Research Article

INCIDENCE AND RISK FACTORS FOR PERIPHERAL INTRAVENOUS CATHETER RELATED THROMBOPHLEBITIS: A PREVENTABLE IATROGENIC COMPLICATION   IN INDOOR PATIENTS

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A R T I C L E   I N F O

A B S T R A C T

Introduction: Peripheral intravenous catheter (PIVC)-related thrombophlebitis is a common and significant problem in clinical practice. This study aimed to investigate the incidence of phlebitis and to evaluate some important related factors.

Methods: 269 patients admitted to Department of Medicine at IGMC Shimla, Himachal Pradesh were prospectively studied. Variables evaluated were age, gender, site and size of catheter, type of insertion and underlying medical conditions. Phlebitis was defined according to the grading scale (erythema, pain, tenderness, warmth, induration, palpable cord and swelling). Patients already suffering from thrombophlebitis at the time of admission, unconscious patients, patients with pre-existing septicemia, patients who were hemodynamically unstable, and patients who either cannulated in casualty or at periphery were excluded. All the study participants were examined for superficial thrombophlebitis every 24 hours, 48 hours, and at 72 hours.

Results: Phlebitis occurred in 53.09 percent of patients. There was no significant relationship between age, catheter bore size, other cannula related factors, hypertension, infections, and phlebitis. Related risk factors were male gender, diabetes mellitus, obesity, hyperlipidemia, smoking, alcohol intake and certain drugs like piperacillin +tazobactam, pantoprazole, mannitol, and D25.

Conclusion: Phlebitis should be specifically looked for and actively managed in indoor patients. In patients with diabetes mellitus, obesity and hyperlipidemia, more attention is needed.

INTRODUCTION

The progress of medical science and technology has been accompanied by the use of new diagnostic and therapeutic devices, each of which is associated with its own complications. One of the most used devices is the peripheral intravenous catheter (PIVC) for drugs, fluid and blood product administration, or blood sampling. One of the most common complications of PIVC is phlebitis.

Phlebitis refers to the clinical finding of pain, tenderness, swelling, induration, erythema, warmth and palpable cord like veins due to inflammation, infection, and or thrombosis.

Incidence of thrombophlebitis ranges from 17% - 75% in different studies.[1-5] Being one of the most commonly performed procedures on hospitalized patients, PIVC insertions make them susceptible to infections and non-infectious complications.[6] PIVC complications are classified into minor and major categories based on the severity of symptoms. Minor complications include catheter occlusions, accidental removals, fear of sharp needles (needle phobia), and pain.

On the other hand, major complications tend to be more severe, such as phlebitis, infection, extravasation, and even skin injuries.[7] Duration of catheterization is the most important predictor of peripheral vein infusion thrombophlebitis[8] and the Centers for Disease Control and Prevention (CDC) recommends rotation of catheter sites every 48 to 72 hours to minimize the risk of phlebitis.[8]

Although, several studies have reported incidence and risk factors associated with PIVC, the data are scarce in our institute. Our institute caters to mainly lower income group patients and is overburdened most of the times. Hence, the present study aimed to investigate the incidence of phlebitis and to evaluate some important related factors so as to reduce the burden of PIVC related phlebitis and reduce the duration of hospitalization in already overburdened healthcare system.

METHODS

All adult patients admitted in Medicine wards and requiring intravenous cannulation during the period from Jul 2018 to Jun 2019 were included in this prospective cohort study conducted in Department of Medicine, Indira Gandhi Medical College (IGMC), Shimla, Himachal Pradesh.

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The patients were excluded if already suffering from thrombophlebitis at the time of admission, unconscious patients, patients with pre-existing septicemia, patients who were hemodynamically unstable, patients who were cannulated in casualty, and/or patients who had already been cannulated at periphery. The study was initiated following approval from institute ethics committee at IGMC Shimla. All the study participants were included after they agreed to participate in the study.

All the study participants were examined for superficial thrombophlebitis every 24 hours, 48 hours, and at 72 hours. Grades of thrombophlebitis were defined as: 0: no symptoms, 1: pain or erythema at intravenous site, 2: pain at intravenous site with erythema or swelling, 3: pain at intravenous site with erythema, and swelling or a palpable venous cord, 4: pain at intravenous site with erythema, swelling and a palpable venous cord, and 5: purulent discharge at intravenous site, along with all the signs of grade 4 thrombophlebitis.

Data was entered in Microsoft Excel spreadsheet and analyzed using Epi Info software version 7.2.2. Categorical data were presented as number of patients, their percentage and 95% Confidence Intervals. For quantitative variables, means and standard deviations was calculated. Chi-square test was used to assess association among categorical variables. A two-sided p-value of < 0.05 was taken as statistically significant.

RESULTS

General characteristics

A total of 269 patients were included in the study. 33.8% of the patients aged above 60 years. Male to female ratio was 0.7:1. 69.9% of the patients were overweight. 10.8% and 24.9% of the patients were diabetic and hypertensive respectively. 22.7% patients had history of alcohol abuse and 25.3% patients were smokers. 15.24% patients included in the study had hyperlipidemia (triglyceride ≥150).

Catheter size

Catheters were inserted for reasons such as administration of fluids, intravenous drugs and blood products. Catheter gauge size was 20 in 236 (87.73%) patients and 18 in 33 (12.27%) patients. 119(44.24%) catheters were inserted in the hand, 48(55.02%) in the forearm and 2 were inserted at the other sites.153(56.88%) cannula were inserted by staff nurse and 116 (43.12%) cannula were inserted by junior resident.

Incidence of thrombophlebitis

Overall, 53.9% (n=145) patients developed thrombophlebitis. At 24 hours, 16 (5.95%) patients developed grade 1 thrombophlebitis. At 48 hours, 60 (22.39%) patients developed grade 1 thrombophlebitis, 14 (5.22%) developed grade 2 thrombophlebitis and 1 (0.37%) patient developed grade 3 thrombophlebitis.

At 72 hours, 93 (36.90%) patients developed grade 1 thrombophlebitis and 34 (43.49%) developed grade 2 thrombophlebitis (Table 1).

Risk factors

Sex, diabetes, alcohol abuse, smoking, BMI and hyperlipidaemia were risk factors for the development of thrombophlebitis (P<0.05) (Table 2).

Table 2 Risk factors for thrombophlebitis

Variable		Thrombophlebitis Number (%)		P value
		Absent	Present	
Age	<60	87(48.88)	91(51.12)	0.201
	≥60	37(40.66)	54(59.34)	
Sex	Male	42(37.84)	69(62.16)	0.023
	Female	82(51.90)	76(48.10)	
T2DM	No	117(48.75)	123(51.25)	0.012
	Yes	7(24.14)	22(75.86)	
HTN	No	95(47.03)	107(52.97)	0.594
	Yes	29(43.28)	38(56.72)	
Alcohol	No	108(51.92)	100(48.08)	0.000
	Yes	16(26.23)	45(73.77)	
Smoker	No	100(49.75)	101(50.25)	0.039
	Yes	24(35.29)	44(64.71)	
B.M.I.	18.5-22.9	45(57.69)	33(42.31))	0.015
	Other	79(41.36)	112(58.64)	
Cannula Size	18	10(30.30)	23(69.70)	0.052
	20	114(48.31)	122(51.69)	
CannulaSite	Hand	51(42.86)	68(57.14)	0.342
	Others	73(48.87)	77(51.33)	
Cannula inserted by	Staff Nurse	68(44.44)	85(55.56)	0.532
	Junior resident	56(48.28)	60(51.72)	
Hyperlipidemia	No	115(50.44)	113(49.56)	0.001
	Yes	9(21.95)	32(78.05)	
Infection	No	98(45.79)	116(54.21)	0.844
	Yes	26(47.27)	29(52.73)	

Table 3 Association of thrombophlebitis with drugs

Drugs		Thrombophlebitis Number(%)		P value
		Absent	Present	
Piperacillin +tazobactam	No	120(50.63)	117(49.37)	0.000
	Yes	4(12.50)	28(87.50)	
Ceftriaxone	No	88(47.57)	97(52.43)	0.473
	Yes	36(42.86)	48(57.14)	
Levofloxacin	No	123(46.77)	140(53.23)	0.222
	Yes	1(16.67)	5(83.33)	
Doxycycline	No	116(46.22)	135(53.48)	0.884
	Yes	8(44.44)	10(55.56)	
Vancomycin	No	122(46.39)	141(53.61)	0.690
	Yes	2(33.33)	4(66.67)	
Pantoprazole	No	103(49.76)	104(50.24)	0.028
	Yes	21(33.87)	41(66.13)	
Metronidazole	No	121(46.54)	139(53.46)	0.513
	Yes	3(33.33)	6(66.67)	
Ranitidine	No	106(45.69)	126(54.31)	0.737
	Yes	18(48.65)	19(51.35)	
Metoclopramide	No	107(45.15)	130(54.85)	0.395
	Yes	17(53.13)	15(46.88)	
Hydrocortisone	No	119(45.95)	140(54.05)	1.000
	Yes	5(50)	5(50)	
Frusemide	No	78(41.27)	111(58.73)	0.015
	Yes	46(57.50)	34(42.50)	
Mannitol	No	123(48.43)	131(51.57)	0.002
	Yes	1(6.67)	14(93.33)	
D25	No	124(50.82)	120(49.18)	0.000
	Yes	0(0.00)	25(100)	
Others	No	102(45.74)	121(54.26)	0.796
	Yes	22(47.83)	24(52.17)	

Different drugs which are commonly used in medicine ward were also studied as risk factors for thrombophlebitis. Among all the drugs, piperacillin+tazobactam, pantoprazole, mannitol

Table 1 Grades of thrombophlebitis at different time intervals

Grades of Thrombophlebitis		Number	Percentage
24 hours	0	253	94.05%
	1	16	5.95%
48 hours	0	193	72.01%
	1	60	22.39%
	2	14	5.22%
	3	1	0.37%
72 hours	0	124	49.21%
	1	93	36.90%
	2	34	13.49%
	3	1	0.40%

and D25 were found to be associated with increased risk of thrombophlebitis (P<0.05) (Table 3).

DISCUSSION

Phlebitis is the most common complication of intravenous catheters and can lead to many problems and costs. It is now well established that the etiology of phlebitis is multifactorial.

In our study, the incidence of phlebitis was 53.09% which is comparable with incidence rates reported at other centres around the world.[1-5] We graded the thrombophlebitis observed according the Visual Infusion Phlebitis Score into five grades. However, in our study only Grade 1 and Grade 2 thrombophlebitis were mostly observed. Grade 1 was more common, observed in 5.95% patients at 24 hours, 22.39% patients at 48 hours and 36.93% patients at 72 hours. Grade 2 thrombophlebitis was observed in 5.22% patients at 48 hours and 13.49% patients at 72 hours. This might be because of the good nursing care provided to the patients. Most cases of were detected and preventive measures taken before severe forms or complications developed. In our hospital, the cannula was immediately replaced once the patient complains of pain or even slight erythema or swelling, so grade 3, 4 and 5 were not observed.

In the study by Maki and Ringer who used two or more criteria, the incidence was 41.8%.[9] The incidence of phlebitis was found to be 39% by Monreal *et al*[10], and 36.5% by Karadag and Gorgulu.[11] Male gender was an associated risk factor in our study. Singh *et al*[12] and Salma *et al*.[13] also found out that incidence was higher in the male patients.

In our study, no difference in the incidence of thrombophlebitis was found in different age groups. This is similar to other studies,[6,15] where no difference was found in the incidence of phlebitis in patients aged ≥60 years old or < 60 years old. Study conducted by Mandal and Raghu, found that the risk of developing phlebitis was more in the age group less than 60 years (34.80% Odds ratio [OR] 1.58, 95% Confidence Interval [CI] 0.78‑ 3.19).[14] One of the reasons quoted in literature regarding lower incidence rate in the elderly is impaired inflammatory response.

One of the most striking findings of our study was the relationship between diabetes mellitus and phlebitis. In diabetic patients, phlebitis was more common than in non-diabetics. This risk factor was evaluated in a few studies. This result of our study coincide with the result of the study conducted by Salma *et al* who reported that the incidence of thrombophlebitis in diabetes was 25% compared to 2.68% in non-diabetics.[13] A higher rate of phlebitis in these patients may be due to the endothelial damage induced by diabetes mellitus that predisposes patients to phlebitis. Good control of diabetes mellitus, greater attention and care during insertion, and changing catheters within 72 hours may reduce the rate of phlebitis in these patients.[14]

Hypertension was not associated with increased incidence of thrombophlebitis in our study. Similar results were observed in the study conducted by Jisal *et al*.[15] In our study, alcohol was associated with greater occurrence of thrombophlebitis with p value of 0.000 which was significant. Similarly, smoking was also found as a significant risk factor with p value of 0.039. This is in contrast to study conducted by Jisal *et al*.[15] in which

smoking was not found as a significant risk factor for thrombophlebitis.

Large bore catheters generally cause more phlebitis due to greater mechanical irritation. However, in contrast to most studies[16], our findings did not show catheter bore as a risk factor for phlebitis. One of the possible reasons may be that very large bore catheters (16G) were not used in our patients. In our study, no relationship was found between thrombophlebitis and site of insertion of cannula and whether the cannula was inserted by junior resident or staff nurse. SOP were not followed in 13(4.83%) patients and 15(5.58%) patients dressing of the cannula site was not done daily. So, there is a need to train and retrain staff nurses and junior residents regarding the SOP and need for daily cannula site dressing to reduce CRBSIs. Special training sessions need to be held to in wards to make them well aware according to CDC guidelines and recommendations for preparation of skin for cannulation, cannula dressing and risk factors as well as consequences of CRBSIs.

Hyperlipidemia was also found as a risk factor for thrombophlebitis in our study which developed in 32(78.05%) patients with hyperlipidemia compared to 113(49.56%) patients without hyperlipidemia. This is similar to the results found in the study done by Salma *et al*.[13]

Our study found no significant difference in the incidence of thrombophlebitis in patients with or without infection. Most of the patients were suffering from UTI, Pneumonia, enteric fever, tropical infections like scrub typhus or leptospirosis and other non- specified infections. This is in contrast to the results of the studies conducted by Maki *et al*[9], and Barbut *et al*[17] in that infectious diseases increase risks of phlebitis (OR 6.21, 95% CI 4.27-9.03). One of the reasons may be related to the fact that the intravenous antibiotics used in these patients cause chemical irritation of the endothelium, with resultant phlebitis. Our study established relationship between intravenous drug administered and incidence of thrombophlebitis. Increased incidence of was observed with piperacillin+tazobactam, pantoprazole, mannitol and D25. This result is similar to other studies which have shown that medications and fluids of low pH and high osmolality are associated with chemical thrombophlebitis.[17] One of the reasons may be related to the fact that the intravenous antibiotics cause a chemical reaction of the endothelium with resultant phlebitis.

Further studies are needed to improve the understanding of risk factors for phlebitis, especially diabetes mellitus, smoking, alcohol intake, obesity, dyslipidemia and infectious diseases and to discover more effective protection methods. Based on our findings, we believe that if certain variables influencing the risk of phlebitis (especially diabetes mellitus, infectious diseases and gender) are taken into consideration, the rate of phlebitis can be reduced in high risk groups by: shortening the intervals between catheter replacements, better supervision during insertion and maintenance of catheters, use of milder irritant intravenous drugs, especially with respect to antibiotics, and better control of underlying diseases.

CONCLUSION

PIVC induced complications are one of the most important preventable problems in hospitalized patients which increase the morbidity and prolong the hospital stay. Predisposing

factors for phlebitis are use of antibiotics and associated co morbidities like T2DM, obesity and hyperlipidemia. Changing catheter is recommended when clinically indicated rather than 72 hours of insertion. We would like to recommend that all patients with peripheral venous catheter in situ be screened for complications at least once daily as recommended by the CDC guidelines on prevention of intravascular catheter related infections. Patients with diabetes, obesity and dyslipidemia need more attention. Also, patients receiving antibiotics with more risk of thrombophlebitis should be screened. Observation charts to document the development of signs of phlebitis may be developed in the hospital and training and re-training of staff nurses and resident doctors may be conducted. This would help detect phlebitis much earlier and decrease patients' discomfort and unnecessary hospital stay.

Conflict of interest

All authors declare they have no conflict of interest.

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References

1. Nassaji-Zavareh M, Ghorbani R. Peripheral intravenous catheter -related phlebitis and related risk factors. *Singapore Med J* 2007; 48:733-6
2. Abolfotouh MA, Salam M, Bani-Mustafa A, White D, Balkhy HH. Prospective study of incidence and predictors of peripheral intravenous catheter-induced complications. Ther Clin Risk Manag. 2014;10:993-1001
3. Brezenger T, Conen D, Sakman P, Widmer AF. Is routine replacement of peripheral intravenous catheters necessary? Arch Intern Med.1998;158:151-6
4. Maddox RR, Rush DR. Double-blind study to investigate methods to prevent cephalothin-induced phlebitis. *Am J Hosp Pharm*. 1977;34:29–34
5. Miliani K, Taravella R, Thillard D, Chauvin V, Martin E, Edouard S, *et al*. Peripheral Venous Catheter-Related Adverse Events: Evaluation from a Multicentre Epidemiological Study in France (the CATHEVAL Project). PLoS One. 2017;12:e0168637
6. Todd J. Peripherally inserted central catheters and their use in IV therapy. *Br J Nurs*. 1999;8:140-48.
7. Johansson ME, Pilhammar E, Khalaf A, Willman A. Registered nurses' adherence to clinical guidelines regarding peripheral venous catheters: a structured observational study. Worldviews Evid Based Nurs. 2008;5:148-59.
8. Tagalakis V, Kahn SR, Libman M, Blostein M. The epidemiology of peripheral vein infusion thrombophlebitis: a critical review. *Am J Med*. 2002;113:146-51
9. Maki DG, Ringer M. Risk factors for infusion -related phlebitis with small peripheral venous catheters. A randomized controlled trial. Ann Intern Med 1991; 114:845-54.
10. Monreal M, Quilez F, Rey-Joly C, Rodriguez S, Sopena N, Neira C, *et al*. Infusion phlebitis in patients with acute pneumonia. Chest. 1999;115:1576-80
11. Karadag A, Görgülü S. Effect of two different short peripheral catheter materials on phlebitis development. *J IntravenNurs*. 2000; 23:158-66.
12. Singh AK, Dwivedi R, Ghaharwar APS. Risk factors of thrombophlebitis at infusion sites in patients admitted in surgical ward: A prospective observational study. *IntSurg J* 2018;5:1781-4
13. Salma U, Sarker M, Zafrin N, Ahamed K. Frequency of Peripheral Intravenous Catheter Related Phlebitis and Related Risk Factors: A Prospective Study. *J Med*. 2019;20:29-33
14. Mandal A, Raghu K. Study on incidence of phlebitis following the use of pherpheral intravenous catheter. *J Family Med Prim Care* 2019;8:2827-31
15. Jisal S, Korula SV, Mathew A, Mohan L. The Incidence of Thrombophlebitis Following the Use of Peripheral Intravenous Cannula in Post- Operative Patients A Prospective Observational Study. IOSR *Journal of Dental and Medical Sciences* (IOSR-JDMS). 2015;14:1-4
16. Singh R, Bhandary S, Pun K. Peripheral intravenous catheter related phlebitis and its contributing factors among adult population at KU Teaching Hospital. *Kathmandu University Medical Journal*. 1970;6:443-7.
17. Barbut F, Pistone T, Guiguet M, Gaspard R, Rocher M, Dousset C, *et al*. [Complications due to peripheral venous catheterization: prospective study]. Presse Med 2003; 32:450-6.

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