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Factors affecting Intravenous Infiltration among Hospitalized Children

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Abstract: Peripheral intravenous (PIV) insertion is one of the most common procedures undertaken for pediatric patients requiring short-term infusion therapy. Infiltration, which considered one of the most common complications of PIV insertion, may cause discomfort, pain, inconvenience or delay in treatment due to reinsertion of the IV catheter, or more serious negative consequences, such as tissue ulceration or necrosis. Such complications have not only increased the length of hospital stay and care costs for additional treatments, but also resulted in permanent damage and limitations of physical functions in pediatric patients. Nurses working at the children' hospitals should consider the risk of IV infiltration for children receiving intravenous infusion therapy and make efforts to identify IV infiltration in high-risk children at an early stage to prevent damage. Therefore, this study aimed, firstly, to investigate the risk factors for intravenous infiltration among hospitalized children and, secondly, to develop clinical guidelines for nurses for early recognition, prevention and management of intravenous infiltration. A descriptive correlative research design was used. The study was conducted at pediatric inpatient medical and surgical wards of Children's University Hospital in Mansoura city, Egypt. The participants werehospitalized children (253) from less than one year to 16 years who received peripheral IV insertions.Interview questionnaire sheet was developed by the researcher to collect relevant data. The results indicated that the infiltration rate was 23.3% and it was from stage 1 and 2. Conclusion: the most important risk factors for infiltration were the child weight, previous experiences of insertion of peripheral catheter, dwell time, site of insertion, catheter size, repeated insertion on the same site, infusion of antibiotics and IV fluids. Recommendation:in future studies, it would be important to account for nurse-associated factors in the study design, including, educational status, experience of the nurses, the nurses' potential preference for a particular insertion site or method and catheter insertion skills.

Key wards:Peripheral intravenous, risk factors, infiltration, extravasation, children

INTRODUCTION

Obtaining peripheral intravenous (PIV) access is a nearly universal procedure for medical management of the hospitalized pediatric patient **(Wilson, 2007)**. This technique is an effective method for the administration of some drugs, and is also used for delivery of drugs to pediatric patients with absorption defects due to diarrhea, dehydration, or peripheral blood vessel collapse. Furthermore, this method is used for pediatric patients who need to maintain a high blood drug concentration, being infected with strains of bacteria with a high resistance to antibiotics and therefore must receive medications through IV insertion for a certain period, and require continuous pain relief **(Walter & Pitter, 2009 and Flippo& Lee, 2011)**.

In children, PIV placement can often be difficult due to the inability to identify peripheral veins .The success of this procedure may be influenced by many factors including the child's age, diagnosis, venous access history, hydration level, vein size and location, depth of subcutaneous tissue, skin pigmentation, and cooperation with the procedure. Delayed or failed PIV insertion may result in an increased risk for complications from the delay in IV treatment **(Fitzsimons, 2001)**.

Peripheral IV insertion is a basic nursing technique, but it is also a complex and technically difficult procedure that needs to be performed successfully within a limited time **(Thomas, 2007)**. It is particularly difficult in children who have thin and weak blood vessels, and move continuously due to the pain associated with insertion. According to a previous study, the success rates of peripheral IV insertion performed on pediatric patients were 42.8% for the first trial, 39.7% for the second trial, 37.5% for the third trial, and 38.8% for the fourth trial **(Peterson et al, 2012)**. These results indicate that the first trial success rate of peripheral IV insertion for pediatric patients is very low compared to that of adults, and the patients consequently become more vulnerable to IV infiltration and extravasation **(Fang, Fang, & Chung, 2011)**. Infiltration, which considered one of the most common complications of PIV insertion, may cause discomfort, pain, inconvenience or delay in treatment due to reinsertion of the IV catheter **(Kim, Lee, & Kim, 2012)**, or more serious negative consequences, such as tissue ulceration or necrosis, which may require a surgical intervention **(Park et al, 2015 and Talbot & Rogers, 2011)**. Such complications have not only increased the length of hospital stay and care costs for additional treatments **(Woody & Davis, 2013)**, but also resulted in permanent damage and limitations of physical functions in pediatric patients **(Park et al, 2015)**.

The literature consistently reports that the pediatric population is at significant risk for infiltrations, and the outcome of such events can be devastating to the child, parents, and health care team **(Doellman et al, 2009; Dychter et al, 2012 and Walsh &Schad, 2012)**. Considering such negative consequences of infiltration, the healthcare providers need to know the various measures that help to prevent or promptly recognize infiltration in order to

reduce the risk of the complications **(Doellman et al, 2009)**. Primary prevention of IV infiltration in the early stage is extremely important and the effort to minimize damage by noticing injury at an early stage is also needed. Specifically to pediatric age group, parent education on a normal site, complaints of IV pain from the child, increased agitation and/or anxiety in the child, or infusion device alarms are all helpful pieces of information the parent can use to alert the nurse to potential issues **(Anson et al, 2010 and Dougherty, 2008)**. Furthermore,well-known strategies include appropriate site selection, use of the smallest-gauge catheter, stabilization and security of an IV needle, confirmation of blood return, and assessment of the IV site **(Infusion Nurses Society, 2011)**.

SIGNIFICANCE OF THE STUDY

The insertion of a peripheral intravascular (PIV) access device is one of the most common invasive procedures performed on hospitalized children to provide therapeutic IV medication. IV infiltration and extravasation (sometimes used interchangeably), are frequently observed in the clinical setting as complications related to intravenous injection. PIV complications were reported at rates as high as 28% in children **(Pettit, 2003)** compared to 8.5% in adults **(Flippo& Lee, 2011)**. Furthermore, infants and children pose challenges to optimal PIV management because of their limited communication abilities, unpredictable behavior and activity levels, and small vessel sizes. IV infiltration can lead to problems like discomfort, the need for reinsertion of the intravenous catheters which associated with pain and anxiety from repetitive failed PIV insertion attempts , or compartment syndrome, which can increase not only the period of hospitalization and medical expenses for treatment but also permanent damage in children. These problems can lead to prolonged hospitalization, increased medical costs, higher mortality, and greater morbidity. Children are particularly vulnerable to these PIV-induced complications. Considering these negative consequences, it is important to prevent these outcomes. Therefore, IV infiltration related factors must be identified to determine high-risk groups and come up with appropriate management strategies.

AIM OF THE STUDY

This study aimed to:

- Investigate the risk factors of intravenous infiltration among hospitalized children.
- Develop clinical guidelines for nurses for early recognition, prevention and management of intravenous infiltration.

RESEARCH QUESTION

What are the risk factors of intravenous infiltration among hospitalized children?

METHODOLOGY

Research design:Descriptive correlative research design was used.

Setting:The study was conducted at pediatric inpatient medical and surgical wards of Children's University Hospital in Mansoura city, Egypt. Data were collected from June to September 2016.At the time of the study, the most common admission diagnoses were complications of congenital heart diseases, gastroenteritis, dehydration, various respiratorytract infections, and common congenital anomalies of gastrointestinal tract.

Subjects of the study:The participants in this study (253) were children from less than one year to 16 years(because the Children's University Hospital not accept the children with age more than 16 years) who received peripheral IV insertions whenhospitalized from June to September.

Age was classified according to the pediatric classification system as less than 1 year of age (infancy), 1–5 years of age (early childhood), 6–12 years of age (school age), and 13–18 years of age (adolescence).In relation to the weight, subjects 2 years of age or younger were classified as underweight when the body weight percentile according to gender and age was 5 percentile or lower and overweight when the percentile was 95 percentile or higher. Subjects over 2 years old were classified as underweight when the body mass index percentile according to gender and age was 5 percentile or lower and overweight when the percentile was 95 percentile or higher **(Buuren&Wouwe,2011)**.

Tools of data collection:

Interview questionnaire sheet was developed by the researcher to collect databased on a review of literature relevant to the problem and by reviewing previous studies**(Wengstrom& Margulies, 2008; Doellman et al, 2009;Groll et al,2010; Jacinto et al, 2011; Martin & Pharm, 2013 ; Park, Jeong, & Jun, 2016 and Anderson et al,2016)**. This tool was measured for content validity by two professors of nursing and three head nurseswho had bachelor degree and worked for over 10 years in the above mentioned setting.The data collection form consisting of 3 parts:-

1. General characteristics: demographics of study participants included age,gender, clinical department, diagnosis and nutritional status.
2. Catheterization specific characteristics or IV infusion related characteristics were duration, site, size of the IV catheterization, and the type of injected drug or fluid.
3. The IV infiltration related characteristics included stage of IV infiltration and type of acquired skin damage(infiltration symptoms). The stage of IV infiltration was scored on a scale of 0 to 4 by using **Infusion Nurses Society (2006) criteria,** where 0 indicated ‘no IV infiltration’ while 1 to 4 indicated the extent of effusion of fluid that had occurred.

Pilot study:

A pilot study was conducted involving 10% of the expected study sample. It was carried out to test the validity of the study tools. Results of the pilot study helped in necessary modification of the study toolsin order to achieve the aims of the study.

Procedures of Data Collection:

- Preparatory phase; a review of the related literature on the various aspect of the problem. This review helped the researcher to be acquainted with the actual

dimension and magnitude of the problem and guide in developing the study tools.

- Prior to data collection, a written permission to conduct this study was obtained from medical and nursing directors in Children's University Hospital in Mansoura City after clear explanation about the aims and expected outcomes of the study.Permission from mothers was also taken verbally after explaining the purpose of the study.Total confidentiality of any obtained information was ensured, and these were to be used only for the research purpose. The rights, privacy and safety of the study sample were secured.
- The actual field work started from June to September 2016. It was started by interviewing the mothers' of children at the above mentioned settings. The researcher started by introducing herself to study subjects (according to their developmental age) or to their mothers and giving them a brief idea about the aim of the study.
- A three-day/weekfrom 9am to 3pmdata collection interval for this study was scheduled within 3 months.
- Each child included in the study was assessed by a prepared questionnaire, data collected by direct interview with child's mother then each child was assessed to detect the stage of IV infiltration.

Statistical analysis:

Statistical Package for the Social Sciences (SPSS) forversion 19.0 was used for data analysis. The data was revised, coded, tabulated, and presented using descriptive statistics in the form of frequencies and percentage for qualitative variables, and means and standard deviations for quantitative variables. One sample t- test was used to test for the association and/or difference between categorical variables.Results were accepted to be statistically significant for $p < 0.05$.

RESULTS

Table 1:Percentage distribution of children according to their general characteristics and its relation with occurrence of infiltration

Items	Frequency	Percentage	Occurrence of infiltration		P value
			No	%	
Age					
▪ <1 year of age (infancy)	43	17.0	16	27.1	**0.014**
▪ 1– 5 years of age (early childhood)	107	42.3	28	47.5	
▪ 6 – 12 years of age (school age)	68	26.9	9	15.2	
▪ 13 –16 years of age (adolescence)	35	13.8	6	10.2	
X ± SD	**5.6 ± 2.4**				
Gender					
▪ Girl	117	46.2	21	35.6	**0.001**
▪ Boy	136	53.8	38	64.4	
Diagnosis					
▪ Surgical	37	14.6	6	10.2	
▪ Respiratory	103	40.7	17	28.8	**0.001**
▪ Gastrointestinal	113	44.7	36	61.0	
Clinical department					
▪ Medical	216	85.4	53	89.8	**0.000**
▪ Surgical	37	14.6	6	10.2	
Nutritional status					
▪ Underweight	73	28.9	35	59.3	**0.001**
▪ Normal	143	56.5	19	32.2	
▪ Obese	37	14.6	5	8.5	
Previous experiences of submitted to peripheral intravenous					
▪ Yes	119	47.0	33	55.9	**0.013**
▪ No	134	53.0	26	40.1	
Total	**253**	**100.0**	**59**	**100.0**	

Table (1): This table shows that more than half of studied children (53.8%) were boys with mean age 5.6 years. Regarding diagnosis, 44.7% of children were admitted with gastrointestinal diseases and the majority of them (85.4%) were inpatient in medical department. In relation to their nutritional status, more than half of them (56.5%) were have normal weight. Finally, more than half of them (53.0%) didn't have previous experiences of insertion of peripheral intravenous.

In relation to the occurrence of infiltration, this table illustrates that the total number of children who have signs and symptoms of infiltration was 59(23.3%) children; 47.5% of them were boys with mean age 5.6 years, about two third of them were boys and had gastrointestinal diseases, the majority of them (89.8%) were in medical department, more than half of them were under weight and had previous experiences of insertion of peripheral intravenous.

Table 2:Percentage distribution of catheterization-specific characteristicsand its relation with occurrence of infiltration

Items	Frequency	Percentage	Occurrence of infiltration		P value
			No	%	
Duration :Catheter dwell time (hours)					
▪ ≤24.0	51	20.1	5	8.5	
▪ 24.1–48.0	43	17.0	26	44.1	**0.002**
▪ 48.1–72.0	128	50.6	20	33.9	
▪ ≥ 72.1	31	12.3	8	13.5	
X ± SD	**59.25 ± 3.5**				
Site of insertion					
▪ Antecubital/cephalic	93	36.7	26	44.1	
▪ Brachial/basilica /upper arm	84	33.2	14	23.7	**0.014**
▪ Wrist/hand/forearm	64	25.3	17	28.8	
▪ Scalp	5	2.0	1	1.7	
▪ Lower extremities	7	2.8	1	1.7	
Catheter sizes (gauge)					
▪ ≤22	82	32.4	13	22.0	**0.001**
▪ 24	171	67.6	46	78.0	
Frequency of catheter insertion on the site					
▪ First insertion	159	62.8	22	37.3	**0.005**
▪ Repeated insertion on the same site	94	37.2	37	62.7	
Fluid & medications administered					
▪ Antibiotics	139	54.9	30	50.8	
▪ IV fluids and other medications	106	41.9	28	47.5	**0.003**
▪ Total parenteral nutrition (TPN)	8	3.2	1	1.7	
Total	**253**	**100.0**	**59**	**100.0**	

Table (2): It is observed from this table that, about half (50.6%) of peripheral catheter dwell time ranged from 48.1 to 72 hours and the site of insertion in 36.7% of children was the antecubital and cephalic veins. The catheter sizes in more than two third of children (67.6%) was 24 gauge and the catheter was inserted on the site for the first time in 62.8%. More than half of children (54.9%) take antibiotics through the peripheral catheter. Furthermore, this table clarifies that, the mean dwell time in 44.1% of children who had infiltration was 59.25 hours and the antecubital and cephalic veins were the common sites of insertion of peripheral catheter. The catheter size in the majority of them (78%) was 24 gauge and more than two third of them (62.7%) had repeated insertion on the same site. The infiltration occurred in 50.8% of children who take antibiotics followed by 47.5% take IV fluids.

Table 3: Percentage distribution of children according to their general characteristicsand IV infiltration related characteristics

General Characteristics of the children	IV infiltration related characteristics			
	Grade 1		Grade 2	
	No	%	No	%
Age				
▪ <1 year of age (infancy)	7	43.8	9	56.2
▪ 1– 5 years of age (early childhood)	11	39.3	17	60.7
▪ 6 – 12 years of age (school age)	6	66.7	3	33.3
▪ 13 –16 years of age (adolescence)	5	83.3	1	16.7
Gender				
▪ Girl	13	61.9	8	38.1
▪ Boy	25	65.8	13	34.2
Diagnosis				
▪ Surgical	2	33.3	466.7	
▪ Respiratory	1055.8		741.2	
▪ Gastrointestinal	1438.9		22 61.1	
Clinical department				
▪ Medical	24	45.3	29	54.7
▪ Surgical	2	33.3	4	66.7
Nutritional status				
▪ Underweight	19	54.3	16	45.7
▪ Normal	11	57.9	8	42.1
▪ Obese	2	40.0	3	60.0
Previous experiences of submitted to peripheral intravenous				
▪ Yes	18	54.5	15	45.5
▪ No	9	34.6	17	65.4

Table (3): This table illustrates that more than two thirds (66.7%) of children aged from 6 to 12 years had infiltration of grade 1 while 60.7% of children aged from 1 to 5 years had infiltration of grade 2. More than two thirds of either boys or girls had infiltration of grade 1. More than two thirds of children diagnosed with surgical or gastrointestinal problems had infiltration of grade 2 and 60.0% of obese children had infiltration of grade 2. 65.4% of children who had infiltration of grade 2 previous experiences of submitted peripheral intravenous.

Table 4: Percentage distribution of catheterization-specific characteristicsand IV infiltration related characteristics

Catheterization-specific characteristics	IV infiltration related characteristics			
	Grade 1		Grade 2	
	No	%	No	%
Duration :Catheter dwell time (hours)				
▪ ≤24.0	3	60.0	2	40.0
▪ 24.1– 48.0	15	57.7	11	42.3
▪ 48.1– 72.0	12	60.0	8	40.0
▪ ≥ 72.1	5	62.5	3	37.5
Site of insertion				
▪ Antecubital / cephalic	17	65.4	9	34.6
▪ Brachial / basilica / upper arm	8	57.1	6	42.9
▪ Wrist / hand / forearm	11	64.7	6	35.3
▪ Scalp	1	100.0	0	0.0
▪ Lower extremities	1	100.0	0	0.0
Catheter sizes (gauge)				
▪ ≤22	9	69.2	4	30.8
▪ 24	31	67.4	15	32.6
Frequency of catheter insertion on the site				
▪ First insertion	15	68.2	7	31.8
▪ Repeated insertion on the same site	23	62.2	14	37.8
Fluids& medications administered				
▪ Antibiotics	8	26.7	22	73.3
▪ IV fluids and other medications	9	32.1	19	67.9
▪ Total parenteral nutrition (TPN)	0	0.0	1	100.0

Table (4): This table clarifies that about sixty percent of children who had peripheral catheter for 72, and inserted in antecubital/cephalic or forearm, had catheter size of 22 and repeated insertion on the same site had infiltration of grade 1, while the highest percentage of children who take antibiotics and total parenteral nutrition had infiltration of grade 2.

DISCUSSION

Most pediatric patients require a peripheral venous catheter (PVC) for the administration of pharmacological and nutritional support, but indwelling PVCs may lead to complications such as infection, thrombophlebitis, infiltration or occlusion. Maintaining optimal function of PVCs is essential because reinsertion is often highly stressful for the child (**Reigart et al, 2012)**.Despite the increasing frequency of IV injections and catheter insertions today, establishing PIV access can be challenging, particularly in pediatric patients **(Dychter et al, 2012)**. Although PVC-related complications may be severe and can cause considerable morbidity, studies investigating such complications in pediatric patients are mostly dated and studies investigating the overall level of complications are rare. The most common PVC-related complication reported in published studies affecting hospitalized children seems to be infiltration, which ranges from 16% to 79.2% (**Gomes et al, 2011; Jacinto et al, 2011)**.It is notable that younger children cannot verbally express discomfort and communicates, for example by physical activities, which by itself may increase the complication risk **(Unbeck et al, 2015)**.Intravenous infiltrates pose tremendous risk for the hospitalized pediatric patient. Infiltrate events prolong the length of hospital stay, cause patients to undergo unnecessary diagnostic procedures and treatments, expose patients and their families to stress, increase workload of medical staff and lead to economic losses **(Abadi et al, 2013)**.So, the aim of this study, firstly, was to investigate the risk factors for intravenous infiltration among hospitalized children. Since, IV catheterization is carried out and followed-up by nurses. For this reason, nurses must know about factors that lead to infiltration, practices that will prevent infiltration and take necessary precautions, and inform patients and their families about IV applications if the treatment is to be continued at home, then the second aim of this study was to develop clinical guidelines for nurses for early recognition, prevention and management ofintravenous infiltration.

In this study, more than half of studied children (53.8%) were boys with mean age 5.6 years. This result is supported with **Sauerland et al, (2006)** mentioned that toddlers were liable to IV infiltration because they were likely to be more active and able to move more freely than infants. The findings are similar to those of both**Silva, (2015**) who observed that most of the children were boys and in the age group of 1 to less than 5 years, and **Anderson et al, (2016)** added that peripheral intravenous catheter was inserted more often in boys than girls and in children with a medical diagnosis compared with surgical children.Furthermore, **Jeong et al, (2017)**found thatthe risk of infiltration was higher in medical children than surgical children.

Whereas the results of the present study are not similar to other studies as illustrated in the following;**Negri et al, (2012)**who study the predisposing factors for peripheral intravenous puncture failure in children, found that, the majority of the children were of school age, not malnourishedand the most important variables for failure of peripheral intravenous punctureare infiltration, were being malnourished and having previously received intravenous therapy.Additionally,**Park, Jeong& Jun, (2016)**who study therisk factors for intravenous infiltration among hospitalized children, found that, the majority (61%) of the study subjects was males with a mean age of 6.3 years and 66.6% of them had a normal body weight.Less than half (40%) of the subjects received treatment for allergies and respiratory system problems.Physiological factors related to the occurrence of IV infiltration were being underweight

and added thatchildren admitted to the surgical ward were less likely to have infiltration. Furthermore,**Silva et al, (2016)**who study the technical and clinical aspects of the utilization of peripheral catheters in children, their results showed the average age of the children was 6 years old.Moreover, **Major & Huey (2016)**who designed and implement a project to decrease the rate of infiltrate occurrences and subsequently decrease harm in the pediatric acute care population, found that, the number of infiltrates that occurred on the medical unit was 11 pre-implementation and 5 post-implementation; surgical unit was 16 pre-implementation and 6 post-implementation. Additionally,**Park et al, (2016)** who conducted a study to investigatethe effect of intravenous infiltration management program for hospitalized children, found that,IV infiltration showed the highest incidence in infants in the comparison group, and in toddlers in the experimental group.

Regardinginfiltration rate, the result of the current study clarified that infiltration rate was 23.3%. This result is agreed with**Sung & Kim, (2007)** where the infiltration rate was 23.7%.While this result in contrast withother research studiesas; 9.3% in**(Kim, 2006)**, 16% in (**Jacinto et al,2011)**, 14.3% in (**Malyon et al, 2014)**, 7.8%in**(Park, Jeong& Jun, 2016)**.The IV infiltration rate for the comparison group was 4.4% and 0.9%for the experimental group (**Park et al, 2016)** and finally, 43.8 % in (**Silva et al, 2016)**.

It was found in this study that, the mean dwell time in 44.1% of children who had infiltration was 59.25 hours. This is confirmed with **Park, Jeong& Jun, (2016)** who found that mean retention time of the intravenous injection was 59.96 hours. **Jeong et al, (2017)** added thatrisk for infiltration was approximately 10% after 72 hours of the IV catheter insertion, and then increased by 1.8–2 times per every 24 hours between 48 and120 hours after the IV catheter insertion.On the other hand, this result is not in line with that obtained by**Malyon et al, (2014)** who found thatmedian catheter duration was 29 h. Moreover, **Park et al, (2016)** stated that the most frequent duration of IV catheterization was 24 to 48 hours.

It is indicated in the literature that repeated use of the same vein may lead to infiltration and it is recommended for this reason that the repeated use of the same vein is avoided if possible and in cases where the repeated use is unavoidable, the proximal of the insertion site should be preferred **(Phillips &Gorski 2014)**. The finding of this study support this recommendation because more than two third of children who had infiltration had repeated insertion on the same site.

This study indicated that theantecubital and cephalic veins were the common sites of insertion of peripheral catheter. The catheter size in the majority of them (78%) was 24 gauges and the infiltration occurred in 50.8% of children who take antibiotics followed by 47.5% take IV fluids especially 5% and 10% dextrose. These results were in accordance withmost studies. **Warren, (2011)** who mentioned that, total parental nutrition, 10–15% dextrose solutions, antibiotics, sodium bicarbonate infusions or blood products and the use of some medications, such as dopamine or adrenaline, can generate tissue damage secondary to infiltration and extravasation.It was found by **Malyon et al, (2014**) that the site of insertion was antecubital fossa.Regarding intravenous therapy, in a study of**Silva, (2015)** 85% of children use of more than two drugs; the infiltration was the predominant complication.**Park, Jeong& Jun, (2016**) reported that the size of 94% of the catheters used was 24-gauge. The insertion site was in the upper limb for 85% of the subjects. The largest portion of subjects (64%) received an infusion of 5% dextrose while 27% of thesubjects were treated with cefotaxime. Moreover, significant device-related factors were retention time and insertion site. Significant drug-related factors were 10% dextrose, high-concentration electrolytes, vancomycin, ampicillin/sulbactam combinations, steroids, and cefotaxime. Similarly, the main conclusion reached on the study of**Silva et al, 2016**was that the incidences of the infiltration are related to the pH of the drugs and the duration of the therapy. Furthermore,**Park et al, 2016** reported that the most common intravenous insertion site was the back of the hand; 24-gauge was used more frequently. The most frequently injected fluid and antibiotics was 5% dextroseand cefotaxime.

Whereas these results not agreed with **Kagel&Rayan (2004)**, it was reported that infiltration was most frequently observed on the back of the hand.**McCullen& Pieper, (2006**) who examined variables associated with extravasation and the resulting tissue damage in neonates with peripheral IV, observed that, the most common medications were TPN and calcium. The sites of the infiltrate were in the arm, foot/leg, and scalp. Similarly,**Jacinto et al,(2011)** conducted a study to compare characteristics of children with peripheral intravenous catheters who developed infiltration and those who did not and to identify risk factors for developing this complication, found that, risk factors in those who developed infiltration were the following: intravenous therapy for more than 5 days, presence of predisposing factors to peripheral venipuncture failure, history of previous infiltration, shorter dwell time and not included the insertion site.It was observed that infiltration was most commonly seen in catheters on wrist **(Anabela et al, 2012 and Phillips &Gorski, 2014)**. In the study of **(Unbeck et al, 2015)** found that, inserting PVCs in the bend of the arm or the ankle were risk factors for infiltration. Additionally, **Silva et al, 2016** added that the metacarpals veins were the most punctured ones, followed by the forearm basilicas. The risk of infiltration was higher in children who had the IV site in their lower extremities (**Jeong et al, 2017**).

In relation to IV Infiltration related characteristics, the present study showedthat the IV infiltration stage was stage 1 and stage 2. This result in supported with the result of **Park et al, (2016)**who found that,the most frequent IV infiltration stage was ‘stage 2’. While this result is not correspondent with **McCullen& Pieper, (2006)** who observed that the two most common stages were stage 0 and stage 4.Furthermore,**Kostogloudis et al, (2015**) found that 2.4% of cases recorded of stage 3.

CONCLUSION

The results of the study indicated that the infiltration rate was 23.3% and it was from stage 1 and 2. The study concluded that the most important risk factors for infiltration were the child weight, previous experiences of insertion of peripheral catheter, dwell time, site of insertion(antecubital and cephalic veins), catheter size, repeated insertion on the same site, infusion of antibiotics (cefotaxe) and IV fluids (as 5% and 10% dextrose).

RECOMMENDATIONS

- Future research should be conducted on a large sample size and in randomized clinical trials.
- In addition, a replication study on children with different characteristics should be conducted to increase the possibility for generalization of the risk factors.
- In future studies, it would be important to account for nurse-associated factors in the study design, including, educational status, experience of the nurses, the nurses' potential preference for a particular insertion site or method and catheter insertion skill.
- Researchers and practitioners must continue to search for the best evidence to reduce PIV complications in children.

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APPENDIX A

CLINICAL GUIDELINES FOR RECOGNITION, PREVENTION AND MANAGEMENT OF INTRAVENOUS INFILTRATION

INTRODUCTION

Peripheral intravenous (PIV)catheters are the most commonly used intravenous device in hospitalized pediatric patients. It is primarily used for therapeutic purposes such as administration of medications, fluids and/or blood products. Despite the increasing frequency of IV catheter insertions today, establishing PIV access can be challenging, particularly in pediatric patients. Maintaining optimal function of PIV is essential because reinsertion is often highly stressful for the child. Infiltration is considered one of the most common complications of PIV insertion, which ranges from 16% to 79.2%. Intravenous infiltrates pose tremendous risk for the hospitalized pediatric patient. Infiltrate events prolong the length of hospital stay, cause

patients to undergo unnecessary diagnostic procedures and treatments, expose patients and their families to stress, increase workload of medical staff and lead to economic losses.

AIM

The aim of this clinical guideline is to provide an outline for nurses to help them for early recognition, prevention and management of intravenous infiltration.

Definition of infiltration and extravasation

Infiltration is the inadvertent administration of a non-vesicant solution or medication into the tissue surrounding the intravenous (IV) catheter. A vesicant is an agent that has the potential to cause varying degrees of localized tissue damage when leaked or inadvertently administered into the tissue.

Extravasation is an unintentional injection or leakage of fluid in the perivascular or subcutaneous space. Extravasation is the inadvertent administration of a vesicant into the surrounding tissue instead of the intended vascular pathway.

Factors Associated With an Increased Risk of Infiltration and Extravasation

Device related factors:

- Use of metal "butterfly" needle
- Catheter size and type

Clinician related factors:

- Lack of IV insertion skills
- Multiple attempts at cannulation
- Lack of blood return before infusion
- Probing during IV insertion
- Interruptions/distractions during administration
- Inadequately secured needle or catheter
- Placement in an undesirable location
- Unfavorable cannulation site (Antecubital fossa, Dorsum of hand, Wrist, Areas of flexion/movement-prone areas)

Patient related factors:

- Age (very young or elderly)
- Hard or sclerosed veins
- Small and / Fragile veins
- Impaired communication or altered sensory perception
- Sedation/somnolence
- Impaired cognition/altered mental status
- Unconscious/use of general anesthetics /comatose
- Patient movement (vomiting, coughing, stretching, seizures)

Medications related factors

- **Bolus injection/ High flow pressure**
- **Anti-infective (antibiotics)**

  Acyclovir, Amikacin, Amphotericin B, Dicloxacillin, Nafcillin, Oxacillin, Vancomycin
- **Electrolyte solutions**

  Calcium chloride, Calcium gluconate
  Parenteral nutrition, Potassium chloride
  Sodium bicarbonate, Sodium chloride > 0.9%
- ***Vasopressors***

Dobutamine, Dopamine, Epinephrine, Norepinephrine

- ***Miscellaneous***

Aminophylline, Chlordiazepoxide, Contrast media, Dextrose ≥ 10%

Diazepam**,** Digoxin**,** Doxapram**,** Intralipids**,** Mannitol**,** Phenytoin**,** Promethazine**,**Urea

Signs and symptoms of infiltration (The scale of infiltration)

Infiltration Grade	**Infiltration Symptoms**
Grade 0	▪ No symptoms
Grade 1	▪ Skin blanched ▪ Edema less than 1 inch in any direction ▪ Cool to touch ▪ With or without pain
Grade 2	▪ Skin blanched ▪ Edema 1 to 6 inches in any direction ▪ Cool to touch ▪ With or without pain
Grade 3	▪ Skin blanched, translucent ▪ Gross edema greater than 6 inches in any direction ▪ Cool to touch ▪ Mild to moderate pain ▪ Possible numbness
Grade 4	▪ Skin blanched, translucent ▪ Skin tight, leaking ▪ Skin discolored, bruised, swollen ▪ Gross edema greater than 6 inches in any direction ▪ Deep pitting tissue edema ▪ Circulatory impairment ▪ Moderate to severe pain ▪ Infiltration of any amount of blood product, irritant, or vesican

PREVENTION

SITE SELECTION

- Appropriate site selection to minimize the number of needle sticks the child must undergo in the course of I.V. line placement.
- Start by choosing a vein suitable for the therapy. Choose a vein that feels smooth and resilient, not one that's hard or cordlike.
- Avoid areas of flexion because movement can dislodge the catheter. If you must choose a site near an area of flexion, use an arm board directly adjacent to areas of flexion.
- The veins of the forearm, especially on the inner aspect are usually a good choice. Forearm bones act as a natural splint to support the site, providing stability.
- Start as low on the forearm as possible (avoid any site below a recent venipuncture in the same vein), but don't use veins on the volar aspect of the wrist because they lie close to nerves.
- Avoid using the inner aspect of the elbow (the antecubital fossa) to administer I.V. therapy. An infiltration in this area is difficult to detect until it becomes quite large. Fluid infiltrating the antecubital fossa could compress important structures in the area, such as the brachial artery and median nerve, causing nerve damage or tissue necrosis.
- Insertion should be avoided near joints because it may not only increase the risk of complications; they may also be uncomfortable for the child and reduce mobility.
- Avoid insertion site in the children's right arm and hand, which is usually dominant. The child's play and learning experiences during the hospital stay can be affected if the dominant arm or hand is used for PVC insertions (dominant hand develops around 3 years)

TECHNIQUE OF INSERTION

- Asepsis principles are strictly followed during peripheral IV catheterization,
- Use of the smallest gauge catheter is also recommended to allow optimal blood flow around the catheter within the vein.
- To maximize hemodilution of the medication, choose the smallest possible I.V. catheter that will safely deliver the infusion. This will allow blood flow to dilute the infusate and carry it away from the insertion site.
- Insert the I.V. device with its bevel facing up to reduce the risk of puncturing the vein's opposite wall.
- The use of the same arm is avoided when reinserting catheters. The repeated use of the same vein is avoided if possible and in cases where the repeated use is unavoidable, the proximal of the insertion site should be preferred
- Injury to the vein wall during insertion has been cited as a contributing factor for infiltrations.
- Use of a keep vein open (KVO) rate as a protective measure to maintain the patency of an IV cannula

IV SECUREMENT METHOD /CATHETER OR CANNULA STABILIZATION

- Proper securement of a peripheral device is imperative to prevent dislodgement and trauma to the vessel wall. Transparent, semi-permeable dressings must be used to promote visualization of the site, to reduce complications, prevent catheter dislodgement, and prolong dwell times.
- Dressings to IV sites are the first line of defense against infections and must be kept secure, clean and dry.
- The type of secure dressing for the IV cannula depends upon the child's age, condition of the skin, site of the IV, child's activity and/or or mobility.
- Consider placing a small piece of cotton wool ball or gauze underneath the hub of the cannula to reduce pressure.
- Cover the cannula site with sterile transparent semipermeable occlusive dressing placed aseptically over the catheter.
- If desired, place sterile tape over the hub and wings of the device before placing the transparent dressing.
- IV board / splints are recommended to secure IV cannula placed in or adjacent to areas of flexion. This will adequately immobilize the joint and minimize the risk of venous damage resulting from flexion.
- When using splints, ensure these are positioned and strapped with the limb and digits in a neutral position to prevent restricting blood or nerve supply and pressure sores.
- Inspect the splint at least daily and change if soiled by blood or fluid leakage.
- Cover with gauze or non-compression tubular bandage
- When using non compression tubular bandage, ensure there is a clear window where the cannula enters the skin so the site can be viewed
- When dressing a peripheral IV cannula ensure:
- it is secure, but not too tight.
- the site is visible
- the child can't injure themselves on the connections
- the child can't remove or dislodge the cannula
- Change the dressing only if it becomes insecure or if there is blood or fluid leakage.

SITE ROTATION/I.V. ADMINISTRATION SET CHANGES

- Peripheral catheters now routinely dwell for 72 hours, as long as they're free from observable complications.
- Restart or remove a peripheral I.V. catheter if the patient complains of discomfort or pain related to the catheter that can't be corrected, or if the site develops complications.
- Change administration of IV sets every 72 hours.
- Blood administration sets should be replaced with every unit of blood (or every 4 hours, whichever comes first), but parenteral nutrition tubing for infusions without fat emulsions should now be changed every 72 hours. Replace parenteral nutrition tubing used to administer fat emulsions every 24 hours.

ASSESSING THE SITE

- After establishing a peripheral I.V. access, assess the insertion site using the infiltration scale every 1 or 2 hours for a child receiving a continuous infusion.
- Assess the IV site at least every hour for neonates and pediatric patients on continuous infusion and every 5 to 10 minutes for those who receive infusions of vesicants or vasoconstrictive agents.
- Make sure the site is easily visible by covering it with a clear, moisture-vapor transmissible dressing.
- Palpate around the site for tenderness or coolness and swelling. Pick up the patient's arm to check for dependent edema.
- Frequent assessment of IV site for redness, tenderness, swelling, numbness, or tingling on the regular basis
- Assess the IV site at least per every shift. In addition to that, they instruct the patient and his/her caregiver about the infiltration risk by providing educational materials and encourage them to notify nurses if the patient shows any infiltration sign or symptoms such as pain, burning or change in sensation at the IV site, or fluid leaking on the skin by frequently observing the site of IV insertion
- Pediatric nurses are required to assess the IV site at least every hour after 72 hours of catheter dwell time for infusion of non-irritants, and after 24 hours for infusion of irritants for safer IV therapy

WATCH FOR THESE SIGNS

To avoid problems, be alert for common signs and symptoms of I.V. infiltration, which include:

- skin that looks blanched, firm, or stretched or that the patient says feels "tight"
- edema at the insertion site
- cool skin temperature
- discomfort
- slowing or stopped gravity infusion
- I.V. fluid leaking out of the insertion site or from under the dressing
- a tourniquet applied above the I.V. insertion site that doesn't stop fluid from infusing
- no visible blood returns when the infusion bag is lowered and you apply pressure on the vein proximal to the tip of the cannula. (Note: Blood return doesn't rule out infiltration.)
- Discomfort or burning while an irritant or vesicant is being administered may indicate damage to the vessel.
- Additionally, patient and family education can play a vital role in early recognition and limiting tissue injury. Parent education on a normal site, complaints of IV pain from the child, increased agitation and/or anxiety in the child, or infusion device alarms are all helpful pieces of information the parent can use to alert the nurse to potential issues.

MANAGEMENTS

- When infiltration or extravasation occurs, it is important for the nurse to estimate the volume of infiltrated fluid on the basis of the hourly flow rate and the length of time the problem has been evident and to document it.
- Nursing interventions for infiltration or extravasation include elevation of the affected limb and application of cold (for infiltration or extravasation of hyperosmolar fluids) or heat (for extravasation of alkaloids).
- Elevation of the affected limb may aid in reabsorption of the infiltrate or extravasated vesicant by decreasing capillary hydrostatic pressure.
- The use of local warming therapy (dry heat) is based on the theory that it increases vasodilation, thus enhancing dispersion of the vesicant agent and decreasing drug accumulation in the local tissue.
- Consider a complaint of pain to be a warning signs that extravasation may occur and should take these steps:
- turn off the infusion
- start an I.V. line in the other arm if not contraindicated
- follow your facility's policy for treating an infiltration or extravasation. For example, for an infiltration you may need to remove the line and apply warm or cool compresses; for an extravasation, you may need to administer an antidote before you remove the I.V. line.

ACT FAST WHEN PROBLEMS OCCUR

- If you discover that an I.V. line has infiltrated or extravasated, stop the infusion and thoroughly examine the site.
- After removing the catheter, elevate the affected arm if it makes the patient more comfortable and apply cool compresses (or warm compresses, if alkaloids are involved).
- If the patient develops blistering, which may occur 48 to 96 hours after the injury, he may need to be examined by a plastic surgeon or the wound care service.

DOCUMENTING THE PROBLEM

- Follow your facility's guidelines for documenting infiltration or extravasation.
- Take pictures and take exact measurements of arm circumference or the area of infiltration or extravasation.