Risk factors of peripheral venous catheterization thrombophlebitis

Wilkinson Yoong Jian Tan[1], Jo Wearn Yeap[1], Sharifah Sulaiha Syed Aznal[2]

Background: Peripheral venous catheterisation is indispensable in modern practise of medicine. The indications of venous access should be weighed against the risk of complications, the commonest being thrombophlebitis. Thrombophlebitis causes patient discomfort and the need for new catheter insertion and risk of developing further widespread infections.

Methodology: This observational study was conducted on adult patients admitted to the surgical and medical ward of a tertiary hospital in Negeri Sembilan Malaysia in 2011. Four researchers visited patients daily and examined for signs of thrombophlebitis; warmth, erythema, swelling, tenderness or a palpable venous cord. Risks factors that were studied in this research were patient/s age and gender, duration of catheterization, use of catheter for infusion, size of catheter, site of catheter insertion and types of infusate. Thrombophlebitis was graded using a scale adapted from Bhandari *et al.* (1979).

Results: In total, 428 patients were recruited with an incidence rate of thrombophlebitis of 35.2%. Among those who developed thrombophlebitis, 65% had mild thrombophlebitis, 19% moderate and 8% severe thrombophlebitis. Results showed that female patients had a significant increased risk of developing thrombophlebitis. Also risk increased significantly with increased duration of catheterization and usage of the catheter for infusion. The age of a patient, types of infusate use, size of catheter and site of catheter insertion did not significantly influence the development of thrombophlebitis.

Conclusion: The study showed that risk of developing thrombophlebitis is significantly increased among female patients, and also with increased duration of catheterization and use of the peripheral venous catheter for infusion. We recommended elective replacement of catheter every 72 hours and daily examination of catheters for signs of thrombophlebitis by a healthcare personnel.

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Introduction

Intravenous devices are indispensable and commonly used among hospitalized patients in the modern practise of medicine. The peripheral venous catheter is sometimes routinely inserted into veins of the forearm and hands for possibilities of administration of fluids, drugs and blood products or left unused.

The indication for venous access should be weighed against its risk of complications. The commonest complication associated with a peripheral venous catheter is thrombophlebitis. This causes patient discomfort as removal of the catheter and insertion of a new catheter at a different site may be required.[1] If left untreated the inflammation could later turn into an infection. This will clearly consume more healthcare resources and put patients into unnecessary jeopardy.

There have been many theories on the pathophysiology of peripheral vein infusion thrombophlebitis. The currently accepted concept suggests that catheterization of the vein leads to inflammation and thrombus formation. However, the exact mechanism of this is still unclear. Many risks factors of thrombophlebitis have been identified such as duration of catheterization, catheter material, size of catheter and infusate characteristics. Factors which are more patient specific are gender, choice of peripheral veins, insertion at lower extremity and presence of underlying medical illnesses.[1] Other studies which have also reported risk factors to such complications such as demographic factor, the catheter's size, type and duration of insertion, frequency and types of infusion and time of its removal.[2]

However, there have been limited studies on the risks of using a peripheral venous catheter in our local

[1]Hospital Taiping, MALAYSIA

[2]Department of Obstetrics and Gynecology, International Medical University, MALAYSIA

Address for Correspondence:

Dr Wilkinson Tan Yoong Jian, House Officer, Hospital Taiping, Jalan Taming Sari, 34000 Taiping, Perak, MALAYSIA

Email: wilkinsontan@gmail.com

practices. Two local studies on peripheral venous catheter have been identified. Patimah conducted a study on the quality of nursing care of intravenous catheters with emphasis placed on the need of a good nursing care protocol for intravenous catheters. It should be noted however that no statistical analysis was done in this study.[3] A second study conducted by Zahara *et. al* concluded that peripheral venous catheters should be replaced every 72 hours.[4] In our study, we have widened the scope of possible risk factors to include other patient and catheter related risk factors. It is hoped that this study will be able to shed some light on different factors that may influence the development of thrombophlebitis among our local community. Risk factors identified in this study could serve as targets of possible interventions to improve care of intravenous catheters and to decrease the incidence of peripheral venous catheter related complications.

Methodology

An observational study was conducted on patients admitted to the medical and surgical wards of a tertiary hospital in Negeri Sembilan, Malaysia in year 2011. All patients above the age of 12 who have at least one insertion of peripheral venous catheter during hospital stay were invited to participate.

The patient's age, gender, number of intravenous catheters inserted, size of catheter, whether the catheter have been used at least once, the duration of catheter *in situ* and the types of infusion used through the catheter throughout hospital stay were recorded. Four researchers visited the patients daily and examined for signs of thrombophlebitis.

Thrombophlebitis was defined as an inflammation of the vein, and was recognised as warmth, erythema, swelling, tenderness, or a palpable venous cord. This was graded as Grades 1, 2 and 3 using a scale adapted from the clinical grading of thrombophlebitis by Bhandari *et. al*.[5] A score of zero to two points was given according to the size of redness, swelling, induration, vein involvement and local sepsis. One point was awarded each for redness, swelling, induration and vein involvement of 1-7 cm. Two points were awarded each for redness, swelling, induration, vein involvement above 7cm. Absence of these signs was awarded zero point. Local serous discharge was awarded one point while local purulent discharge was awarded two points. The total number of points awarded was calculated and the thrombophlebitis graded. A score of 1-3 was considered mild thrombophlebitis, 4-6 points was graded as moderate thrombophlebitis and a score above 7 was graded as severe thrombophlebitis. Information obtained was recorded on a structured observational protocol. Other complications of intravenous catheter (extravasations, infection, electrolyte imbalance, and embolism) were not monitored in this study.

The inclusion and exclusion criteria for patients are as follows:

Inclusion Criteria: All patients above 12 years old with at least one peripheral venous catheter.

Exclusion Criteria: Patients who are unconscious, unstable, or are unable to give consent.

The authors would like to note that the grading scale suggested by Bhandari *et al.* was originally used to grade thrombophlebitis among children. There may be a difference in its application for grading thrombophlebitis among adult patients. However, we were unsuccessful in identifying a more appropriate grading scale when this research was conducted and was compelled to use the grading by Bhandari *et. al* nonetheless.

We were able to identify another grading scale from the Infusion Nurses Society during the preparation of this manuscript. This scale grades thrombophlebitis based on the development of symptoms; a higher grade of thrombophlebitis is designated as more signs develop. Erythema at access site with or without pain is designated as Grade 1. Pain at access site with erythema and/or edema is Grade 2. Grade 3 is pain at access site

with erythema and/or edema, streak formation, and a palpable venous cord. The highest grading is Grade 4 with pain at access site with erythema and/or edema, streak formation, a palpable venous cord greater than one inch in length and purulent discharge.[6] We were however unable to adapt our data into this grading system as the parameters monitored are different. The authors would recommend the use of this scale in future studies.

We analysed the association between development of thrombophlebitis and risk factors of quantity, duration, size, and types of infusion used through the catheter. We also evaluated influence of the patient age and gender. Information obtained was analysed using SPSS version 17.0. The relationship between the variables was analysed using chi square test. Test of significance was based on a 95% confidence interval and a P value of <0.05.

Results

A total of 428 patients were successfully recruited for this study. One hundred and fifty one out of 428 patients developed thrombophlebitis secondary to a peripheral venous catheter (35.2%). Among those who developed thrombophlebitis, 65% had mild thrombophlebitis, 19% had moderate thrombophlebitis and 8% had severe thrombophlebitis. Another 8% of patients had their catheters accidently removed while bathing or changing clothes. The effects of catheter related risks factors are illustrated in Table 1. We found a significant difference between the duration of a catheter left *in situ* and the development of thrombophlebitis. Patients who had catheters left *in situ* for more than 3 days were 1.46 times more likely to develop thrombophlebitis compared to those whose catheters were left for less than 3 days. Similarly, a female patient was found to have 1.55 times higher risk of developing thrombophlebitis compared to a male patient. Thrombophlebitis was also significantly more likely to occur if the catheter has been used during hospital admission.

Forty five patients had catheters that were not used amongst which 8 patients (17.8%) developed thrombophlebitis. The rate of thrombophlebitis among patients whose catheters were used at least once during hospital admission was 37.3%. Catheters that were used during hospital admission were two times more likely to develop thrombophlebitis. Catheters of size 18 Gauge, 20 Gauge and 22 Gauge were most commonly used at our institution. Our observations showed that although the percentage of developing thrombophlebitis increased with the size of catheter used, there were no significant differences in the risk of developing thrombophlebitis (p= 0.783).

The risk of developing thrombophlebitis when antibiotic have been infused through a catheter was compared to that when only crystalloids were infused. Results showed that the percentage of patients developing thrombophlebitis was higher when catheters were used to infuse antibiotics but the difference was not statistically significant (p= 0.324).

Age of patient as a risk factor for developing thrombophlebitis was observed. Our analysis found that there was equal percentage of patients developing thrombophlebitis among all age groups with no statistical difference between the age groups (p=0.794).

Mild thrombophlebitis was the commonest grade of thrombophlebitis affecting two thirds of our patients. We did not observe any relationship between the risk factors and grade of thrombophlebitis developed. No risk factor was significantly associated with developing a lower or higher grade of thrombophlebitis (p=0.332).

Discussion

The incidence for all grades of peripheral vein infusion thrombophlebitis among our study sample was 35.2% which is comparable with incidence rates reported at other centres around the world. The reported incidence of peripheral vein thrombophlebitis ranges from 25% to 59.1%.[1, 7] We graded thrombophlebitis

observed into three grades of mild, moderate and severe thrombophlebitis using a scale adapted from the clinical grading of thrombophlebitis by Bhandari *et. al.*[5] Mild grades of thrombophlebitis was the commonest, comprising approximately two thirds of the observed incidence. Moderate and severe thrombophlebitis were uncommon. No other studies have attempted to distinguish the grading of thrombophlebitis developed. We are therefore unable to compare the distribution of different grades of thrombophlebitis. However, it is important to note that most cases of thrombophlebitis were detected and preventive measures taken before moderate to severe thrombophlebitis developed.

The peripheral vein is traumatized during insertion of peripheral venous catheter. The catheter is also foreign to the human body. This initial trauma and presence of foreign body in the vein stimulates an inflammatory response which predisposes the development of thrombus and subsequent phlebitis. Catheters that are left longer *in situ* also have increased exposure to handling and drugs infusion which may explain the higher rate of thrombophlebitis for longer duration of its insertion.

Female gender is identified as a significant risk factor to the development of thrombophlebitis secondary to peripheral venous catheterization. Similar findings have been reported by Cicolini and Tagalakis.[1,8] We attempted to identify a reason for this but were unable to explain this observation.

A catheter that is used for infusion has double the risk of developing thrombophlebitis compared to a catheter that has not been used. This may be due to the type of solution infused through the catheter. Certain infusates such as antibiotics, chemotherapeutic drugs, solutions of low pH and high osmolarity are associated with increased risk of thrombophlebitis.[1,9] We attempted to observe for an increased incidence of thrombophlebitis when infusate are used in patients. However, there was no significant difference between type of infusate and the development of thrombophlebitis among the sample population in this study. This may be due to the inadequate size of the study sample and the fact that most of the patients received different infusate through the same peripheral catheter. A further study using only one infusate per catheter may be helpful in confirming the risk of different infusates on development of thrombophlebitis.

For difference in risk and incidence of thrombophlebitis in different age groups, it was found that the incidence of thrombophlebitis was similar throughout all age groups of patients. The age of a patient did not influence the development of thrombophlebitis among our patients. This observation has also been reported in other studies.[8]

The duration a catheter is left in the vein was found to significantly influence the incidence of thrombophlebitis. Patients who have a catheter for more than 3 days are more likely to have an increased risk of developing thrombophlebitis. Similar findings have previously been reported by Uslusoy and Barker.[10,11] The duration of catheterization is the only modifiable risk factor identified. The results of many studies have shown that the risk of thrombophlebitis increases with increased duration of catheterization. It is recommended that prophylaxis re-sitting of catheter should be practised in all patients. The catheter should be removed or replaced in a different site after 72 hours of insertion, even when there is no sign of thrombophlebitis. A randomised clinical trial in Scarborough, UK has found that there was a significant reduction of thrombophlebitis incidence when catheter was electively replaced.[6] This practice in fact did not result in increased catheterization of the patients as compared to re-sitting only when thrombophlebitis develops. This is because catheters used for increased durations will subsequently develop thrombophlebitis which will also require replacement. The practise of electively replacing catheter has also been recommended by the United States Centre of Disease Control and Prevention (CDC). The CDC recommended that peripheral catheter should be replaced every 72 - 96 hours to reduce the risk of infections and phlebitis in adult patients.[11] The practice of electively replacing venous catheter after 72 hours should therefore be

practised for all patients. Catheters which are no longer required should also be removed (Table 2).

The choice of catheter size inserted is influenced by the rate of infusion required in the management of patient. Patients anticipated requiring rapid infusion of fluids or blood products will have larger catheters inserted. We have observed that the risk of developing catheter related thrombophlebitis was similar for the three commonly used catheter sizes (18G, 20G and 22G) at our institution. The choice of catheter size should therefore be made based on the rates of infusion needed for the patient.

The location of catheter placement has been found by previous studies to influence the incidence of peripheral venous catheter thrombophlebitis. Catheters placed on the lower limbs have been found to have higher incidence than catheters in the veins of the upper limb. On the upper limb, the brachium is preferred to veins on the dorsum of the hand due to a lower risk of developing thrombophlebitis. We were not able to study the difference in incidence rate between catheters placed in veins of upper and lower limbs as only one patient had a catheter in the lower limb. It is a standard practice in our hospital to avoid placing catheters in the lower limb unless unavoidable.

In this study, the incidence of thrombophlebitis between placement of catheter in veins on the dorsum and brachium of the upper limb was similar among patients for both sites. However, it should be noted that only a small number of the patients had catheters placed in the brachial veins and this may have influenced observed findings in this study. The CDC recommends that placement of catheter on brachium veins is superior to dorsal veins and upper limb is preferable to veins of the lower limbs.

We would like to recommend that all patients with peripheral vein catheter in situ be screened for complications of peripheral venous catheter at least once daily as recommended by the CDC guideline on prevention of intravascular catheter related infections.[12] This should be performed by visual examination and palpation of the vein for warmth, tenderness, erythema and a palpable cord. Patients with these symptoms should have their catheters replaced at a different site.[9] Malfunctioning catheters should also be replaced. We propose that all units should have an observation chart to document development of signs of thrombophlebitis. The chart should include the signs mentioned as well proper documentation of the date of catheterisation. This would help detect thrombophlebitis much earlier and decrease patients' discomfort and pain. Catheters that are not used should be removed within 72 hours of placement or when signs of developing thrombophlebitis have been detected.[12]

Limitations

We did not evaluate the technique of catheter insertion. The catheters were inserted by different personnel from different units. The data was collected by four researchers and although all efforts were made to standardise the symptoms evaluated, there is still a factor of interpreter variability. We also did not evaluate the influence of the patient's clinical diagnosis on the development of thrombophlebitis.

Conclusion

The incidence of peripheral vein infusion related thrombophlebitis among our patients was comparable with other centres in developed countries. We confirmed an increased risk of developing thrombophlebitis among female patients, increased duration of catheterization and usage of the catheter for infusion. The age of a patient, types of infusate used and the size of catheter inserted did not significantly influence the development of thrombophlebitis. The practice of electively replacing catheter every 72 hours is recommended for all adult patients. All patients with

peripheral venous catheter should be examined for signs of thrombophlebitis at least once daily. A suitable peripheral vein catheter chart should include date of catheterisation, development of warmth, erythema, tenderness and a palpable venous cord. These signs should be examined during every review of the patient by healthcare personnel.

REFERENCES

1. Tagalakis V, Kahn S, Libman M, *et al.* The epidemiology of peripheral vein infusion thrombophlebitis: A critical review. Am J Med. 2002; 113: 146-51.
2. Maki D.G, Ringer M. Risk factors for infusion-related phlebitis with small peripheral venous catheters. Ann Inter Med. 1991; 114: 845-54.
3. Patimah A. Quality of nursing care of intravenous lines in Hospital Kajang. IMR Quarterly Bulletin. 2003;(55):5-8.
4. Zahara S, Rosnah AR, Kaliama R. Intravenous infusion-related phlebitis at Hospital Ipoh. [Abstract]. Medical Practice Hospital Ipoh. 1995; 2(1): 20.
5. Bhandari B, Joshi T, Tak SK. Anti-coagulant ointment in the prevention of post-infusion thrombophlebitis in children. Indian J Pediatr. 1979; 46: 289-94.
6. Infusion Nurses Society Standards of Practice. Vascular access device selection and placement. J Infus Nurs. 2012; S37.
7. Singh R, Bhandary S, Pun KD. Peripheral intravenous catheter related phlebitis and its contributing factors among adult population at KU Teaching Hospital. Kathmandu Univ Med J. 2008; 6: 443-7.
8. Uslusoy E & Mete S. Predisposing factors to phlebitis in patients with peripheral intravenous catheters: a descriptive study. J Am Acad Nurse Pract. 2008; 20: 172–80.
9. Barker P, Anderson AD, MacFie J. Randomized clinical trial of elective re-sitting of intravenous cannulae. Anns R Coll Surg Engl. 2004; 86: 281–83.
10. Cicolini G, Bonghi AP, Di Labio L, *et al.* Position of peripheral venous cannulae and the incidence of thrombophlebitis: an observational study. J Adv Nurs. 2009; 65: 1268–73.
11. Monreal M, Quilez F, Rey-Joly C, *et al.* Infusion phlebitis in patients with acute pneumonia- A prospective study. Chest. 1999; 115: 1576-80.
12. O'Grady N, Alexander M, Lilian A. *et al.* Guidelines for the Prevention of intravascular catheter-related infections, 2011. Centre for Disease Control and Prevention (CDC).

Table 1: Catheter Related Risk Factors for Thrombophlebitis

Catheter Related Factors	Catheters with thrombophlebitis n (%) [n=151]	Catheters without thrombophlebitis n (%) [n=277]	Total n (%) [n=428]	Chi Square	Relative Risk
Gender					
Male	65 (28)	166 (72)	231 (54)	(χ^2 = 11.211, p = 0.001)	1.55
Female	86 (43.7)	111 (56.3)	197 (46)		
Duration of Catheter					
1 to 3 Days	114 (32.6)	236 (67.4)	350 (81.8)	(χ^2 = 6.172, p = 0.013)	1.46
More than 3 Days	37 (47.4)	41 (62.6)	78 (18.2)		
Use of Catheter					
Catheter Used	143 (37.3)	240 (62.7)	383 (89.5)	(χ^2 = 6.747, p = 0.009)	2.1
Catheter Not Used	8 (17.8)	37 (82.2)	45 (10.5)		
Age					
Below 30	36 (33.3)	72 (66.7)	108 (25.2)	(χ^2 = 1.031, p = 0.794)	
31 to 50	47 (38.8)	74 (61.2)	121 (28.3)		
51 to 70	49 (34.8)	92 (65.2)	141 (32.9)		
Above 70	19 (32.8)	39 (67.2)	58 (13.7)		
Size of Catheter					
18G	51 (33.1)	103 (76.9)	154 (36.2)	(χ^2 = 1.073, p = 0.783)	
20G	85 (35.7)	153 (64.3)	238 (56)		
22G	11 (42.3)	15 (47.7)	26 (6.2)		
Other Sizes	3 (42.3)	4 (57.1)	7 (1.6)		

Relocation of Catheter					
Same Limb	21 (63.6)	12 (36.4)	33	(χ^2 = 0.582, p = 0.446)	
Different Limb	35 (55.6)	28 (44.4)	63		
Site on Upper Limb					
Brachium	8 (32)	17 (68)	25	(χ^2 = 0.088, p = 0.767)	
Dorsum	149 (36.3)	261 (63.7)	410		
Upper or Lower Limb					
Upper Limb	148 (34.7)	278 (65.3)	426	NA	
Lower Limb	0 (0)	1 (100)	1		
Types of Fluids					
Crystalloids	2 (50)	2 (50)	4 (13.3)	(χ^2 = 4.657, p = 0.324)	
Antibiotics	20 (76.9)	6 (23.1)	26 (86.7)		

Table 2: The Centre for Disease Control and Prevention Recommendation for Preventing Peripheral Vein Infusion Thrombophlebitis.[12]

- Use of an upper extremity is preferable to a lower extremity site
- Select catheter based on intended purpose and duration of use and known complications
- Use a midline catheter or peripherally inserted central catheter when duration of IV therapy will likely exceed six days
- Practice aseptic technique for insertions
- Disinfect site before insertion with alcohol, povidone iodine or chlorhexidine
- Replace catheters and rotate peripheral venous sites every 48-72 hours
- Secure catheter with sterile gauze or transparent dressings
- Replace dressing when catheter is removed, replaced or when dressing becomes damp, loosened or soiled
- Evaluate catheter insertion site at least once daily by palpating for tenderness