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Original Article

Risk factor for phlebitis: a questionnaire study of nurses' perception

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Objectives: to assess nurses' perceptions of risk factors for the development of phlebitis, with a special focus on the perception of phlebitic potentials of some infusion medications and solutions. Method: a cross-sectional questionnaire study, which included a sample of 102 nurses. Results: Nurses recognized some factors that may reduce the incidence of phlebitis; however, more than half of the nurses were unaware that the material and diameter of the cannula can affect the incidence rate of phlebitis. Furthermore,underlying disease and high pH of medications or solutions were identified as potential risk factors, whereas low pH and low osmolality were not. Nurses identified Vancomycin and Benzylpenicillin antibiotics with the strongest phlebitic potential. Among other medications and intravenous fluids, Aminophylline, Amiodaronehydrochloride and Potassium chloride 7.4% were identified as potentially causing phlebitis. Conclusion: predisposing factors for phlebitis relating to patients and administered therapy were identified by nurses, while some cannula related risk factors, in particular its physicochemical properties and the time for cannula replacement, were not fully perceived.

Descriptors: Phlebitis; Infusions, Intravenous; Risk Factors; Nurses; Questionnaires.

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Introduction

Phlebitis (mechanical, chemical and bacterial) is a common local complication of peripheral intravenous therapy administered through a peripheral venous cannula[1]. According to the standards of the Infusion Nurses Society (INS), the accepted phlebitis rate is 5% or less[2]. However, research findings suggest that there is a significant discrepancy in reported incidence. Thus, Webster cites that the phlebitis rate ranges from 2.3% - 67%[3].

No generally accepted classification of predisposing factors for phlebitis exists. A large number of risk factors have been identified in various studies, and they can be classified as those relating to: patients, cannula, administered therapy, and other factors[1,4].

Most common patient-related risk factors include: age, gender, and associated diseases. Incidence of phlebitis increases with age; with most studies showing that obvious signs of phlebitis were present in approximately 50% of patients over the age of 60[5]. Although most studies suggest that phlebitis is more prevalent in women, there is still no satisfactory explanation for such findings[6-7]. Furthermore, conditions that impair circulation(e.g., peripheral vascular disease, and smoking status), and conditions that cause lack of sensation (peripheral neuropathy) increase the risk of phlebitis. Other associated diseases, especially diabetes, can contribute significantly to the occurrence of phlebitis[5].

Physicochemical properties of the peripheral venous cannula (PVC) material and its size affect the development of phlebitis[3].The results obtained in the study conducted by Maki and Ringer[8] indicate that the incidence of phlebitis following the use of PTFE (Teflon®) cannulas is 30 % higher than following the use of Vialone (Vialone®) cannulas. Choosing an inadequate cannula diameter can increase the rate of phlebitis, and the risk rises with increasing diameter[5-6]. A smaller diameter PVC that accommodates the patient's veins and prescribed therapy minimizes the risk of phlebitis[9-10]. Proper stabilization and securing of the insertion site can significantly reduce the risk of phlebitis, and other phlebitis-related complications[11-13]. The risk of mechanical phlebitis is significantly lower with a proper primary (proximal) and secondary (distal) stabilization of the cannula[14]. Most current standards and best-practice guidance indicate that PVC replacement should be considered every 72-96 hours[9,15]. Results of the previous studies show that the incidence of phlebitis increases three or four days after PVC insertion[8], or when a cannula is inserted in an antecubital vein[5,16] or wrist region[8].

There is a significant risk of the development of chemical phlebitis if the pH and osmolality in the medications and solutions are different in relation to their values in the blood[17]. Hypertonic solutions with an osmolality greater than 450mOsm/l and those with a pH of less than 5.0 are associated with the frequent occurrence of phlebitis[4-5,18]. The use of antibacterial medications, primarily from the beta-lactam group, may also increase the risk of chemical phlebitis[18].

One of the major risks for phlebitis incidence is related to the placement and maintenance of a PVC by insufficiently trained staff and staff with less work experience[19].

Intravenous therapy is an integral part of professional nursing practice in all healthcare institutions in Serbia and Croatia. A nurse should possess required knowledge and skills for setting up and maintaining IV equipment, the patient's venous system, as well as knowledge of the physicochemical characteristics of the administered medications. Given that intravenous therapy is often accompanied by complications, phlebitis being among the most common, nurses have a responsibility to minimize this incidence, at the same time ensuring that patients receive treatment in an appropriate and timely manner.

Nurses' knowledge and early recognition of risk factors for the development of phlebitis can reduce complications. This improves the quality of care, patient safety, patient satisfaction ratings, and at the same time reduces length of hospital stay and the overall cost of health care.

Therefore, the aim of this study was to assess the nurses' perception of risk factors relating to the patient, cannula and administered therapy, with a special focus on the perception of phlebitis potentials of some medications and solutions.

Method

The study was conducted in three health care institutions in Serbia and Croatia (Novi Sad, Niš and Osijek, respectively), using a cross-sectional, questionnaire method, in September of 2012.

A modified questionnaire of Lanbeck et al.[20] was used as the survey instrument. As it was not copyrighted, permission was not necessary in order to use and modify some of their items for our study. Modification included the expansion of the questionnaire with the questions

related to risk factors, such as the choice of antiseptic agents, syringe cleaning agents and use of infusion pumps, as well as revision of the questions related to the material of the cannula and its insertion site. To assess the reliability of the questionnaire, a pilot test–retest study with a three-week interval check was performed. A Cohen's k > 0.60 was determined to be the good level of item reliability.

The questionnaire contained three sections and an introductory paragraph which provided the definition of phlebitis.The first section was used to collect general data (gender, age, and job data). The second section contained 17 close-ended questions regarding the risk factors for phlebitis and one open-ended question: "Do you know of any other risk factor for phlebitis not specified?" If the answer was "yes", respondents were asked to state the other risk factor. This section of the questionnaire contained another two questions to which the nurses should respond – whether they considered the occurrence of phlebitis as a great, moderate or trivial problem, and if the occurrence of phlebitis indicated the quality of care provided. In the third section of the questionnaire, nurses ranked medications (antibiotics and other medications) and solutions, which are currently used in both countries, according to their impact on the development of phlebitis. Generic medication names were listed first, followed by the brand names in brackets. The rankings ranged from 1 = very rarely causes phlebitis, 2 = rarely causes phlebitis, 3 = sometimes causes phlebitis, 4 = often causes phlebitis, to 5 = very often causes phlebitis, while 0= indicated that the nurses were not familiar with the specified medication or solution, or that they did not administer it and thus they could not evaluate its phlebitic potentials.

The study included a sample of 102 nurses working in the adult intensive care unit (ICU) (surgical and internal medicine) and anaesthesia department (AD). As convenience sampling was used, all nurses employed in the adult ICU and AD for were invited to participate in the study. Data collection in each hospital lasted for three weeks. During the collection period, questionnaires were collected personally by the researchers, and nurses returned them in the sealed envelopes (provided by the researchers). A total of 120 questionnaires were distributed to the three hospitals, and 102 of them were completed, returned and used for analysis. The overall response rate was 85%.

The Statistical Package for the Social Sciences for Windows (SPSS, Inc., Chicago, IL, USA), version 19.00, was used for descriptive and inferential analysis. Methods of descriptive statistics used in this study were: measures of central tendency (arithmetic mean) and measures of variability (standard deviation) for numerical characteristics and frequency determination (proportion) for attribute characteristics. The Pearson c2 test for testing differences between groups was used as a method of inferential statistics. Values of $p < 0.05$ were considered significant.

The implementation of this study was approved by the Ethics Committee of the Medical Faculty of the University of Novi Sad (May, 2012), and administration was approved by all health institutions where the study was conducted.

Results

Of the total number of nurses who participated in the study, 23 (22.5%) were male and 79 (77.5%) were female (Table 1).

The mean age of the nurses was 33.2 (SD=7.2) years of age. The youngest nurse was 20 and the oldest was 56 years old. Most of the nurses 63 (61.8%) completed secondary medical school, while 36 of them (35.3%) graduated from college or university, and three (2.9%) had a master's degree in nursing. An almost equal number of nurses who participated in the study worked in surgical and internal medicine intensive care units (n = 43, 42.1% and n= 42, 41.2%, respectively), while others worked in the anesthesia care unit (n = 17, 16.7%). The mean work experience of the nurses was 11.7 (SD= 7.8), with the span ranging from one to thirty-five years.

Table 1 – Demographic characteristics of participants (n=102). Novi Sad, Niš and Osijek, Serbia and Croatia, 2012

Demographic variable	Category	Frequency	Percentage
Gender	Male	23	22.5
	Female	79	77.5
Education	Secondary school	63	61.8
	Technical College	13	12.7
	3 – year bachelor's degree	22	21.6
	4 – year bachelor's degree	1	1.0
	Master's degree	3	2.9
Work setting	Surgical intensive care unit	43	42.1
	Internal intensive care unit	42	41.2
	Department of anaesthesia	17	16.7
		Mean	**SD***
Age (years)		33.2	7.2
Work experience (years)		11.7	7.8

*Standard deviation

The perception of the risk factors for phlebitis

Most nurses considered phlebitis a great problem (n = 69, 67.6%), whose prevalence indicated the quality of the nursing care (n = 67, 65.7%), while one-third considered phlebitis a moderate problem in patient care. Analysis of the other responses shows that nurses recognized some factors that may affect the reduction of the incidence of phlebitis such as: good venipuncture practice, regular and adequate documentation, and administering short-term infusions of medications. However, more than half of the nurses were unaware that the cannula material and diameter may affect the incidence of phlebitis, and did not distinguish the phlebitic potentials of the flushing solution on cannulas, such as heparin and 0.9% NaCL.

The nurses also recognized the factors that influenced the development of phlebitis, such as choice of devices which facilitate dressing and securing of the intravenous cannula, and the length of time before the infusion system was replaced. The nurses' perceptions were mostly divided in relation to the recommended time of IV medication administration, setting cannula in situ, and the impact of the choice and methods of local anesthetic administration on the reduction of the incidence of phlebitis.

In the nurses' opinion, factors that could lead to phlebitis were: higher medication concentration and medications or solutions with a higher pH, as well as thromboembolic diseases, diabetes mellitus and venous insufficiency.

After analyzing nurses' perceptions about the risk factors for phlebitis, we observed a difference, depending on the level of education (Table 2).

Table 2 –The nurses' perception of some risk factors for phlebitis in relation to educational level. Novi Sad, Niš and Osijek, Serbia and Croatia, 2012

Offered Responses	Secondary school n (%)	Technical College, Bachelor's and Master degree n (%)
In youropinion,which cannula material reduces the risk for phlebitis?		
Teflon®	7 (11.0)	13 (33.4)
Vialon®	11 (17.7)	12 (30.8)
I don't know	45 (71.3)	14 (35.8)
c^2 test = 13.216; p = 0.001		
Do you think that the length of time before the infusion system is replaced influences the development of phlebitis?		
Yes	27 (42.9)	29 (74.4)
No	31 (49.2)	8 (20.5)
I don't know	5 (7.9)	2 (5.1)
c^2 test = 9.818; p = 0.007		

(continue...)

Table 2 - (continuation)

Offered Responses	Secondary school n (%)	Technical College, Bachelor's and Master degree n (%)
In your opinion, the IV cannula placed in situ (in one place):		
Should stay no longer than 24 hours	5 (7.9)	7 (17.9)
Should stay no longer than 48hours	14 (22.2)	12 (30.8)
Should stay no longer than 72hours	15 (23.8)	13 (33.4)
Should be replaced depending on the clinical indications	29 (46.1)	7 (17.9)
c^2 test = 8.921; p = 0.03		

Nurses with secondary education, as opposed to nurses with higher education, were not aware that the cannula's material (c2 test = 13.216; p = 0.001) and the replacement time of the infusion system (c2 test = 9.818; p = 0.007) could affect the incidence of phlebitis. A difference was also noted in terms of the time of maintaining an intravenous cannula in situ. A significant number of nurses with secondary education believed that the intravenous cannula should be replaced depending on clinical indications (c2 test = 8.921; p = 0.03).

With regard to work experience, there was a significant difference in the nurses' perception about the selection of an appropriate insertion site for an intravenous cannula, in order to reduce the incidence of phlebitis (c2 test = 29.691, p = 0.003) and the recommended time for the IV medication administration (c2 test = 16.986, p = 0.049). Nurses who had between six and ten years of experience made a better choice of veins (forearm veins), in comparison to colleagues with less experience who predominantly selected hand veins. Less experienced nurses (£ 5 years) would administer infusion medications lasting more than 60 minutes.

Phlebitic potentials of some medications and solutions

Phlebitic potentials of antibiotics, which nurses administered in their everyday practice, were rated from 2.21 to 3.12 (Table 3), other medications from 1.90 to 2.77 (Table 4), and solutions from 1.62 to 3.39 (Table 5).

Nurses identified Vancomycin (3.12±1.26) and Benzylpenicillin (3.06±1.13) as antibiotics with the strongest phlebitic potential (Table 3).

Among other medications, Calcium glubionate (2.77±1.35); Aminophylline (2:58±1:18) and Amiodarone hydrochloride (2.56±1.21) were also identified as potentially causing phlebitis (Table 4).

Table 3– Phlebitic potentials of intravenous antibiotics. Novi Sad, Niš and Osijek, Serbia and Croatia, 2012

Generic Name	n*	Min.	Max.	Mean	SD†
Chlarithomycin	42	1	5	2.21	1.04
Azithromycin	75	1	5	2.39	1.11
Vancomycin	94	1	5	3.12	1.26
Aciclovir	58	1	5	2.45	1.14
Ceftazidime	92	1	5	2.58	1.12
Tigecycline	71	1	5	2.83	1.06
Imipenem/cilastatin	92	1	5	2.59	1.16
Ertapenem	76	1	5	2.71	0.89
Netilmicin	71	1	5	2.55	1.03
Cefotaxime	81	1	5	2.36	1.02
Ciprofloxacin	94	1	5	2.64	1.28
Benzylpenicillin	65	1	5	3.06	1.13
Clindamycin	93	1	5	2.60	1.09
Metronidazole	96	1	5	2.39	1.23
Cefuroxime	96	1	5	2.26	1.17
Gentamicin	97	1	5	2.31	1.14
Amikacin	95	1	5	2.41	1.14

*n = Number of participants who rated the drug
†Standard deviation

Table 4 – Phlebitic potentials of intravenous medications other than antibiotics. Novi Sad, Niš and Osijek, Serbia and Croatia, 2012

Generic Name	n*	Min.	Max.	Mean	SD†
Diazepam	89	1	5	2.17	1.27
Epinephrine hydrochloride	87	1	5	1.90	1.07
Aminophylline	91	1	5	2.58	1.18
Pethidine hydrochloride	54	1	4	2.24	0.97
Digoxin	86	1	5	2.16	1.13
Amiodarone hydrochloride	90	1	5	2.56	1.21
Hydrocortisone	84	1	5	2.37	1.31
Metoclopramide	90	1	5	2.01	1.02
Morphine hydrochloride	83	1	5	2.54	1.32
Heparin	86	1	5	1.93	1.15
Furosemid	89	1	5	1.87	0.97
Calcium glubionate	88	1	5	2.77	1.35

*n = Number of participants who rated the drug
†Standard deviation

According to nurses' perception, potassium chloride 7.4% (3.39 ± 1.32) is an intravenous fluid often causing phlebitis (Table 5).

Table 5 – Phlebitic potentials of intravenous fluids. Novi Sad, Niš and Osijek, Serbia and Croatia, 2012

Intravenous Fluid	n*	Min.	Max.	Mean	SD†
Glucose 10%	90	1	4	1.74	0.91
Glucose 5%	92	1	5	1.65	0.95
Intralipid lipids 20%	71	1	5	3.11	1.37
Amino acid 15%	78	1	5	3.08	1.28
Amino acid 10%	83	1	5	3.08	1.35
Amino acid 5%	75	1	5	3.03	1.26
Amino acid - Hepatosol8%	69	1	5	2.93	1.31
Vamin aminoacids 14 g	34	1	5	2.82	1.16
Emulsion for infusion (Glucose, Amino acids and electrolytes Fat emulsion)	73	1	5	3.01	1.45
Albumin (human) 20%	88	1	5	2.30	1.19
Polygeline infusion solution 3.5%	70	1	5	1.93	1.01
6% Hydroxyethyl Starch 130/0.4 in 0.9% Sodium Chloride Injection	89	1	5	1.84	0.93
Erythrocyte concentrate	93	1	5	2.67	1.21
Fresh – frozen plasma	92	1	5	2.45	1.17
Ringer's solution	91	1	4	1.62	0.82
Hartmann's solution	78	1	5	1.71	1.02
Mannitol 10%	88	1	5	2.03	0.96
Mannitol 20%	90	1	5	2.24	1.10
Potassium chloride 7.4%	93	1	5	3.39	1.32
0.9% Sodium Chloride Solution	94	1	5	1.73	1.09
Sodium Bicarbonate 8.4%	90	1	5	2.44	1.19

*n = Number of participants who rated the fluid
†Standard deviation

Discussion

The aim of this study was to evaluate the perceptions of nurses about risk factors for phlebitis and the phlebitic potential of some medications. It was conducted in the health care institutions of Serbia and Croatia, in which the educational and professional competence of nurses were almost identical prior to Croatian entry to the European Union. Both countries were members of the former Socialist Federal Republic of Yugoslavia and they both had (and Serbia still does) a traditional form of nurse education at the secondary school (four-year education for nurses after eight years of general education), with the possibility of continuing their education at a higher level, and then obtaining the title of master's in nursing. It is therefore not surprising that 61.8% of nurses with secondary education participated in the study. However, the majority of nurses identified phlebitis as a major problem and its incidence as the indicator of the quality of nursing care.

Comparing the current standards of infusion therapy[9-10] and the nurses' knowledge about risk factors for phlebitis with our findings, we observed a large gap

between the two. Namely, although some studies have confirmed that the cannula material influences the development of phlebitis[8], nurses in our study did not recognize this as a predisposing factor. The reason for this misperception could be interpreted by the increased availability of Teflon® cannulas. Despite the wide variety of types of intravenous cannula in the European market, the main discriminator in selecting them is their price[21]. Therefore, institution management often opts for Teflon® cannula with a more favourable price, as they do in Serbia and Croatia.

For a successful and safe use of intravenous therapy and a reduction of complication rates, it is important to respect the golden rule: "The catheter selected shall be of the smallest gauge and length, with the fewest number of lumens, and shall be the least invasive device needed to accommodate and manage the prescribed therapy"[10]. Taking into account that 41.2% of nurses chose the largest offered diameter cannula (18G) as a dimension that reduces the risk of phlebitis, while only 21.6% opted for the lowest offered diameter (22G), it could be concluded that the golden rule is not followed by all nurses involved in the study. Since the study was conducted in the intensive care units, we assume that nurses based this decision on their perception that rapid volume restoration, which is often needed by the critically ill, requires a larger cannula diameter, regardless of the possible risk of adverse complications.

Flushing and locking are important procedures that influence both the effectiveness and safety of therapy administered through an intravenous cannula[9-10]. Therefore, it is important to select the appropriate solution. Comparing the effectiveness and safety of 0.9% sodium chloride solution versus heparin saline solution as flushing and locking solutions for peripheral intravenous access devices in a prospective controlled trial, Wang *et. al*.,[22] concluded that both agents are equally effective and safe. This was confirmed in our study, where a difference in the phlebitic effect of these two solutions was not perceived by nurses, either. In contrast, Bertolino et. al.[23] found that the rate of cannula-related phlebitis/occlusions was significantly lower in the group of patients who used heparin as a flushing solution. At the same time, Bertolino et. al.[23] recommend that cost/ benefit analyses should be done before making the final decision on the choice of agents.

In terms of retaining intravenous cannula in situ, nurses' perceptions were greatly divided. Therefore, for successful intravenous medicine management and reduction in associated complications, it is essential to address the issue of the time of cannula replacement. Taking into account that globally, a large number of patients require intravenous cannulation, clinically indicated versus routine replacement in 72 – 96 hours would have a positive effect on health care costs worldwide[24]. Routine replacement of the cannula was and still is the source of an overwhelming expenditure and burden on patients and nurses.

There is still another dilemma to be resolved for successful intravenous medicine management. Namely, the nurses in clinical practice are faced with a variety of recommendations regarding site selection. Recommendations of the RCN[9] and INS[10] suggest that initial cannulation should be in the veins of the upper extremity in the distal areas, while subsequent cannulation should be made proximal to the previous one. In our study, nurses' perception that the hand veins have a lower risk for phlebitis areprobably due to the influence of previous CDC recommendations for the Prevention of Intravascular Catheter-Related Infections.

In analyzing the nurses' perception of phlebitic effects of some antibiotics, it was expected that they would recognize Vancomycin and Benzylpenicillin as potentially potent medications. Namely, with its pH of 2.5-4.5, Vancomycin is a very vessel-irritating antibiotic; whereas Benzylpenicillin, classified as a beta-lactam antibiotic, has an irritating effect. Cefuroxime, in our study, was not significantly associated with a higher risk, although it is classified as a beta-lactams. To reduce the rate of phlebitis and avoid a mistake in medication administration known as "failure to check for phlebitis", medications with an extremely acidic pH of 2.5 - 3.5 should be diluted with a volume of 200 - 500ml[18].

Other potent medications identified by nurses were Calcium glubionate, Aminophylline and Amiodaronehydrochloride. Calcium glubionate cause injection site irritation, while Aminophylline (pH 8.8-10) and Amiodarone hydrochloride (pH 3-5) are medications which may be related to the incidence of phlebitis, due to their extreme pH. For example, in the study of Norton *et. al.*[25], Amiodarone hydrochloride-induced phlebitis occurred in 40% of patients. Potassium chloride 7.4%, as well as the other hyperosmolar solutions, but also acidic solutions such as parenteral nutrition solutions and glucose ≥ 10%, are known to be risk factors for phlebitis. This was well known to nurses in our study.

A periodic check of nurses' perceptions about risk factors for the development of phlebitis, using the questionnaire that was administered in this study,

can help nurse managers to determine in which part of the process of administering intravenous therapy (preparation, administration or monitoring) the nurse should receive education or training courses. Therefore, results from this study are a good basis for the design of educational activities. In addition, this questionnaire can be applied to assess the learning outcomes before and after these courses. Improving knowledge regarding risk factors and altering nurses' practices could significantly reduce the risk for phlebitis. In addition to being valuable for further research, the results of this study can become the basis for improving the concept of nursing care quality and patient safety.

Limitations

Results from this study add information to the body of knowledge on nurses' perceptions about risk factors for phlebitis. However, some limitations should be noted. The use of a convenience sample, drawn only from the intensive care unit and anesthesiology department from two hospitals in Serbia, and one from Croatia, limits the generalizability of the findings. Future studies should recruit larger random samples of nurses from different settings and across a broader geographical area.

Conclusion

Phlebitis as a common local complication of peripheral intravenous therapy was perceived as a significant problem in clinical practice by nurses who participated in this study. However, some risk factors related to its occurrence, especially risk factors associated with the cannula, were not fully perceived. The majority of nurses did not identify the effects of the cannula material, its diameter, the time before cannula were replaced, and solutions used to flush the cannula as potential risk factors. However, risk factors related to the patient and administered therapy were well known. Namely, nurses were aware of the fact that some underlying diseases increase the incidence of phlebitis, as well as the phlebitic effects of certain medications and solvents, such as Vancomycin, Benzylpenicillin, Calcium Glubionate, Aminophylline and Amiodarone Hydrochloride.

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