

Incidence of phlebitis in patients with peripheral intravenous catheters: The influence of some risk factors

AUTHORS

Anabela Salgueiro-Oliveira

Msc, RN,
Adjunct Professor at the Nursing School of Coimbra,
Rua 5 de Outubro, Apartado 7001, 3046-851 Coimbra,
Portugal.
anabela@esenfc.pt

Pedro Veiga

BSc in Probabilities and Statistics
Manager of Statistics and Research Department at
Curva de Gauss – Studies, Training and Consulting.

Pedro Parreira

RN, PhD,
Adjunct Professor at the Nursing School of Coimbra,
Portugal.

KEY WORDS

Intravenous catheters; phlebitis; nurses; risk factors.

ABSTRACT

Objective

To identify the incidence of phlebitis and the risk factors which contribute to its development in patients with peripheral intravenous catheters.

Design

Prospective observational study.

Setting

Medical ward of a central hospital in Portugal.

Subjects

Patients with peripheral intravenous catheters hospitalised in the medical ward.

Interventions

Nurses observed the peripheral intravenous (IV) catheterisation site daily. If there were complications, the catheter was replaced, and both the development of phlebitis and the procedure were recorded.

Results

A total of 1,244 catheters were observed, and 317 were removed/inserted. Incidence of phlebitis was 11.09%. A multivariate analysis of risk factors for phlebitis showed patients with KCI (OR: 2.112; CI: 1.124-3.969), who were on antibiotics (OR: 1.877; CI: 1.141-3.088) and who had a catheter in an upper limb (OR: 0.31; CI: 0.111-0.938) were at higher risk for phlebitis.

Conclusion

Despite the patients' profile (high mean age and high level of dependency), the risk factors are related to the use of prescribed medication and the catheterised limb. Although these findings show the development of phlebitis is not solely related to nurses' practices, the authors believe these professionals can have an important impact on the prevention of phlebitis. The results show the accurate selection of the catheterisation site, which relies entirely on the nursing intervention, is an important factor for phlebitis.

INTRODUCTION

Today the insertion of peripheral intravenous catheters (PIVCs) is a common practice in hospitals, resulting in local or systemic complications (Lopez et al 2004). Phlebitis is the main local complication (Malasch et al 2006; Lanbeck et al 2004; Juvé Udina et al 2003) with incidence varying according to different settings (3.7% - 67.24%) (Oliveira and Parreira 2010).

Phlebitis is an inflammation of a vein, with multiple causes: traumatic (e.g. *catheter too wide for the vein*); chemical (e.g. *solution irritates the vein*) and septic (e.g. *inappropriate aseptic technique during catheter insertion*) (Clayton and Stock 2006; Rivas Doblado et al 2004).

Incidence of local or bloodstream infections (BSIs) associated with PIVCs is usually low, but they produce considerable morbidity because of the frequency of catheter insertion (O'Grady et al 2002). The most common route of infection for short-term catheters is the migration of skin organisms at the insertion site into the cutaneous catheter tract and along the external surface of the catheter (O'Grady et al 2011), and the development of biofilms, leading to an evasion of host defence mechanisms and to a phenotypic resistance to antimicrobial agents (Von Eiff et al 2005).

Over the last two decades, studies about phlebitis have divided risk factors into four main groups: patients' characteristics; therapy administered; health professionals' practices; and materials used. Other guidelines based on findings from scientific studies systemise a set of recommendations for health professionals on the prevention of PIVC-related complications (O'Grady et al 2011; RCN 2010; Joanna Briggs Institute (JBI) 2008; ISN 2006; O'Grady et al 2002).

Given phlebitis can put patients' safety at risk, this study aimed to identify the incidence of phlebitis and its risk factors in patients with PIVCs.

METHODOLOGY

Study design and data collection tool

A prospective observational study was conducted at a medical ward of a central hospital to assess the incidence of phlebitis and its risk factors in patients with PIVCs.

The data collection tool was designed and validated by the research group based on the theory and guidelines on phlebitis, after it had been tested in a clinical setting. Besides the phlebitis scale proposed by the RCN (2010), the tool included variables related to: the individual (gender, age, level of dependency, status of consciousness and whether the patient was confined to a bed); catheterisation (ward, anatomic site of catheter insertion, catheter gauge and material, catheterisation instructions, catheter dwell time, securement device, reason for catheter removal, signs and symptoms of phlebitis, number of catheters inserted); and intravenous drugs (fluid therapy, KCl, antibiotherapy, number of antibiotics, and drugs administered within 24 hours, continuous/intermittent perfusion, use of infusion pumps).

Study participants and ethics approval

The sample was composed of patients with PIVCs hospitalised for six weeks. A total of 1,244 catheters were observed, of which 372 catheters were removed/inserted. Fifty-five were rejected because documentation was incomplete or due to difficulties in obtaining consent from patients/families. In the end there were 317 cases.

In addition to obtaining the institution's permission, informed consent was obtained from the patients with PIVCs and/or their families. Both anonymity and confidentiality were ensured.

Data collection

Data were collected over six weeks (30 January - 12 March 2010). Nurses observed the IV catheterisation site daily, tested its functionality and recorded any changes which could influence its removal/replacement.

Statistical analysis

Incidence of phlebitis was assessed based on the number of catheters inserted over the 42 days. Correlation between the variables under analysis and phlebitis was also assessed using the t-test and the chi-square test, for a level of significance of 0.05. The risk factors were also assessed using the odds ratios. Logistic regression analysis was used to identify independent risk factors for phlebitis. Data were analysed using SPSS (Version 19).

FINDINGS

Most patients with PIVCs were elderly adults (mean age=75.92 years; SD=14.52), 50.6% were men. They showed high level of dependency in different areas: 81.6% were totally dependent in hygiene care, 65.8% in feeding, 74.1% in mobility and 81.6% in elimination needs. In this sample, 79.7% were confined to a bed and 23.9% were confused.

Table 1 shows some characteristics found in catheter insertion. In most situations, PIVCs were inserted in the ward, upper-extremity veins were more frequently catheterised (93.9%), particularly the hand or forearm. As for catheter gauge, nurses usually used the 20G (0.80mm) (57.9%), made of polyurethane (84.6%). Most catheters were secured with adhesive tape (74.4%). Each patient had, on average, 1.26 simultaneous catheters with a mean dwell time of 3.88 days. In most cases, the reason for removal was phlebitis (43.8%), namely grade 1 and 2. Of the total of 1,244 cases, the incidence of phlebitis was 11.09%.

Table 2 shows most patients were prescribed isotonic solution (72.2%) and 15.9% also received potassium chloride. Antibiotherapy was observed in 35.3% of patients. Five antibiotics were administered more than 15 times: Meropenem (17.7%), Amoxicillin-clavulanate (12.0%), Azithromycin (10.4%), Levofloxacin (9.1%), Cefuroxime (6.6%), Piperacillin/tazobactam (5.4%). Using antibiotherapy, the mean number of intravenous administrations was 23.89. In 63.7% of patients perfusion was continuous; however, infusion pumps were only used in 11.8% of patients.

Table 1: Characterisation of the puncture (n= 317)

	n	%
Catheter insertion setting		
Ward	235	74.4
Emergency room	79	25.0
Other	2	0.6
Total	316	100.0
Missing	1	
Catheterised limb		
Upper	295	93.9
Lower	19	6.1
Total	314	100.0
Missing	3	
Catheterisation site		
Hand	112	35.7
Wrist	48	15.3
Forearm	82	26.1
Antecubital area	30	9.6
Arm	23	7.3
Leg	6	1.9
Foot	13	4.1
Total	314	100.0
Missing	3	0.0
Catheter gauge		
18 G	4	1.5
20 G	154	57.9
22 G	108	40.6
Total	266	100.0
Missing	51	
Catheter material		
Teflon	38	15.4
Polyurethane	209	84.6
Total	247	100.0
Missing	70	
Catheter stabilisation material		
Adhesive tape	209	74.4
Transparent dressing	72	25.6
Total	281	100.0
Missing	36	
Catheter dwell time		
Average 3.88; standard deviation. 2.14; Median 3; Min. 1 Max. 14		
Reason for catheter removal		
Phlebitis	138	43.8
Infiltration	41	13.0
Loss of function/obstruction	37	11.7
Extravasation	32	10.2
Discharge or transfer	51	16.2
Death	4	1.3
Other	12	3.8
Total	315	100.0
Missing	2	
Grades of phlebitis		
1	51	37.0
2	74	53.6
3	10	7.2
4	3	2.2
Total	138	100.0
Missing	2	
Number of simultaneous catheters		
Average 1.26; standard deviation 0.45; Median 1; Min. 1 Max. 3		

Table 2: Intravenous medication (n= 317)

	n	%
Serum infusion		
Isotonic	226	72.2
Hypertonic	3	1.0
Hypotonic	1	.3
No saline	83	26.5
Total	313	100.0
Missing	4	
KCl		
Yes	50	15.9
No	264	84.1
Total	314	100.0
Missing	3	
Antibiotics		
Yes	205	35.3
No	112	64.7
Total	317	100.0
Number of antibiotics		
One	137	66.8
Two	63	30.7
Three	5	2.4
Total	205	100.0
Number of IV medication administrations		
Mean 23.89; standard deviation 21.41; Median 18		
Infusion rate		
Continuous	188	63.7
Intermittent	50	16.9
No infusion	57	19.3
Total	295	100.0
Missing	22	
Use of infusion pump		
Yes	37	11.8
No	276	88.2
Total	316	100.0
Missing	4	

The chi-square test and the t-test analysis of the relationship between the different factors and phlebitis showed statistically significant results in the variables 'lower limb catheterised', 'administration of potassium chloride', and 'receiving IV antibiotics', namely 'Levofloxacin' and 'Azithromycin' (table 3).

Using the odds ratios and a CI of 95%, table 3 shows patients with catheterised upper-extremities had a less than 72% chance of developing phlebitis than those with lower catheterised limbs (OR: 0.281; CI: 0.097-0.807). The odds increase 1.95 times (OR: 1.951; CI: 1.057-3.601) if potassium chloride is prescribed, and 1.92 times (OR: 1.916; CI: 1.184-3.100) with IV antibiotics. If Levofloxacin is used, odds increase 2.3 times (OR: 2.264; CI: 1.031-4.968) and if it is Azithromycin, they increase 2.5 times (OR: 2.468; CI: 1.168-5.213).

Table 4 shows the multivariate analysis of risk factors for phlebitis. The most significant risk factors for phlebitis were patients receiving KCl (OR: 2.112; CI: 1.124-3.969) or antibiotics (OR: 1.877; CI: 1.141-3.088) and patients with an upper catheterised limb (OR: 0.31; CI: 0.111-0.938).

Table 3: Risk factor for phlebitis in patients with PIVCs

Factors	Phlebitis		Bivariate Analysis OR (95% CI)	
	Yes n (%)	No n (%)		
Catheterised limb			X ² = 6.217, df= 1, p = 0.015	0.281 (0.097-0.807)
Upper	124 (42.2)	170 (57.8)		
Lower	13 (72.2)	5(27.8)		
KCl			X ² = 4.671, df=1, p = 0.043	1.951 (1.057-3.601)
Yes	29 (58.0)	21 (42.0)		
No	109 (41.4)	154 (58.6)		
Antibiotics			X ² = 7.106, df= 1, p = 0.009	1.916 (1.184-3.100)
Yes	37 (33.6)	73 (66.4)		
No	101 (49.3)	104 (50.7)		
Levofloxacin			X ² = 4.326, df= 1, p = 0.049	2.264 (1.031-4.968)
Yes	18 (62.1)	11(37.9)		
No	120 (42.0)	166 (58.0)		
Azithromycin			X ² = 5.886, df=1, p = 0.025	2.468 (1.168-5.213)
Yes	21 (63.6)	12 (36.4)		
No	117 (41.5)	165 (58.5)		

Table 4: Logistic regression of risk factors for phlebitis

Independent variables	B	S.E.	df	Sig.	OR	OR 95% CI	
						Lower	Upper
KCI (Yes)	0.748	.322	1	0.020	2.112	1.124	3.969
Antibiotics (Yes)	0.630	.254	1	0.013	1.877	1.141	3.088
Catheterised limb (Upper)	-1.132	.545	1	0.038	0.322	0.111	0.938
Constant	0.283	.576	1	0.623	1.327		

DISCUSSION

Incidence of phlebitis

The incidence of phlebitis in this study (11.09%) is congruent with the findings of (3.7% to 67.24%) Oliveira and Parreira (2010); however, it is above the 5% established by the INS (2006). The most common grades of phlebitis were grade 1 and 2 (37.0% and 53.6%, respectively). Uslusoy and Mete (2008) also found grade 1 phlebitis to be the most frequent (44.5%).

Gender and age

No gender differences were observed in the development of phlebitis, which is in congruent with other studies (Furtado 2011; Uslusoy and Mete 2008; Abbas et al 2007; Regueiro Pose 2005; Owens et al 1998). However, Campbell (1998) and Maki and Ringer (1991) found the female gender was a predictor of phlebitis. In other studies, the male gender showed a greater risk of phlebitis (Lanbeck et al 2003 and 2002; Lundgren et al 1993).

Correlation between age and phlebitis was not significant, which is congruent with other studies (Furtado 2011; Uslusoy and Mete 2008; Malasch et al 2006; Regueiro Pose et al 2005; Owens et al 1998). Other studies show patients aged 60 and over are more at risk for phlebitis (Carballo et al 2004; Lundgren et al 1993; Maki and Ringer, 1991).

Anatomical region used for catheterisation

When upper-extremity veins were catheterised, patients had less than 72% chance of developing phlebitis, in comparison with the lower limbs. However, no statistically significant differences were observed between the specific anatomical site used (hand, forearm, wrist) and phlebitis, which is congruent with studies by Regueiro Pose et al (2005) and Owens et al (1998). Other studies show the risk is lower when PIVCs are inserted in the hand/wrist than in the forearm (Lanbeck et al 2003; Maki and Ringer 1991). Nevertheless, dorsal side of the hand veins are predictive of high risk for thrombophlebitis (Cicolini et al 2009). Thus, it seems catheter insertion in flexion or high mobility areas contribute to the development of traumatic phlebitis (Furtado 2011; Uslusoy and Mete 2008; Rivas Doblado et al 2004), and both veins of the upper limbs should be considered, instead of those of the lower limbs, due to the risk of embolisms and thrombophlebitis (RCN 2010; INS 2006).

Catheter gauge

Catheter gauge has no influence on phlebitis, which is congruent with other studies (Uslusoy and Mete 2008; Abbas et al 2007; Ferreira et al 2007; Regueiro Pose et al 2005; Rivas Doblado et al 2004). Nonetheless, many authors have highlighted the advantages of using smaller gauge catheters (Furtado 2011; Cicolini et al 2009; Tagalakakis et al 2002; Lanbeck et al 2002). The guidelines consulted confirm this as these catheters allow blood to flow in the adjacent tissue, preventing vein damage (O'Grady et al 2011; RCN 2010; JBI 2008; ISN 2006; O'Grady et al 2002).

Catheter material

No statistically significant differences were found between catheter material and phlebitis. However, some studies have indicated catheter material can cause complications. Tagalakis et al (2002) found polyurethane was associated to a decrease of 30-45% on the incidence of thrombophlebitis, when compared to teflon. Maki and Ringer (1991) showed vailon catheters are less likely to cause phlebitis than teflon catheters. Nonetheless, the JBI (2008) and O'Grady et al (2002) state teflon and polyurethane are associated with less infectious complications (more resistant to bacterial adherence) than polyvinyl or polyethylene catheters.

Number of simultaneous catheters

No significant differences were found between the number of simultaneous catheters and phlebitis. However, Maki and Ringer (1991) show that the risk of phlebitis increases 1.54 times when another catheter has already been inserted. Regueiro Pose et al (2005) also found that the incidence of phlebitis increases depending on the number of catheters inserted, as does the level of severity (Ferreira et al 2007). Incidence also increases when catheters are repeatedly inserted in the same arm (Uslusoy and Mete 2008).

Catheter securement

In 74.4% of the cases, the material used to secure the catheter was adhesive tape. However, it was not possible to significantly correlate this fact with phlebitis. Other studies compared the use of sterile gauze with a transparent film and concluded there were no statistically significant differences between both types of dressings and the early detection of phlebitis (Bispo and Zanetti 2004; San Martin et al 2002). The easiness, the time necessary to place the dressing and the possibility of seeing the catheterisation site are aspects regarding the transparent dressing which nurses valued in these studies.

Catheter dwell time

No statistically significant differences were found between catheter dwell time and phlebitis. However, most studies recommend PIVCs should be replaced every 72 hours (Powell et al 2008; Ferreira et al 2007; Myrianthefs 2005; Regueiro Pose et al 2005; Carballo et al 2004). Other studies suggest catheter removal only when it is clinically indicated is not different, in terms of complications, from its replacement every three days (Rickard et al 2010). O'Grady et al (2011) and the Lee et al (2009) consider there is no need to replace PIVCs more than every 72-96 hours to reduce the risk of infection and phlebitis.

Intravenous medication

Statistically significant differences were found between the administration of potassium chloride and antibiotics, particularly Levofloxacin and Azithromycin. Potassium chloride increased the probability of phlebitis by 1.95 times and antibiotics led to an increase of 1.92 times, which was 2.3 times higher with Levofloxacin and 2.5 times higher with Azithromycin. Furtado (2011) and Maki and Ringer (1991) also refer medication, such as KCl, as leading to phlebitis. Antibiotics also increased the risk of phlebitis significantly when compared to other drugs (Regueiro Pose et al 2005; Lanbeck et al 2002; Maki and Ringer 1991).

No significant differences were found between the administration of a serum infusion and phlebitis. However, the low pH and the high osmolarity of solutions, such as hypertonic solutions, are associated to a high risk of phlebitis (Uslusoy and Mete 2008; Tagalakis et al 2002; Campbell 1998).

As for the number of IV drugs, no significant differences were found. However, according to Uslusoy and Mete (2008), drugs administered four or more times a day were two times more likely to cause phlebitis than drugs administered one to three times a day. Furtado (2011) also found drugs administered seven or more times led to a high rate of phlebitis. The reasons presented for this may be linked to the pH of the administered drugs and the need to manipulate the catheter site more often (Uslusoy and Mete 2008).

Regarding the infusion rate (continuous or intermittent), no differences were observed. Other researchers found the risk of phlebitis was higher in the PIVCs which were kept intermittently than in those maintained continuously (Ferreira et al 2007; Regueiro Pose et al 2005; Carballo et al 2004; Owens et al 1998). In contrast, Furtado (2011) stated continuous infusion was a predictor of phlebitis.

No statistically significant differences were found between the use of infusion pumps and phlebitis. Nonetheless, Uslusoy and Mete (2008) found a higher incidence of phlebitis when perfusions were made using infusion pumps. In contrast, a study by Curran et al (2000) showed the incidence of phlebitis decreased with infusion pumps.

Catheter insertion setting

PIVCs inserted on the ward where the study was being conducted (74.4%) or in the emergency room (25.0%). No statistically significant differences were observed in the development of phlebitis, which is congruent with other studies (Regueiro Pose et al 2005; Carballo et al 2004). However, other researchers indicate catheter insertion in the emergency room promoted the development of phlebitis in comparison with those inserted in inpatient units (Maki and Ringer 1991; Tagalakakis et al 2002). In contrast, Furtado (2011) found PIVC insertion in an inpatient unit was a predictor of phlebitis, when compared to other services (emergency room and operating room).

STUDY LIMITATIONS

The fact that different members of the nursing team assessed and recorded the development of phlebitis may have created different assessment criteria.

RECOMMENDATIONS

A randomised controlled trial should be conducted to improve variable control and further develop the issue of PIVC replacement only when clinically indicated and not as a routine – an issue which O'Grady et al (2011) has not yet solved. Follow-up should be conducted with patients after catheter removal, not only when phlebitis is detected.

CONCLUSIONS

The predisposing factors for phlebitis are the catheterisation site and the use of antibiotics and potassium chloride, regardless of the patient's profile (mean age and high levels of dependency). Although the results show the development of phlebitis does not rely solely on nurses' practices, the authors conclude these professionals can have an important role in the prevention of phlebitis, reducing the number of risk factors through vigilance and compliance with drug administration guidelines. The careful selection of the catheterisation site is also an important risk factor for phlebitis and depends entirely on nursing intervention.

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