group B received specific measures of high-quality nursing which were as follows:

One, hierarchical nursing was conducted according to the nursing staff's seniority, professional title and abilities. Senior nurses were in charge of first-grade critically ill patients or patients with difficult work, and guided low-level nurses. Clear division of responsibilities and work processes were implemented to improve the working efficiency of the nursing staff.

Two, the head nurse monitored the implementation of nurse-quality measures, such as monthly checks on nursing documents, assessment of nursing operations and patient satisfaction. The head nurse also developed training plan for nursing operations to ensure the continuous improvement of the ability of nurses at all levels.

Three, the nurses educated the participants and their guardians throughout the hospitalisation to ensure that they focussed adequate attention towards safeguarding the infusion site.

Fourth, the ward was decorated with multimedia and cartoon stickers to reduce children's agitation. A sign was placed at the head of the patient's bed or on the ground regarding protocols for infusion-site protection.

Fifth, the patency of the catheter and vein were assessed by the attending nurse frequently, including checking

that the secure tape was not too tight; the transparent dressing covered the insertion site; the insertion site was kept clear and visible; and that infusion treatment time and name was marked.

The outcomes were measured using the Infusion Nurses Society (INS) score¹¹ which is a valid and reliable measure to evaluate the degree of infiltration in PIV infusions. Measurements were conducted to assess the grade of peripheral infiltrate by observing the extent of the swelling, pain, warmth, and erythema at the catheter insertion site. The INS scale ranges from 0 'no symptoms of infiltration' to 4 'severe infiltration'. Key variables recorded were age, gender, duration of hospitalisation, diagnostics, and cause of infiltration and extravasation. To ensure data quality, the information recorded was audited daily by the head nurses.

Data was analysed using SAS software version 9.4. Categorical data was presented as frequencies and percentages, and was analysed using Chi-square and Wilcoxon rank-sum tests, as appropriate. Continuous data was presented as means and standard deviation (SD) if normally distributed, and as median values if non-normally distributed. It was analysed using student's t-test, as appropriate. $P < 0.05$ was considered statistically significant. Taking into account potential confounders, ordinal logistic regression analyses were performed to investigate whether high-quality care can reduce the incidence and severity of infiltration and extravasation.

Results

Of the 16,268 subjects, 2147(13%) were in control group A

Table-1: Characteristics of the study sample.

	High-quality care (n=14121)	Routine care (n=2147)	P-value
Mean Age (years)	1.18± 1.13	1.22±0.88	0.058
Males, n (%)	8191 (58.01)	1265 (58.92)	0.42
Mean Hospitalisation days	6.69±2.08	6.68±1.92	0.58
Diagnosis, n (%)			-
Diarrhoea,	1185 (8.4)	240 (11.2)	
Pneumonia	5280 (37.39)	423 (19.70)	
Encephalitis	127 (0.9)	8 (0.3)	
Cardiomyopathy	194 (1.4)	10 (0.5)	
Sepsis	1916 (13.57)	15 (0.7)	
Hand-foot-mouth disease	3636 (25.75)	1266 (59.00)	
Infection, n (%)	141 (1.00)	19 (0.88)	0.73
Agents with high osmolarity, n (%)	82 (0.58)	34 (1.58)	0.000
Vein in poor condition, n (%)	68 (0.48)	28 (1.30)	0.000
Guardianship negligence, n (%)	68 (0.48)	52 (2.42)	0.000
Allergies to dressing materials, n (%)	74 (0.52)	29 (1.35)	0.000
Infiltration and extravasation, n (%)	704 (4.99)	111 (5.17)	<.0001
1 Grade*	221(1.57)	10 (0.48)	<.0001
2 Grade*	342 (2.42)	31 (1.44)	
3 Grade*	107(0.76)	60 (2.79)	
4 Grade*	34 (0.24)	10 (0.47)	

* Grade was evaluated by the Infusion Nurses Society (INS) infiltration scale. SD: Standard deviation.

Table-2: Independent risk factors for infiltration and extravasation.

	B	OR	95%CI	P-value
High-quality care	-0.28	0.75	0.63-0.90	0.0017
Infection	0.094	1.09	0.63-1.86	0.073
Agents with high osmolarity	2.20	9.06	5.72-14.18	< 0.001
Vein in poor condition	0.95	2.58	1.41-4.48	0.0012
Guardianship negligence	2.71	15.06	10.01-22.50	< 0.001
Allergies to dressing materials	1.85	6.37	3.83-10.40	< 0.001

OR: Odds ratio; CI: Confidence interval.

with a mean age of 1.22 ± 0.88 years, and 14,121 (87%) were in the high-quality care group B with a mean age of 1.18 ± 1.13 years. There were 1,265 (58.92%) boys in group A and 8,190 (58%) in group B. There were 704 (4.99) and 111 (5.17) in group A ($p < 0.05$). The difference in severity between the two groups was significant ($p < 0.05$) (Table-1).

Group B had lower severity of infiltration and extravasation compared to group A (odds ratio: 0.75; 95% confidence interval: 0.63-0.90). The causes of infiltration and extravasation included agents with high osmolarity, poor condition of veins, guardianship negligence and allergies to dressing materials ($p < 0.05$) (Table-2).

Discussion

The current study is rare in terms of comparing routine care with high-quality care, and finding that the latter was significantly associated with a lower risk of infiltration and extravasation. The incidence of infiltration and extravasation in the high-quality care group was 5.88%, which is lower than reported by other studies.^{12,13}

In secondary analysis, the co-variables discussed in the current study are representative of some of the major underlying risk factors for infiltration and extravasation events considered in previous studies.^{14,15} According to the results of the current study, the majority of events were due to factors, like agents with high osmolarity, the catheter falling out due to guardian negligence, poor condition of the vein, and allergy to the dressing material.

The current study aimed at minimising the risk of confounding by adjusting for a range of well-established risk factors. However, the study has its limitations, as it was a retrospective study in which bias related to database completeness and measurement bias due to individual variability cannot be avoided. This leads to difficulty in collection information, such as mitigation time of infiltration and extravasation as well as treatment

measures. In addition, infiltration and extravasation with mild symptoms might have been easily overlooked due to inadequate nursing education.

Conclusion

High-quality care for preventing infiltration and extravasation of PIV in children aged <3 years, especially serious leakage prevention, was found to be very effective.

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References

- Legemaat M, Carr PJ, van Rens RM, van Dijk M, Poslawsky IE, van den Hoogen A. Peripheral Intravenous Cannulation: Complication Rates in the Neonatal Population: A Multicentre Observational Study. *J Vasc Access*. 2016; 17:360-65.
- Gorski LA. The 2016 Infusion Therapy Standards of Practice. *Home healthc Now*. 2017; 35:10-8.
- Buyukyilmaz F, Sahiner NC, Caglar S, Eren H. Effectiveness of an Intravenous Protection Device in Pediatric Patients on Catheter Dwell Time and Phlebitis Score. *Asian Nurs Res (Korean Soc Nurs Sci)*. 2019; 13:236-41.
- Helm RE. Accepted but Unacceptable: Peripheral IV Catheter Failure: 2019 Follow-up. *J Infus Nurs*. 2019; 42:149-50.
- Doellman D, Hadaway L, Bowe-Geddes LA, Franklin M, Ledonne J, O'Donnell PL, et al. Infiltration and Extravasation: Update on Prevention and Management. *J Infus Nurs*. 2009; 32:203-11.
- Gerceker GO, Kahraman A, Yardimci F, Bilsin E, Binay S, Ozdemir HNC, et al. Infiltration and extravasation in pediatric patients: A prevalence study in a children's hospital. *J Vasc Access*. 2018; 19:266-71.
- Tanenbaum SJ. What is Patient-Centered Care? A Typology of Models and Missions. *Health Care Anal*. 2015; 23:272-87.
- Barker I, Steventon A, Deeny SR. Association between continuity of care in general practice and hospital admissions for ambulatory care sensitive conditions: cross sectional study of routinely collected, person level data. *BMJ*. 2017; 356:j84.
- Work plan to promote quality care services in 2011. National Health Commission of the People's Republic of China; [Online] 2011 [Cited 2019 October 11]. Available from: URL: <http://www.nhc.gov.cn/cms-search/xxgk/getManuscriptXxgk.htm?id=51078>.
- Simona R. A pediatric peripheral intravenous infiltration assessment tool. *J Infus Nurs*. 2012; 35:243-8.
- Hetzler R, Wilson M, Hill EK, Hollenback C. Securing Paediatric Peripheral IV Catheters-Application of an Evidence-Based Practice Model. *J Pediatr Nurs*. 2011; 26:143-8.
- Atay S, Sen S, Cukurlu D. Incidence of infiltration/extravasation in new-borns using peripheral venous catheter and affecting factors. *Rev Esc Enferm USP*. 2018; 52:e03360.
- Yan YM, Gong M, Chen JL, Li D, Xu TT, Zou H, et al. Incidence, risk factors and treatment outcomes of drug extravasation in paediatric patients in China. *Turk J Pediatr*. 2017; 59:1621-168.
- Lee SU, Jung JY, Ham EM, Wang SW, Park JW, Hwang S, et al. Factors associated with difficult intravenous access in the pediatric emergency department. *J Vasc Access*. 2020; 21:180-5.