Original Article

Vancomycin Infusion Methods on Phlebitis Prevention in Children

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Abstract

Background: Hospitalized children require antibiotic therapy. The most common side effect of intravenous injections is Phlebitis. Due to high usage of Vancomycin in children and subsequent phlebitis in their intravenous lines, the current study aimed at comparing the effects of two intervention and routine vancomycin infusion methods in preventing phlebitis in hospitalized children. **Materials and Methods:** The current study is a quasi-experimental study investigating 74 individuals between ages of 1 month and 6 years undergoing treatment using vancomycin. First, 37 children, hospitalized in internal medicine ward of Isfahan Paediatrics' Hospital, Iran with vancomycin infusion orders, were placed in control group, and another 37 children were placed in the intervention group through matching with control group. The intervention group used phlebitis prevention guidelines, created by the authors, while control group used routine infusion method of the hospital. Data were analyzed by SPSS software, and statistical significance was set at 5%. **Results:** The occurrence of phlebitis was 45.90% in intervention and 89.10% in control group. Results showed that the frequency of phlebitis in intervention group was significantly lower than control group (χ^2 = 15.79, df = 1, p < 0.001) and the average time of phlebitis onset in control group was also significantly lower than that of the intervention group (t_{72} = 2.99, p = 0.004). **Conclusions:** According to the results, intervention vancomycin infusion method is more effective in reducing phlebitis as a result of intravenous catheter, compared to the routine vancomycin infusion method.

Keywords: *Hospitalized child, intravenous infusion, Iran, phlebitis, vancomycin*

Introduction

Bacterial infections are one of the main causes of infectious diseases and one of the major causes of death worldwide.[1] One of the standard medicines used for treatment of infections is vancomycin.

However, due to its relatively small number of side effects, compared to similar medicines, vancomycin is a common and widespread treatment for he diseases, caused by Gram-positive bacteria in children and infants.[2] Use of an intravenous catheter is one of the most common aggressive treatment methods, used in hospitals.[3] Although this treatment is a common, technically difficult and aggressive practice, often nursing staff lack the necessary trainings in this method.[4]

Intravenous injection is a common treatment practice in children.[5] Phlebitis is one of the common complications of injections by intravenous catheters,[6] which can occur in around half of the patients and is a potential risk for deadly infections[7-9] In many cases, after administration of intravenous medicines, the used vein suffers from an inflammation, which is seen as local heat and reddening of the vein, burning, dead pain, decrease in blood flow and hardening of vein walls. This phenomenon is known as Phlebitis.[10] Phlebitis is among the most important adverse effects of intravenous catheters. This preventable complication, if ignored, can lead to cardiovascular and respiratory risks. In case of Phlebitis, the catheter should be removed.[11] Phlebitis, along with its own risks and the possibility of clotting and thrombophlebitis and embolism, can also reduce the life of venous cannulas.[12] Furthermore, phlebitis leads to complications such as pain, sepsis, prolonged hospitalization and an increase in medical costs. Phlebitis can also lead to physical, psychological, social, and financial problems.[13] Phlebitis is a potentially

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hazardous source of systemic infections that increases the risk of systemic infections up to 8 folds. Therefore, phlebitis increases the length of stay in the hospital and in some cases, it can lead to death in the patients.[14]

However, in the study of Mohammadi *et al*. with the administration of vancomycin in the intensive care unit, the number of vancomycin days were 294 to 178 days per 1,000 days, the average length of stay varied from 11.4 days to 8.4 and the mortality rate also fell from 2.10% to 7%.[15] SalgueiroOliveira *et al*., in their study, showed that the occurrence of phlebitis was 11.9%, and with antibiotic use (Odds ratio = 1.87), the patients had a higher risk of phlebitis.[16] Helm *et al*. in their 2015 study reviewed all studies between years 1990 and 2014. Their results showed that the reported prevalence of phlebitis varied between 0.1 and 63.3%.[17] Their results in Iran reported phlebitis prevalence of 69% in Sanandaj,[18] and 88.6% in Isfahan.[19] However, according to the guidelines of American Nursing Association, only a prevalence of 5% or lower is acceptable.[20] Therefore, the current study focuses on phlebitis complications during routine infusion and intervention method which contains suitable protocols for reducing phlebitis in children under vancomycin treatment. Clinical guidelines help physicians, nurses, and patients in decision-making and prepare them for successful implementation of treatment process. Clinical guidelines can also help prevent the errors and malpractice, caused by unnatural, undesirable or unpredictable conditions while reducing additional costs.[2] Since literature review revealed no previous guidelines, related to infusion of vancomycin, we aimed to prepare a vancomycin infusion guideline, related to preventing phlebitis in hospitalized children based on available articles and pharmacology books.

Materials and Methods

The current study is quasi-experimental with two groups, carried out to compare the effect of two routine and intervention vancomycin infusion methods on phlebitis prevention in hospitalized children in Imam Hossein Hospital, Isfahan, Iran, from March to July 2017. First, 37 children, hospitalized in 8 internal medicine wards of Isfahan Paediatrics' Hospital, Iran with vancomycin infusion orders, were placed in control group and another 37 children were placed in the intervention group through matching with control group (gender, branula size, and hospitalization history, use of other medicines, using upper limb, and hydration before injection). The study population consisted of 74 children undergoing treatment using vancomycin who were selected by convenient sampling. Given the large size of the population and limited time, sampling from population was carried out by the following equation with confidence limit of 95% ($\alpha = 0.95$), and test power of 80% ($\beta = 0.80$) through relative frequency of P1 = 50% in the base group and relative frequency of P2 = 20% in the intervention infusion group. By this method, 37 patients were placed in control group and 37 patients were placed in the intervention group. Data gathering tool was a checklist including parts for recording personal information and intravenous line conditions. In order to increase scientific credibility, by considering research variables, articles and books, published on this topic as well as the opinions of supervisor and consulting with the faculty members, an initial checklist was created. Quality, content, and the validity of this checklist were confirmed by faculty members. The inclusion criteria for this study were prescription of vancomycin, children between ages of 1 month and 6 years, obtaining a written consent, venepuncture in peripheral vessels, use of intravenous catheters for at least 72 hours. The exclusion criteria of the study were occurrence of acute and emergency conditions, discharging or death, unsuccessful venepuncture in peripheral vessels and the necessity of a central catheter.

Data were gathered based on research aims by the researcher or three educated assistants. First, personal information was gathered before observing the condition of intravenous line before and after intervention and recording the acquired data in the checklist (educated assistants). Checklist questions included the use of upper-extremity veins, checking for dehydration before infusion, final infused vancomycin concentration, not using medicines incompatible with vancomycin, washing with saline solution before infusion, length of infusion, and phlebitis symptoms in days one to three after venepuncture. In order to homogenize the conditions, venepuncture was carried out in both groups by similar tools for stabilizing the limb and the same brand of intravenous catheter (B Brown), made in Germany. In the study group, first, 37 patients were placed in the control group in which a 500 mg vial of vancomycin was diluted with 10 mL of saline solution and the required dosage after dilution was infused during a 30-minute time period. The vein was checked before and after infusion, and the checklist was filled in case of observing phlebitis symptoms (pain, tenderness, erythema, swelling, and palpable venous cord) before quickly replacing the line and finishing the study for that patient. Based on visiting order and inclusion criteria, vancomycin infusion in the intervention group included using upper limb vasculature (preferably brachial) for venepuncture, investigating intravenous line location after each infusion, infusion method including adding 10 mL of sterilized distilled water to a 500 mg or 20 mL of sterilized distilled water to a 1 g vial in order to reach the concentration of 50 mg/ml. Each 500 mg of vancomycin is diluted with 100 mL of saline or dextrose before being infused using Micro set timer (total volume of liquids received was deducted from the volume of received serum).

In this method, the final concentration is equal to or lower than 5 mg/ml.[21] Infusion is carried out in 60 minutes (or 90 minutes for a 1 gram dose). Before vancomycin

infusion, the line was washed using saline solution[22,23] and no other drugs were infused or mixed with vancomycin simultaneously through the use of a T-junction.[22] Before the start of the infusion, the child was checked for dehydration symptoms and if such symptoms were observed, they were treated with the help of a physician before the infusion.[23] The collected data were analyzed by descriptive and inferential statistics, including Chi-square test and independent t-test in Statistical Package for the Social Sciences software (version 18.0, SPSS Inc., Chicago, IL, USA).

Ethical considerations

This study was approved by the Research Ethics Committee of the Isfahan University of Medical Sciences, Isfahan, Iran. Moreover, written informed consent forms were obtained from the parents of the subjects and they were assured of the confidentiality of their information and statements, their freedom to participate in the treatment sessions and leaving the sessions if unwilling to continue without paying for the sessions fee. This article was derived from a nursing master dissertation. Its ethics code is mui. Rec. 1396.3.018.

Results

According to the results, there were no significant demographic differences between control and intervention groups. The results showed no statistically significant differences in frequency distribution of gender (p = 0.81), branula size (p = 0.48), and hospitalization history (p = 0.45) between control and intervention groups [Table 1], but showed a significant difference in distribution of different infusion conditions between control and intervention groups (p < 0.001) [Table 2]. In a total of three days, the prevalence of phlebitis was 45.90% in the intervention group and 89.10% in the control group. The results of Chi-square test showed a significant difference in phlebitis prevalence between control and intervention groups [Table 3]. Independent t-test results showed that the average onset time of phlebitis in the control group was significantly shorter, compared to intervention group (p < 0.05) [Table 4]. In other words, phlebitis in the control group patients occurred faster, compared to intervention group.

Discussion

The results of the current study showed that the incidence of phlebitis in control and intervention groups were 89.10 and 45.90% respectively. This means that the intervention was successful in reducing the occurrence rate of phlebitis by almost 50%. However, the occurrence rate of phlebitis, reported in other studies, is lower. The study by Helm *et al*. showed that the occurrence rate of phlebitis varies between 0.1 to 63.3%in control and intervention groups in patients receiving liquid treatments. The incidence varies so widely because of the technique applied.[17] The results of studies by Salehmoghadam *et al*. showed that phlebitis occurrence rate

Table 1: Frequency distribution of gender, branula size, and hospitalization history between two groups

Variable		Intervention		Control		df	χ^2 (p)
		Frequency	Percent	Frequency	Percent		
Gender	Girl	15	40.50%	16	43.20%	1	0.60 (0.81)
	Boy	22	59.50%	21	56.80%		
Branula size	24	18	48.60%	15	40.50%	1	10.43 (0.48)
	22	19	51.40%	22	59.50%		
Hospitalization history	Yes	13	35.10%	10	27.00%	1	10.57 (0.45)
	No	24	64.90%	27	73.00%		

df: Degree of freedom, χ^2: Chi-Square test

Table 2: Distribution of different infusion conditions

Group infusion conditions	Intervention		Control		df	χ^2 (p)
	Frequency	Percent	Frequency	Percent		
Using upper limb vasculature	37	100%	16	43.20%	1	29.32 (<0.001)
Vein puncture by the researcher	37	100%	37	100%	1	(1)
Proper use of splints for limb immobilization	37	100%	37	100%	1	(1)
Controlling child's hydration before injection	36	97.20%	9	24.30%	1	41.34 (<0.001)
Informing physician about dehydration if present	37	100%	16	43.20%	1	29.32 (<0.001)
Final injection of vancomycin with concentration ≤5 mg/mL	37	100%	12	70%	1	70.10 (<0.001)
Lack of simultaneous use of other medicines incompatible with vancomycin	37	100%	25	25.40%	1	66.41 (<0.001)
Washing the line with saline solution before injection.	37	100%	4	10.80%	1	59.56 (<0.001)
Infusion in 60 minutes (90 minutes for 1 gram dose)	37	100%	0	0.00%	1	74.00 (<0.001)
Investigating phlebitis symptoms before and after infusion	37	100%	2	5.40%	1	66.41 (<0.001)
Checking for allergic reactions at the line location	37	100%	1	2.70%	1	(0.50)

df: Degree of freedom, χ^2: Chi-Square test

Table 3: Phlebitis prevalence in two groups

Time	Intervention		Control		df	χ^2 (*p*)
	Frequency	Percent	Frequency	Percent		
First day	0	0.00%	9	24.30%	1	(<0.001)
Second day	6	16.20%	14	37.81%	1	4.38 (0.04)
Third day	11	29.71%	10	27.00%	1	10.07 (0.80)
Total	17	45.91%	33	89.11%	1	115.79 (<0.001)

df: degree of freedom, χ^2: Chi-Square test

Table 4: Mean time of phlebitis in two groups

Variable	Mean (SD)		df	*t* (*p*)
	Intervention	Control		
Time	2.64 (0.49)	2.03 (0.76)	72	2.99 (0.004)

SD: Standard deviation, df: degree of freedom, *t*: Independent *t*-test

was 32.1% in control group and 10.7% in intervention group, which reveals statistically significant changes.[24] These results are in agreement with the results of the current study.

The results of the current study showed that the occurrence rate of phlebitis increased from the first to the second and third days in both control and intervention groups. However, the occurrence rate of phlebitis in the third day showed no significant differences between control and intervention groups. In general, the frequency of phlebitis in intervention group was significantly lower than that of the control group. The results reported by Borzou *et al*. regarding the onset time of phlebitis showed that in 23.9% of cases, phlebitis symptoms occur in the first 24 hours, 41.9% after 48 hours, 20.9% after 72 hours and 12.4% after 96 hours.[25] The results of their study regarding the retention time of the catheter are similar to the results, observed in the current study. The results of a study by Fadakarsougheh *et al*. showed that phlebitis was observed in 89% of cases, the majority of which (43%) occurred in the second day after catheter installation. They also reported a statistically significant relation between phlebitis and use of branula.[26] The results reported by Ramaei *et al*. showed that patients who used catheter for less than 24 hours had the least amount of phlebitis symptoms. On the other hand, patients using catheter for 25 to 48 hours suffered from second degree phlebitis while the patients, in whom 49 to 72 hours had passed since insertion of angiocath, suffered from the third and fourth degree phlebitis.[18] These results are in agreement with the results of the current study.

In the current study, 16.20% of phlebitis cases occurred in the second day after infusion, and only in children, 29.70% of phlebitis symptoms were observed after 72 hours. The results of study by Helm *et al*. indicated that phlebitis prevalence increases when more time passes since catheter insertion.[17]

The majority of phlebitis cases in the current study occurred 24 to 48 hours after catheter insertion while the study by Fadakarsougheh *et al*. reported that the majority of phlebitis cases occurred in the second day after catheter insertion[26] which is compatible with the current results. Premature and repeated catheter changes not only increase the cost of the treatment for the patient and healthcare system but can also lead to more physical and metal damage to the patients and their families and make patients more vulnerable to other infections. Repeated catheter changes also waste the time of medical and nursing staff. Furthermore, phlebitis itself is the source of many potentially dangerous and systematic infections and can increase the change of infection.[27] On the other hand, changing the intravenous catheters, inserted in peripheral veins every 72 hours, minimizes the risks of infections related to catheter.[28,29]

The results of the current study showed that the average onset time of phlebitis in the control group was significantly shorter than that of intervention group. In other words, the onset of phlebitis in control group was faster, compared to intervention group. Results from this study add information to the body of knowledge on nurses` perceptions about a solution to prevent the occurrence of premature phlebitis in children under treatment with vancomycin. However, some limitations should be noted. The use of a convenience sampling method, subjects drawn only from the internal medicine ward of Isfahan Paediatrics Hospital and individual differences in children with phlebitis limited the generalizability of the findings. Future studies should recruit larger random subjects from children in different settings and across a broader geographical area.

Conclusion

The findings of the current study showed that the new method is more effective than the routine vancomycin infusion method and can prevent the onset of phlebitis, especially in the second day after catheter insertion. The onset of phlebitis in the intervention vancomycin infusion method was also slower, compared to the routine infusion method. Therefore, the results indicated that the new method could be suggested as a way to reduce phlebitis occurrence during vancomycin infusion.

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Conflicts of interest

Nothing to declare.

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