Position of peripheral venous cannulae and the incidence of thrombophlebitis: an observational study

Giancarlo Cicolini, Antonia Pollidoro Bonghi, Luisa Di Labio & Rocco Di Mascio

Accepted for publication 21 January 2009


**Abstract**

Title. Position of peripheral venous cannulae and the incidence of thrombophlebitis: an observational study.

Aim. This paper is a report of a study conducted to investigate the most suitable location of peripheral venous cannulae to reduce the incidence of thrombophlebitis.

Background. Peripheral intravenous cannulae are used for vascular access, but the site of insertion and size of the cannula could expose patients to local and systemic infectious complications. Small cannula size is an important factor in reducing the incidence of thrombophlebitis, but cannula location has not yet been studied. Evidence-based knowledge on how to prevent these complications is needed.

Method. An observational survey carried out was carried out in 2007 with 427 patients in one Italian hospital. A structured observation protocol was used to survey the frequency of thrombophlebitis and the relationship of location and size of peripheral intravenous cannulae. The variables evaluated were age, gender, cannula size and site of cannula location. Chi-square or Student t tests were used, and the adjusted odds ratios and relative 95% confidence intervals are reported.

Results. The frequency of peripheral intravenous cannulae thrombophlebitis was higher in females (OR:1.91;CI:1.20–3.03;P < 0.006). The highest incidence was found in patients with cannulae inserted in the dorsal side of the hand veins compared to those with cannulae inserted in cubital fossa veins (OR:3.33;CI:1.37–8.07;P < 0.001).

Conclusion. The use of cubital fossa veins rather than forearm and hand veins should be encouraged to reduce the risk of thrombophlebitis in patients with peripheral intravenous cannulae.

**Keywords**: complications, incidence, nursing, observational study, peripheral venous cannulae, position, thrombophlebitis

**Introduction**

Insertion and care management of peripheral venous catheters (PVC) is routine for nurses in various healthcare settings. Nurses generally prefer arm veins, i.e. cubital fossa veins, forearm veins and hand veins. Routine use of PVCs includes administration of drugs, fluids, nutrition, blood and blood products (Macklin 2003, Ahlqvist *et al.* 2006). Although such
devices provide necessary vascular access, their use puts patients at risk for local and systemic infective complications, including insertion site infection, intravascular catheter-related bloodstream infections (CRBSI) and thrombophlebitis (Th). PVC-related complications can be related either to patient- or to hospital-related factors (O’Grady et al. 2002). Hospital-related factors, such as materials and PVC size, insertion sites and placement, frequency and time of catheterization, and types of infusion fluids influence the risk of complications (Uslusoy & Mete 2008). Prolonged PVC use increases the risk of developing a Th episode, especially in older patients, women and patients with vascular disease or neutropenia (Macklin 2003). The frequency of Th varies widely in different reports, but 5% was shown by Creamer et al. (2002), 54-5% by Uslusoy and Mete (2008) and 67-2% by Karadeniz et al. (2003). Many studies show different Th incidences in patients admitted with PVC, the incidence of Th in these patients increasing in relation to the duration in which the catheters are kept in situ (Barker et al. 2004, Uslusoy & Mete 2008). There are different opinions concerning Th development and appearance, but duration of catheterization, catheter-related infections, and catheter materials are important risk factors for peripheral vein Th. The symptoms of Th vary in different reports, but include tenderness, redness, pain, swelling, increased local temperature, hardness, increasing pain, spreading redness and sometimes fever (Grune et al. 2004, Ahlqvist et al. 2006).

Several studies have been performed to identify the ideal PVC location. Handling of peripheral intravenous cannulae (Ahlqvist et al. 2006), PVC size and duration of PVC application in veins have been studied (Abbas et al. 2007, Uslusoy & Mete 2008). However, to our knowledge no researchers have specifically compared different anatomical sites of cannulation, and therefore the site associated with lowest risk of Th is not known.

The study

Aim

The aim of the a study was to investigate the most suitable location of peripheral venous cannulae in order to reduce the incidence of thrombophlebitis.

Design

An observational study carried out in 2007 in the surgical and medical departments of a hospital in Italy. A structured observational protocol was used for data collection.

Participants

A total of 427 consecutive patients admitted to the surgical and internal medicine departments were enrolled in the study. Patients admitted with a catheter from the emergency room, those admitted for less than 12 hours and those with blood infection were excluded.

Data collection

For data recording purposes, time 0 (T0) was considered the time when a PVC was inserted. All PVCs were inserted by specialist nurses from surgical or Internal medicine departments. All patients were followed from cannulae insertion to removal. Sex and age were taken from individual patient records, and duration catheter remained in situ (hours), size and location were recorded. In agreement with the Guidelines for the Prevention of Intravascular Catheter-Related Infections from the Centre for Disease Control (CDC) of Atlanta (2002), we observed PVC sites for a minimum of 12 hours to a maximum of 96 hours. Only one specialist nurse performed all the observations, and made assessments according to the criteria for thrombophlebitis ranking. Every PVC location was observed daily, specifically after 12 hours (T1), 24 hours (T2), 48 hours (T3), 72 hours (T4) and 96 hours (T5). In the presence of redness, tenderness (first-degree) or further signs of Th, the catheter was removed. In patients without signs of Th, the catheter was removed or replaced after 96 hours (four days and nights), as recommended by the CDC of Atlanta (2002). Insertion site and cannula size was observed and documented daily, and only one cannula was observed in every patient. This was done using the checklist from Lundgren et al. (1993).

Thrombophlebitis in this study was defined as follows:

Degree 0: No complications, none or slight discomfort; tenderness at insertion

Degree 1: Slight thrombophlebitis – Redness and tenderness

Degree 2: Medium thrombophlebitis – Redness, tenderness, pain and slight swelling

Degree 3: Severe thrombophlebitis – Redness, tenderness, pain, swelling more than 2 × 4 cm; increased temperature in the area and palpable cord in the vein

Degree 4: Very severe thrombophlebitis – Redness, pain, swelling more than 5 × 8 cm; increased temperature in the area; palpable cord in the vein; pain spreading up to the arm; red line; and possibly fever.

The duration time of the peripheral catheter, care and handling of the catheter, fluids infused, complications and signs/symptoms were all observed and recorded. When a complication was noted, observation of the patient’s
symptoms continued after removal of the catheter until the patient was symptom-free. If complications remained after discharge, contact continued by means of regular telephone interviews for up to 1 week.

**Ethical considerations**

The study was approved by the appropriate ethics committee. Eligible patients were given information about the study and informed consent was obtained from all patients included.

**Data analysis**

The variables evaluated were: age (≤30, 31–60 or ≥61 years), sex, size of cannula and location of insertion. The quantitative variable (age) was summarized as mean (SD), while all qualitative variables were summarized as frequencies and percentages. Percentage incidence rate of thrombophlebitis was calculated for each variable. Chi-square or Student t tests were used to evaluate differences in patient characteristics between the two subgroups (patients with and without thrombophlebitis) and to identify independent risk factors which predicted thrombophlebitis.

The relationships of potential predictors of thrombophlebitis were investigated using a multivariate logistic regression model adjusted for age, sex, size and location. For each factor, the adjusted odds ratio (OR) and relative 95% confidence interval (95% CI) are reported. All statistical analysis was performed using SPSS® Advanced Statistical™ 13 (2004, Chicago, IL, USA) software package.

**Results**

All PVCs were introduced in the peripheral veins of the cubital fossa, forearm or hand. We observed 427 patients (Table 1), with a mean age (SD) of 48.3 years (21.7) and a range of 12–101 years. One hundred forty-one patients were male and 286 were female, and 151 presented no signs of Th [mean age 50.7 (21.6) 66 male (46.8%) 85 female (29.7%)]. However, 276 patients [age 47 (21.7), 75 (53.2%) male and 201 (70.3%) females] showed signs of Th: first-degree, 233 (84.4%), second-degree, 35 (12.7%), and eight (2.9%) third-degree. No patients showed fourth-degree Th. There was no statistically significant difference in Th frequency between age. There was, however, a statistically significant difference in frequency between the sexes, the incidence being greater in female patients (OR:1.91; CI:1.20–3.03; P < 0.006).

Sterile and non-occlusive dressings were used for 384 (89.9%) patients and in 43 (10.1%) a polyurethane dressing was used.

The most commonly used cannula sizes were: n = 215 (50.4%) with size 1.0 mm (20 gauge), n = 132 (30.9%) size 1.2 mm (18 gauge), n = 70 (16.4%) with cannulae size 0.8 (22 gauge) and n = 10 (2.3%) with size 1.4 mm (16 gauge). Of these, 201 (47.1%) were placed in cubital fossa veins, 182 (42.6%) in forearm veins and 44 (10.3%) on the dorsal side of hand.

Thrombophlebitis was statistically significantly higher in patients with catheters inserted on the dorsal side of the hand compared to the cubital fossa veins (75% vs. 62.7%, P < 0.001). Therefore, use of the upper side of the hand as a PVC insertion point was associated with a statistically significant increase in the OR risk for Th (OR:3.33; 95% CI:2.03–5.42; P < 0.001).

**Table 1** Incidence of thrombophlebitis (Th) in relation to sex, age, cannulae size and location of cannulae in patients from surgery and internal medicine department

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>With signs of thrombophlebitis</th>
<th>No signs of thrombophlebitis</th>
<th>Chi-square P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall, n (%)</td>
<td>427</td>
<td>276 (64.6)</td>
<td>151 (35.4)</td>
<td>0.01</td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>141 (33.0)</td>
<td>75 (53.2)</td>
<td>66 (46.8)</td>
<td>0.01</td>
</tr>
<tr>
<td>Female</td>
<td>286 (67.0)</td>
<td>201 (70.3)</td>
<td>85 (29.7)</td>
<td>0.01</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>48.3 ± 21.7</td>
<td>47.0 ± 21.7</td>
<td>50.7 ± 21.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Cannula size, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 gauge</td>
<td>10 (2.3)</td>
<td>70 (70.0)</td>
<td>3 (30.0)</td>
<td>0.01</td>
</tr>
<tr>
<td>18 gauge</td>
<td>132 (30.9)</td>
<td>107 (81.1)</td>
<td>25 (18.9)</td>
<td>0.01</td>
</tr>
<tr>
<td>20 gauge</td>
<td>215 (50.4)</td>
<td>131 (60.9)</td>
<td>84 (39.1)</td>
<td>0.01</td>
</tr>
<tr>
<td>22 gauge</td>
<td>70 (16.4)</td>
<td>31 (44.3)</td>
<td>39 (55.7)</td>
<td>0.01</td>
</tr>
<tr>
<td>Location of cannula, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cubital fossa</td>
<td>201 (47.1)</td>
<td>126 (62.7)</td>
<td>75 (37.3)</td>
<td>0.05</td>
</tr>
<tr>
<td>Forearm</td>
<td>182 (42.6)</td>
<td>113 (62.1)</td>
<td>69 (37.9)</td>
<td>0.01</td>
</tr>
<tr>
<td>Hand</td>
<td>44 (10.3)</td>
<td>37 (75.0)</td>
<td>7 (25.0)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*Student’s t-test for independent sample.
CT: 137–8/07). In contrast, no statistically significant differences in the risk of Th were found between the cubital fossa and forearm veins (OR: 0.83; CI: 0.53–1.30; P = ns) (Table 2).

Seventy percent of patients with signs of Th had 16 gauge cannulae and 107 (81.1%) had 18 gauge, while those with 20 and 22 gauge had signs of Th: 131 (60.9%) and 31 (44.3%), respectively. Thrombophlebitis incidence was statistically significantly lower in patients with 22 gauge cannulae compared to 16–18 gauge (OR: 5.38; CI: 2.70–10.72; P < 0.001). There was a statistically significant difference in thrombophlebitis events between 20 and 22 gauge (OR: 1.89; CI: 1.04–3.47; P < 0.038) (Table 2).

Discussio

Thrombophlebitis is the most common complication of intravenous catheters and can lead to many problems, including higher costs of therapy and longer hospital stays. The purpose of this study was to investigate the most suitable location of peripheral venous cannulae in order to reduce the incidence of thrombophlebitis. About 89 percent of cannulae (89.7%) were located in the cubital fossa or forearm veins vs. 10.3% in the hand veins. These data show that nurses prefer to use the cubital fossa or the forearm veins, rather than the hand veins.

Women developed more Th than men; in fact, we recorded 201 (70.3%) women with Th compared to 75 (53.2%) men. In another study (Nassaji-Zavareh & Ghorbani 2007), female sex was also a predisposing factor in the development of intravenous PVC-related Th (OR: 1.91; CI: 1.20–3.03; P < 0.006), but Uslusoy and Mete (2008) and Cornely et al. (2002) found that sex was not a risk factor. We have no satisfactory explanation for these observations.

We showed statistically significantly higher Th signs in patients with cannulae placed on the dorsal side of the hand compared to the cubital fossa veins (OR: 3.33; CI: 1.37–8/07; P < 0.001). Similarly, Aygu¨n et al. (2004) found phlebitis to occur most frequently in catheters inserted in hand veins, while Karadeniz et al. (2003) reported that it developed most frequently in catheters inserted in the forearm veins. However, Uslusoy and Mete (2008) showed that phlebitis frequently developed in catheters inserted in the cubital fossa.

In our study, Th frequencies were found to be quite high, 64.6% vs. 35.4% of patients without signs, when catheters were in place. This rate of phlebitis was higher than that reported by Uslusoy and Mete (2008) (54.5%), but less than that of Karadeniz et al. (2003) (67.2%). One reason for the different rates may be small sample sizes. In addition, patients remain in general surgery units for a shorter period than those in internal medicine units and other units. As a result, they undergo intravenous interventions for shorter periods of time. The present study was carried out in general surgery and internal medicine inpatient units, while other studies were carried out only in internal medicine inpatient units. However, we should underline that the majority of Th events occurring in our study were of first-degree (84.4%), typically characterized by redness and tenderness around the insertion site. This may be related to nurses’ compliance with the recommendations of the guidelines regarding hygienic aspects and indwelling time of PVCs, an aspect which was not included in the study.

The incidence of phlebitis in patients ≤30 years of age was not statistically significant, but was higher than in those aged 31–60 years (OR: 0.54, CI: 0.31–0.94) and ≥61 (OR: 0.75, CI: 0.41–1.39).

We found a statistically significant difference between Th and catheter size: Th was statistically significantly lower in patients with 22 gauge cannulae compared to 16–18 gauge (OR: 5.38; CI: 2.70–10.72; P < 0.001), and between 22 and 20 gauge (OR: 1.89; CI: 1.04–3.47; P = ns). Uslusoy and Mete (2008) found no statistically significant difference between phlebitis and catheter size. A higher rate of Th in patients with 16–18 gauge cannulae may be due to the endothelial damage induced by the size of the cannula, which may predispose patients to phlebitis. Greater care during insertion and removal of the catheter might reduce the rate of thrombophlebitis in these patients. Macklin (2003) concluded that small catheters allow more blood flow in adjacent tissues and thereby prevent damage to the intima of the vein.

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What is already known about this topic

- The risk factors for thrombophlebitis in patients with intravenous cannulae in situ include older age, frequency and time of catheterization and types of infusion fluids.
- The size of peripheral intravenous catheters is important in reducing the risk of thrombophlebitis.
- Female gender is predictive of high risk for thrombophlebitis.

What this paper adds

- Thrombophlebitis can be correlated to peripheral venous cannulae sites.
- Use of cubital fossa veins could reduce the incidence of thrombophlebitis.
- The incidence of thrombophlebitis could be reduced by using small size peripheral intravenous catheters.

Implications for practice and/or policy

- The cubital fossa veins should be preferred as peripheral venous catheters insertion site.
- Further research is needed to generate interventions for the management of vascular devices.

Study limitations

The study had a number of limitations. The number of patients with PVCs placed in veins of the dorsal side of hands was lower than at other sites (44 vs. 182 and 201). The variable ‘duration between cannulae insertion and removal’ is an important factor in Th incidence, but was not included in our data analysis.

In the literature the definition of catheter-related infections is not clear and clinical presentations vary, and this makes comparisons between reported results more difficult. Furthermore, the inflammatory response in adults and older people is often impaired and signs and symptoms of phlebitis may be subtle. In addition, older patients present fewer signs and symptoms. Given the limitations of this study, it is not possible to generalize the findings. For major change to occur in nursing clinical practice more studies with larger sample sizes are warranted.

Conclusion

The site of venous puncture and cannulae size are very important in reducing the risk of Th. Our data suggest that the dorsal side of the hand veins are predictive of high risk for developing Th and, when possible, the cubital fossa veins should be preferred as PVC insertion site in hospitalized patients.

Our results emphasizes the importance of considering the position of peripheral venous catheters in reducing the risk of a thrombophlebitis event occurring and we encourage future research in this field. It may be useful to investigate the relationship between thrombophlebitis, medical diagnosis and catheterization techniques. It is also important to investigate the correlation between hygienic aspects and thrombophlebitis incidence. Assessing the proper positioning of a PVC can bring advantages both to patients and to hospitals, with a possible reduction of costs. However, further research to test whether our results can be generalized.

Acknowledgements

We are indebted to Prof. Francesco Cipollone for his helpful suggestions and critical review of the manuscript.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of interest

No conflict of interest has been declared by the authors.

Author contributions

CG was responsible for the study conception and design. PBA & DLL performed the data collection. CG & DMR performed the data analysis. CG was responsible for the drafting of the manuscript. DMR provided statistical expertise.

References


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