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# Use of peripheral venous catheters in two Norwegian hospitals

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## ORIGINAL ARTICLE

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## **BACKGROUND**

Most patients in Norwegian hospitals are routinely given one or more peripheral venous catheters. A peripheral venous catheter is considered to be a benign device but may entail a risk of local infection with resulting bloodstream infection and sepsis. Good practice in the insertion and care of these catheters is essential to prevent infection.

## **MATERIAL AND METHOD**

This study presents Norwegian data from the 'One Million Global Catheters Study', which evaluated practice in relation to peripheral venous catheters in 419 hospitals in 51 countries. Two Norwegian hospitals collected data from medical and surgical wards on a single day in November 2014 (Levanger Hospital) and a single day in February 2015 (St Olavs Hospital). Professional development nursing specialists recorded observations of peripheral venous catheters such as insertion site, dressing, documentation and indication.

## **RESULTS**

We evaluated 136 peripheral venous catheters in a total of 121 patients. We found 44 (32.4 %) catheters associated with various clinical problems such as pain, redness or swelling around the insertion site, catheter dislocation, or blood in the infusion set. Altogether 50 peripheral venous catheters (36.8 %) were not in use for either medications or fluid on the day in question. In 93 of 131 cases (71.0 %), there was no documentation of venous catheter assessment in the previous 24 hours.

## **INTERPRETATION**

Care and monitoring of venous catheters could be significantly improved. There was considerable incidence of unused peripheral venous catheters, and lack of documentation was widespread.

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## **Main findings**

An assessment of 136 peripheral venous catheters at two Norwegian hospitals on two arbitrarily chosen days found that 36.8 % of the catheters were not in use on the day in question, while 71.0 % lacked documentation of site assessment in the patient chart within the previous 24 hours.

The prevalence of phlebitis was 22.1 %.

Phlebitis, leakage, pruritus under the dressing, blood in the infusion set, or dislodgement of the venous catheter occurred in 32.4 % of cases.

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Peripheral venous catheters are used frequently in Norwegian hospitals to administer intravenous fluids, drugs and blood products (1). In Norway, no record is kept of the number of patients who have a peripheral venous catheter, how many catheters each patient has, or how long these catheters remain in place. In 2017, there were approximately two million admissions to Norwegian somatic hospitals (2). Up to 3.2 million peripheral venous catheters are used each year, according to procurement statistics (3). The proportion of these catheters that have been in active use is unknown, but international studies suggest that 14 % of venous catheters are inserted 'just in case' (4).

The most common and best known complication of peripheral venous catheter usage is phlebitis. This occurs in approximately 10 % of patients (1, 5) and may have a chemical, mechanical or infectious aetiology (6). Peripheral venous catheters can also be an entry point for catheter-associated bloodstream infections (1). The risk is low when correct procedures are followed (7, 8), but much remains unknown. A review from 2006 estimated the incidence rate of peripheral venous catheter-related bloodstream infections to be about 0.5 per 1 000 catheter days (8), with 12–64 % of these infections caused by *Staphylococcus aureus* (6). The Gemini Centre for Sepsis Research found that 7.5 % of cases of sepsis with *S. aureus* were probably caused by the patient's intravenous catheter (9). Bloodstream infection with *S. aureus* is a serious condition with high morbidity and mortality (10). Given that catheter usage is highly prevalent in clinical practice, catheter-related infections may pose a considerable risk to patients. The mechanisms underlying catheter-related bloodstream infection are unclear, but aseptic technique during insertion as well as proper care and monitoring appear to be of great importance (11).

This study presents the results from the two Norwegian hospitals that participated in the 'One Million Global Catheters Study' (OMG study), a large international prevalence study on the use of peripheral venous catheters (4). In our sub-study, we tested the following: Is phlebitis associated with a) current use of a peripheral venous catheter (yes/no), b) documented site assessment of a peripheral venous catheter (yes/no), c) soiled dressing (yes/no), d) loosened dressing (yes/no), e) visible blood in the infusion set (yes/no) and f) number of catheter days? We also wished to determine whether peripheral venous catheters that were not in use had undergone a documented site assessment, and whether the number of catheter days was associated with the development of phlebitis.

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## Material and method

The One Million Global Catheters PIVC worldwide prevalence study (4, 12) was initiated by the University of Western Sydney, Australia. The aim was to examine complications and risk factors associated with the use of peripheral venous catheters worldwide. The 419 participating hospitals in 51 countries were sent a standardised data collection form developed at Griffith University, Australia (Appendix 1).

The study was approved by the Griffith University Human Research Ethics Committee (application NRS/34/13/HREC). The project was also evaluated and approved by the Regional Committee for Medical and Health Research Ethics, Central Norway (case no. 2014/951). No directly identifiable data were collected, and each patient provided verbal consent upon inclusion.

Hospitals were recruited through professional networks, health organisations, the Norwegian Ministry of Health, suppliers of intravenous equipment, and social media (4). In Norway, the directors of all regional health trusts and all hospitals were contacted by e-mail. Only St. Olavs Hospital and Levanger Hospital responded. The former is a university hospital with 800 beds and responsibility for 725 600 inhabitants in Central Norway. Levanger Hospital is a local hospital in Trøndelag county with 265 beds and responsibility for approximately 100 000 inhabitants. Data were collected in the form of a prevalence study on an arbitrarily chosen weekday in November 2014 (Levanger Hospital) and February 2015 (St. Olavs Hospital, Trondheim University Hospital). Seven surgical and medical wards (156 beds) participated at St. Olavs Hospital, along with all medical and surgical wards (66 beds and 60 beds, respectively) at Levanger Hospital.

The study population comprised all patients  $\geq 18$  years of age with peripheral venous catheters who were available on the wards in question on the screening day. Patients who were undergoing diagnostic examinations at the time of screening were excluded.

A total of 13 professional development nursing specialists at the two hospitals performed the catheter assessments. Prior to data collection, the English-language form (Appendix 1) was reviewed by the participating nurses to ensure common understanding of the variables.

The form was completed for each venous catheter and contained: a) background information (hospital and country, ward, prevalence date, patient age and sex), b) date and time of peripheral venous catheter insertion, reason for catheter insertion, catheter brand and size, insertion environment and anatomical placement, (c) clinical observations of the venous catheter (insertion site, condition of dressing, catheter connections), (d) catheter site assessment within the past 24 hours documented in the patient chart, and (e) intravenous fluids and medications administered on the prevalence day. Data were entered into an electronic form.

After data collection, the nurse responsible for the patient was instructed to inspect, remove or replace the venous catheter if it was causing serious clinical problems, in accordance with professional guidelines.

Descriptive statistics are presented in the form of number (n) and percentage (%) for categorical variables and mean (standard deviation, SD) for continuous variables.

A collective variable for phlebitis (yes/no) was defined as the presence of at least one of the following clinical problems: pain/tenderness on palpation, redness  $>1$  cm from insertion site, swelling  $>1$  cm from insertion site, purulence, palpable hard vein cord beyond IV tip, streak/red line along vein, or induration/hardness of tissues  $>1$  cm (5). Yes/no data for '*peripheral venous*

*catheter in use'* were generated by combining the variables 'IV fluids today (none)' and 'IV medications today (none)' on the basis of information in the patient's chart/medical records. If the catheter had not been used for either infusions or medications, the variable was assigned the value 'no'.

The number of catheter days was defined as the number of days between catheter insertion and the date of screening. Peripheral venous catheters inserted on the screening day were thus scored as 0 catheter days.

We used a two-level, mixed logistic regression model with phlebitis as the dependent variable, the hypothesis variables (one at a time) as independent variables, and the patient as the random effect. The model took into account the lack of independence between multiple venous catheters in the same patient. A sensitivity analysis was performed and two patients with three peripheral venous catheters were excluded.

The analyses were performed in Stata version 15.1 and SPSS version 25.

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## Results

A total of 136 peripheral venous catheters were evaluated – 63 at St. Olavs Hospital, Trondheim University Hospital and 73 at Levanger Hospital – in 121 patients on 17 medical and surgical wards (Table 1). All catheters were of the BD Venflon type. One patient at St. Olavs Hospital chose not to participate in the study. In all, 112 patients (92.6 %) had one catheter, nine patients (7.4 %) had two, and two patients (1.7 %) had three (Table 1). Most catheters were in the hand or in the forearm. The average number of catheter days was 1.7 (SD 1.5, range 0–7).

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**Table 1**

Descriptive statistics for 136 peripheral venous catheters evaluated in 121 patients at two Norwegian hospitals on a single day in November 2014 (Levanger Hospital) and a single day in February 2015 (St. Olavs Hospital). SD = standard deviation

	<b>St. Olavs Hospital</b>	<b>Levanger Hospital</b>	<b>Total</b>
Number of patients	54	67	121
Age: mean (SD)	72 (17.7)	63 (18.5)	68.5 (18.1)
Sex: female, n (%)	28 (44.4)	28 (38.4)	56 (41.2)
Number of venous catheters	63	73	136
Medical ward	12	43	55
Surgical ward	51	30	81
Number of catheter days			
Median (range)	1 (0–7)	1 (0–4)	1 (0–7)
Mean (SD)	2 (2.1)	1.3 (1.1)	1.6 (1.7)

A total of 50 (36.8 %) peripheral venous catheters had not been used on the day of screening. In 93 of 131 cases (71.0 %), the patient chart contained no record of the peripheral venous catheter having been inspected within the past 24 hours; for the other five cases the chart was not available (Table 2). Problems were seen in association with 44 (32.4 %) catheters, such as signs of phlebitis, dislodgement, leakage, or blood in the line. Thirty (22.1 %) venous catheters were accompanied by one or more signs of phlebitis, while nine (6.6 %) had two or more signs. Table 3 shows the number and percentage of cases of phlebitis associated with selected clinical problems.

**Table 2**

Prevalence of clinical problems, lack of documentation, and condition of dressing for 136 peripheral venous catheters on an arbitrarily chosen day at Levanger Hospital (in November 2014) and St. Olavs Hospital (in February 2015).

Variables	Number (%)
Venous catheters with one or more problems <sup>1</sup>	44 (32.4)
Patient-reported pain/tenderness on palpation	18 (13.2)
Redness > 1 cm from insertion site	14 (10.3)
Swelling > 1 cm from insertion site	5 (3.7)
Blood in line	19 (14.0)
Other problems at the insertion site <sup>2</sup>	9 (9.5)
Lack of documentation/use of venous catheter	
No documented venous catheter assessment in the patient chart in last 24 hours <sup>3</sup>	93 (68.3)
Venous catheter not in use on the day in question	50 (36.8)
Condition of dressing	
Soiled dressing	28 (20.6)
Loose or lifting edges	11 (8.1)
Other problems with dressing, including non-sterility	4 (3.0)
Clean, dry and intact	95 (69.9)

<sup>1</sup>A collective variable of 13 underlying clinical problems; the presence of any one of these is sufficient

<sup>2</sup>Itch/rash under dressing, palpable hard vein cord beyond IV tip, streak/red line along vein, induration/hardness of tissues > 1 cm, leaking venous catheter

<sup>3</sup>n = 131 (5 data collection sheets with missing information)

**Table 3**

Crossover table showing the association between phlebitis and specific clinical issues for 136 peripheral venous catheters on an arbitrarily chosen day at Levanger Hospital (November 2014) and St. Olavs Hospital (February 2015).

Clinical issue	Prevalence	Phlebitis <sup>1</sup> , Number (%)	No Phlebitis, Number (%)
Peripheral venous catheter in use	Yes (n = 86)	23 (26.7)	63 (73.3)
	No (n = 50)	22 (44.0)	28 (56.0)
Documented site assessment within the previous 24 hours <sup>2</sup>	Yes (n = 38)	2 (5.3)	36 (94.7)
	No (n = 93)	28 (30.1)	65 (69.9)
Soiled dressing	Yes (n = 28)	17 (60.7)	11 (39.3)
	No (n = 108)	28 (25.9)	80 (74.1)
Loose or lifting edges	Yes (n = 13)	3 (23.1)	10 (77.9)
	No (n = 123)	27 (22.0)	96 (78.1)
Blood in line	Yes (n = 19)	7 (36.8)	12 (63.2)
	No (n = 117)	23 (19.7)	94 (80.3)

<sup>1</sup>Phlebitis was defined as the presence of one or more of the following: Pain/tenderness on palpation (yes/no), redness >1 cm from insertion site, swelling >1 cm from insertion site, purulence, palpable hard vein cord beyond IV tip, streak/red line along the vein, hardness of tissue > 1 cm.

<sup>2</sup>n = 131

Phlebitis was observed in 30 venous catheters, including 5.3 % of those with a documented site assessment within the previous 24 hours, and 30.1 % of those without. In addition, phlebitis was present in 60.7 % of cases where the catheter dressing was soiled, compared to 25.9 % of cases where the dressing was clean. However, these associations were not statistically significant (Table 3).

There was no statistically significant association between the number of catheter days and the development of one or more signs of phlebitis (p = 0.65). None of the venous catheters with the longest dwell time (5–7 days) had signs of phlebitis.

## Discussion

In two Norwegian hospitals, an unannounced inspection of peripheral venous catheters on an arbitrarily chosen day revealed patient-reported pain or visible clinical problems such as redness, swelling, leakage or blood in the line for 32.4 % of catheters, while dressings were soiled or had loosened for 31.7 % of catheters. Many venous catheters (71.0 %) lacked documentation of site assessment within the past 24 hours.

The recommended location for peripheral venous catheters is the forearm (13). For the two Norwegian hospitals, the hand was the most common insertion site (52.2 %). The rest of Europe follows the recommendations on catheter placement, with a greater proportion of catheters inserted in the forearm (34 %) than in the hand (29 %) (4). In our study, 18.4 % of peripheral venous catheters had been inserted in the wrist or the antecubital fossa. These are undesirable locations as movement of the joint results in greater irritation of the vessel wall (13).

In this study, we found a relatively high prevalence of phlebitis (22.1 %). In comparison, the OMG study reports an overall prevalence of 10 %, with the highest prevalence seen in Asia, at 16 % (4). Our study showed a trend towards an increased incidence of phlebitis when there had been no documented site assessment of the peripheral venous catheter in the past 24 hours or when the dressing was soiled. Although this did not reach statistical significance in a two-level analysis, we believe that these factors pose a risk to patient safety and that larger studies are required. Since phlebitis is the strongest predictor of colonisation of a peripheral venous catheter (14) with subsequent increased risk of bloodstream infection (5), it is cause for concern that so many venous catheters were associated with at least one sign of phlebitis. Inspection of the insertion site, with cleansing of the skin and replacement of any soiled dressings, is strongly recommended for central venous catheters (11). These steps should be a natural part of the care of peripheral venous catheters too.

In the two Norwegian hospitals, a very high proportion of peripheral venous catheters were not in use: 36.8 % versus 14 % in the OMG study (4). Even if a catheter is not in active use, it may still be needed. A number of procedures or observations performed in the specialist healthcare service necessitate intravenous access (epidural pain relief, haemodynamic instability, etc), but we do not have data on whether the catheters were genuinely required at the time of the assessment. Given that so many unused catheters caused clinical problems, however, the threshold for removing superfluous catheters seems to be too high. There also appears to be a lack of guidelines on what constitutes a clear indication for a venous catheter, and daily assessment of whether a catheter is required, performed jointly by the doctor and nurse responsible for treatment, is highly important for preventing complications such as bloodstream infections (15).

The number of catheter days ranged from 0 to 7. There is disagreement over whether peripheral venous catheters should be routinely replaced every 72–96 hours (11) or whether they should only be replaced when clinically indicated (16). A long catheter dwell time does not in itself pose a risk of phlebitis as long as the catheter is inspected daily (17) and removed or replaced should any problems arise (16, 18). The percentage of venous catheters that lack documentation of site assessment is a matter of concern.

## **Strengths and weaknesses**

The hypotheses in this study were generated on the basis of the results of a multicentre study and were not based on own predefined research questions. Nevertheless, the study design has a number of strengths, including the use of

an unannounced inspection of all available peripheral venous catheters on an arbitrarily chosen day, and the fact that it was possible to compare the results with those of other countries. With only two participating hospitals, it is unclear whether the findings are representative of Norway as a whole. The study should therefore be repeated both nationally and locally. Following our participation in the OMG study, we have developed a short assessment tool for quality control and improvement (PIVC-miniQ). This can be used as a high-level tool, both for quality assessment in individual wards, but also for prevalence studies at hospital level (19).

The OMG study did not record data on bloodstream infections, and a lack of documentation of peripheral venous catheter usage makes it difficult to know whether such catheters are a potential source of bloodstream infection in Norway.

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## Conclusion

This prevalence study of peripheral venous catheter usage in two Norwegian hospitals shows that care and monitoring of these catheters could be significantly improved. A substantial number of peripheral venous catheters were unused, and inadequate documentation was the rule more than the exception. Best practice was not followed, and both doctors and nurses should be responsible for the monitoring of peripheral venous catheters.

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*We are grateful to the professional development nursing specialists at Nord-Trøndelag Health Trust and St. Olavs Hospital, Trondheim University Hospital, for assistance in connection with this project.*

*The article has been peer-reviewed.*

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Publisert: 22 May 2020. Tidsskr Nor Legeforen. DOI: 10.4045/tidsskr.19.0653

Received 10.10.2019, first revision submitted 15.1.2020, accepted 14.4.2020.

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