




# BMJ Open Quality of care for peripheral intravenous catheters (PIVCs) in Nepal: a cross-sectional study on feasibility and inter-rater agreement of the Peripheral Intravenous Catheters-mini Questionnaire (PIVC-miniQ) in a tertiary care hospital

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## ABSTRACT

**Objectives** There is a lack of data regarding the quality of peripheral intravenous catheter (PIVC)-related care from low-income and middle-income countries, even though the use of PIVCs may lead to local or severe systemic infections. Our main objective was to assess the feasibility and inter-rater agreement on the PIVC-mini Questionnaire (PIVC-miniQ) in a tertiary care hospital in Nepal.

**Design** We performed an observational cross-sectional quantitative study using the PIVC-miniQ to collect information on PIVC quality.

**Setting** Secondary care in a Nepalese hospital. All patients with PIVCs in selected wards were included in the study and PIVCs were assessed independently by two raters. Eight Nepalese nurses, one Nepalese student and three Norwegian students participated as raters.

**Primary and secondary outcome measures** The intraclass correlation coefficient (ICC), positive, negative, absolute agreement, Scott's pi and sum score were calculated using PIVC-miniQ. We also aimed to describe PIVC quality of care, as it is important to prevent PIVC-associated complications such as phlebitis or catheter-associated bloodstream infections.

**Results** A total of 390 patients (409 PIVCs) were included in the study. The ICC between raters was 0.716 for Nepalese raters, 0.644 for Norwegian raters and 0.481 for the pooled data. The most frequently observed problems associated with PIVCs were blood in the intravenous line (51.5%), pain and tenderness on palpation (43.4%), and fixation with opaque tape (38.5%). The average sum score was 3.32 deviations from best practice for PIVCs fixed with non-sterile opaque tape and 2.37 for those fixed with transparent dressing ( $p < 0.001$ ).

**Conclusion** The PIVC-miniQ is a feasible and reliable tool for nurses assessing PIVC quality in hospitalised patients in Nepal. The study revealed gaps in PIVC quality and care that could be improved by providing transparent PIVC dressings for all patients and requiring all PIVC insertions to be documented in patient charts.

## Strengths and limitations of this study

- The data collectors were well trained and supervised by the principal investigator, who ensured the quality of the data.
- Language barriers may have influenced the training of nurses and the assessment of peripheral intravenous catheters (PIVCs).
- Additionally, there was the inability to review many PIVC insertion sites due to the use of opaque tape.
- Another limitation of the study was that there was no information on the years of work experience of the nurses, which could affect the rating.

## INTRODUCTION

### Background/rationale

Peripheral intravenous catheters (PIVCs) are among the most frequently used medical devices for the intravenous administration of fluids or medications in hospitals worldwide<sup>1</sup> and are found in approximately 80% of hospital-admitted patients.<sup>2</sup> Approximately 30%–50% of PIVCs need to be removed prematurely due to a variety of complications<sup>2</sup> such as inflammation and phlebitis<sup>3</sup> or more severe complications such as catheter-associated bloodstream infection (CABSI) and sepsis.<sup>4</sup> A review found that 0.18% of PIVCs showed bacterial growth, most frequently *Staphylococcus aureus*.<sup>3</sup> Serious complications such as CABSI can lead to morbidity, mortality and increased costs globally.<sup>5</sup>

Although PIVC-related complications are a problem worldwide, there is little focus or data on this topic in low-income and

middle-income countries.<sup>6</sup> Complications associated with PIVCs can be reduced with optimal hand hygiene and the use of sterile occlusive dressings,<sup>7</sup> along with the prompt removal of the device if there are signs of inflammation or if the PIVC is no longer medically required.<sup>8</sup> However, these measures are often not followed as recommended by best practice guidelines.<sup>5</sup>

The PIVC-mini Questionnaire (PIVC-miniQ) survey was developed for hospital surveillance and is a simple tool for screening PIVC quality and care. The PIVC-miniQ was developed as a collaboration between St Olavs and Levanger Hospital in Norway and the AVATAR research group in Australia.<sup>9 10</sup> When validated in Norway, the PIVC-miniQ was found to be time-efficient and reliable across raters.<sup>9</sup>

### Objectives

The main objective of this study was to assess the feasibility and inter-rater agreement of the PIVC-miniQ in clinical practice, and to assess PIVC quality and care in patients admitted to a tertiary care hospital in a low-income country. The secondary objective was to assess inter-rater agreement between Norwegian students and Nepalese nurses and that among Nepalese nurses only.

## METHODS

### Study design, setting and participants

Participants for this study were enrolled from Dhulikhel Hospital, also known as Kathmandu University Hospital, which is a 425-bed referral hospital located 30 km east of Kathmandu. All patients aged  $\geq 18$  years from the wards of general surgery, orthopaedics/traumatology, and obstetrics/gynaecology, who provided informed consent and had a PIVC, were included in the study. Data were collected during a 6-week study period from 1 February to 15 March 2020.

An English language version of the PIVC-miniQ was developed in Norway and used with permission.<sup>9</sup> The PIVC-miniQ was previously published by Høvik *et al*<sup>9</sup> (<https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-019-4497-z#Sec12>). Two medical students from Norway were trained in using the PIVC-miniQ at St Olavs Hospital, Trondheim Norway. For their training, the medical students assessed real-life PIVCs using the PIVC-miniQ together with the principal investigator, who is an experienced anaesthetist nurse at St Olavs Hospital. The students then instructed eight nurses and two nursing students (one Nepalese and one Norwegian) at Dhulikhel Hospital on using the PIVC-miniQ to observe the PIVC insertion site before data collection. Twelve raters (nine Nepalese and three Norwegian) participated in the data collection.

Two raters independently assessed the patient's PIVC using the PIVC-miniQ, resulting in two observations per PIVC.

The PIVC-miniQ included two parts,<sup>9</sup> the first of which comprised 13 questions regarding the general information

about the patient, PIVC size, position, and date of inspection and date of insertion. The dwell time was calculated as the difference (in days) between the inspection date and the date of insertion. The variables in the first part can be viewed as the exposure in this study. The second part included 16 items regarding clinical observations of the PIVC insertion site, dressing and documentation where each item was categorised as existing (1 point) if a deviation from best practice was observed or non-existent (0 point) if it was not. The PIVC sum score was calculated in the second part. The outcomes of this study thus consist of the prevalence of each item in the PIVC-miniQ, with the average sum score and the PIVC-miniQ being the data source for the study. To study inter-rater agreement, two independent raters assessed each PIVC, with a short interval (minutes) between ratings. The average time spent for the rating of each survey session was calculated as a measure of feasibility. The sample size was determined to match the study by Høvik *et al*.<sup>9</sup> The raters were paired by convenience (those who were present in the wards the days the PIVC observations were paired).

### Patient and public involvement

Patients and the public were not involved in the planning, design and interpretation of the data analyses.

### Statistics

Descriptive statistics are reported as frequencies, percentages, means and SDs. In cases of minor disagreement between raters in the first part of the PIVC-miniQ (PIVC size, anatomical position and clinical setting), data recorded by the Nepalese raters were considered the gold standard as they could communicate with the patients in Nepalese in the clinical setting. Missing values on single items were imputed using the expectation maximisation algorithm, using the 16 items on the PIVC-miniQ as predictors. Imputed values were thereafter rounded up to the nearest integer 0 (problem does not exist) or 1 (problem exists). This was not done for the item 'date of PIVC insertion lacking in patient chart' as it was not a part of the Dhulikhel Hospital procedures for PIVC care, and was not recorded. For the 15 remaining items, we calculated the negative agreement, positive, absolute agreements along with Scott's pi.<sup>11 12</sup> We analysed the sum scores using a mixed model with the PIVC sum score as the dependent variable, and the PIVC and rater as crossed random effects. The intraclass correlation coefficient (ICC) was computed to quantify the inter-rater reliability. We compared the ICC between the Nepalese and Norwegian raters. The variance components are presented together with CIs. The frequency distribution of the 16 items and the PIVC sum score are shown in a histogram with and without the item 'date of PIVC insertion lacking in patient chart'. Some PIVCs were fixed with opaque tape, which made some of the items difficult to assess, and this could affect the sum score for such PIVCs. As the use of opaque tape could bias the results, we report the average sum score for both PIVCs with opaque and

transparent tape. The SPSS V.26 (IBM) and STATA V.16.0 (StataCorp) software were used for statistical analysis.

## RESULTS

A total of 390 patients (409 PIVCs) were observed twice by independent raters (818 observations) using the PIVC-miniQ form. Each PIVC observation was estimated to take 1–2 min to complete. Data were missing for 5.3% of the items, and most data were missing when the PIVC was fixed with opaque tape as this hindered inspection of the insertion site. The mean dwell time was  $1.9 \pm 1.7$  days (range 0–14 days). Among the 409 PIVCs, 153 (37.4%), 180 (44.0%) and 76 (18.6%) were observed in the orthopaedics/traumatology, surgery ward and obstetrics/gynaecology wards, respectively (table 1). One hundred and thirty-five (33.0%) PIVCs were inserted at the wrist and nine (2.2%) in the antecubital fossa, that is 35.2% of PIVCs were placed near a joint. Cannulas of size 18 gauge (G) and 20 G were used in 236 (57.5%) and 143 (35.0%) of the PIVCs, respectively.

Results from the 818 total PIVC observations showed that the presence of blood in the intravenous line was the most frequently observed problem (51.5%,  $n=421$ ). Similarly, more than half of the dressings were either soiled with blood, fluids and/or were lifting at the edges, and 315 (38.5%) PIVCs were fixed with opaque tape only. The most frequently observed problem at the insertion site was pain and tenderness on palpation, noted in 355 (43.4%) PIVCs. The Norwegian raters reported pain and tenderness on palpation in 215 of 465 (46.2%) observations, while the Nepalese raters did so in 140 of 353 (39.7%) of them ( $p=0.06$ ). Palpable hard veins beyond the intravenous tip were the second most frequently observed problem at the PIVC insertion sites (12.2%,  $n=100$ ) cases. There were no data on the indication for PIVC insertion in 27 (3.3%) cases.

The average sum score of the 15 PIVC-miniQ items was 2.74 (SD 1.47) with a score range of 0–9 (figure 1). The mean sum score of the 315 PIVCs with opaque tape was 3.32 (SD 1.40;  $p<0.01$ ), significantly higher than the sum score of 2.37 (SD 1.39) of the 503 PIVCs with sterile fixation with transparent dressing. The Norwegian raters rated systematically higher than the Nepalese raters, with their sum score being an average of 0.34 ( $p<0.01$ ) higher than the score of the Nepalese raters.

The ICC was 0.48 after analysis of data for all raters (table 2), and it was higher when the two raters were of the same nationality (0.716 for Nepalese and 0.644 for Norwegian raters): the difference was not statistically significant.

The negative and positive agreements between the raters on the 15 items (without the item for documentation in the chart) are presented in table 3 along with Scott's pi. The overall negative agreement was high, ranging from 0.705 to 1. Positive agreement showed more variation, ranging from 0.000 for 'purulence' to 0.876 for 'fixation with tape only'. Among the site assessments, the

**Table 1** Descriptive characteristics of raters, patients and PIVCs

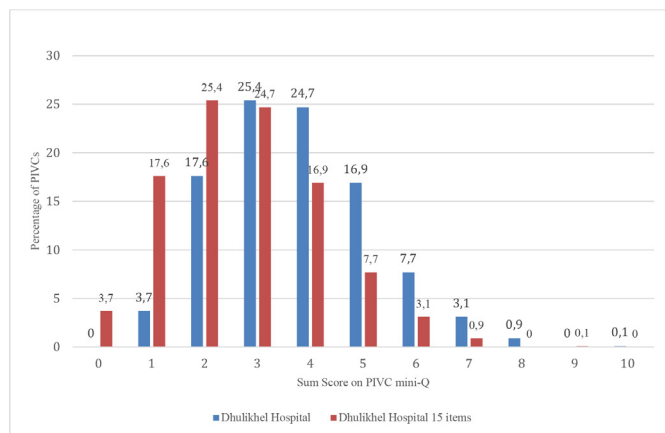
<b>Raters</b>	
Total number of raters, n	12
Nepalese nurses, n	8
Nepalese nurse students, n	1
Norwegian medical students, n	2
Norwegian nurse student, n	1
<b>Patients</b>	
Number of patients, n	390
Age (years), mean (SD)	43.3 (17.1)
Age not recorded, n (%)	14 (3.4)
Female, n (%)	201 (51.5)
<b>PIVC</b>	
Number of PIVCs, n	409
<b>PIVCs by wards</b>	
Obstetrics/gynaecology, n (%)	76 (18.6)
Orthopaedics/traumatology, n (%)	153 (37.4)
Surgery, n (%)	180 (44.0)
<b>PIVC indwell time (days), mean (SD), range</b>	
	1.9 (1.7) 0–14
Indwell time information lacking, n (%)	37 (4.5)
<b>PIVC size (gauge)</b>	
24 G, n (%)	0 (0.0)
22 G, n (%)	21 (5.1)
20 G, n (%)	143 (35.0)
18 G, n (%)	236 (57.7)
16 G, n (%)	9 (2.2)
<b>Clinical setting</b>	
Emergency room, n (%)	47 (11.5)
Operating theatre, n (%)	131 (32.0)
Hospital ward/unit/ICU, n (%)	216 (52.8)
Procedure room, n (%)	1 (0.2)
Other hospital, n (%)	2 (0.5)
Unknown or not recorded	12 (2.9)

G, gauge; ICU, intensive care unit; PIVC, peripheral intravenous catheter.

item 'pain and tenderness on palpation' had the highest positive agreement, with an agreement of 0.772. Items with low positive agreement were also less frequent.

## DISCUSSION

The PIVC-miniQ was found to be feasible for clinical use by nurses in Nepal, who used an estimated 1–2 min to complete the questionnaire for each PIVC. Further, the inter-rater agreement for the total sum score among Nepalese nurses was moderate to high, with an ICC of 0.716. The use of the PIVC-miniQ revealed that in many



**Figure 1** PIVC quality as measured by PIVC-miniQ. PIVCs, peripheral intravenous catheters; PIVC-miniQ, PIVC-mini Questionnaire.

cases, PIVCs are retained despite clinically relevant problems such as pain. An average of 2.74 problems were observed per PIVC, however, in this study healthcare workers including the nurses did not routinely perform documentation in patient charts related to these problems and/or information about PIVC insertion.

The variation in positive agreement between raters was influenced by the prevalence of problems, where items with low prevalence had a lower positive agreement. Similarly, PIVC-related problem items with a high prevalence had a higher positive agreement. These effects are expected to occur<sup>11</sup> and were also observed by Høvik *et al.*<sup>9</sup> The overall inter-rater agreement on the sum score, represented by the ICC, was poor to moderate.<sup>12</sup> When analysing the ICC for Norwegian and Nepalese raters separately, the agreement for the sum score was moderate to high. For clinical use, the form will likely be used by a group of raters that is more homogeneous than that in this study. In such a setting, we believe that the inter-rater agreement for the sum score will be more comparable with that observed for these groups separately than for the overall score.

In the present study, the most commonly used catheter size was 18 G. This contrasts with other studies, in which 20 G was the most common<sup>9 13</sup> size. For PIVCs, the recommended catheter size is 20 G, as smaller catheter sizes are more likely to be dislodged and catheter sizes larger than 20 G are associated with a higher rate of thrombosis.<sup>14 15</sup> A small study from Nepal reported that a catheter size of

20 G or smaller was a risk factor for phlebitis, however, the results for that study were not statistically significant.<sup>16</sup> It is important to note that the results of these above-mentioned studies are difficult to compare, because the Infusion Nurses Society recommends that the smallest G PIVC that will accommodate the prescribed therapy and patient need should be used<sup>17</sup> and we do not have the required data to compare patient prescriptions or needs for PIVCs across studies.

The average PIVC dwell time (1.9 days) in this study may be influenced by the fact that many participants were postoperative patients or women who had given birth in the hospital, who left after a short stay. Thus, it is not possible to generalise the results of this study to all the patients at Dhulikhel Hospital. In this study, only 3.3% of PIVCs lacked indications for insertion. In comparison, Alexandrou *et al* found that 14% of PIVCs were to be idle in their study conducted in 51 countries in 2018, which is almost four times that observed in our study.<sup>6</sup>

The findings in this study from Nepal revealed a higher average sum score of the PIVC-miniQ items indicating lower quality than that reported in a study in Norway.<sup>9</sup> The most frequent problem observed at the PIVC site was pain and tenderness on palpation around the insertion area of the PIVC (43.4%), which was more common than in earlier studies.<sup>5 13</sup> An American study on postoperative pain found that around 80% of patients experienced PIVC-related pain, 86% of whom experienced moderate, severe or extreme pain.<sup>18</sup>

Alexandrou *et al* found non-sterile tape was used in 12.6% of cases. This was more frequently observed in certain regions, for example, 30% of these cases were from South America.<sup>6</sup> That study also found a prevalence of 10% for signs and symptoms of phlebitis in all the countries included in their study, with 16% of such cases in Asian countries. Studies from Norway, Portugal and Italy reported that 22.1%, 61.5% and 64.4% of the PIVCs had at least one sign of phlebitis, respectively.<sup>9 14 19</sup> The relative number of signs of inflammation in our study was comparable with these other international studies. Because use of PIVCs is so widespread, such inflammatory signs can have a big impact on the absolute number of infections if not removed.<sup>9 20 21</sup> Sterile occlusive dressings are important for reducing CABSIs. The most common source of infection for CABSIs is bacterial colonisation of the skin surrounding the insertion site, therefore, sterile dressings aim to reduce this colonisation, thus decreasing

**Table 2** Variance components and the resulting intraclass correlation (ICC) for the PIVC-miniQ; estimate (95% CI)

Variance component	Nepalese raters	Norwegian raters	Total
PIVC	1.507 (1.150 to 1.974)	1.379 (1.075 to 1.768)	1.052 (0.849 to 1.305)
Rater	0.154 (0.043 to 0.551)	0.290 (0.003 to 0.261)	0.137 (0.041 to 0.457)
Residual	0.444 (0.237 to 0.832)	0.734 (0.41 to 0.997)	1.000 (0.870 to 1.149)
ICC (rater)	0.716	0.644	0.481

PIVC, peripheral intravenous catheter; PIVC-miniQ, PIVC-mini Questionnaire.



**Table 3** Agreement and reliability results for the 15 items\* of the PIVC-miniQ, Dhulikhel Hospital

Item on the PIVC-miniQ	Negative	Disagree	Positive	Sum	Negative agreement	Positive agreement	Absolute agreement	Scott's pi
Pain and tenderness on palpation	191	81	137	409	0.825	0.772	0.802	0.597
Redness >1 cm from insertion site	396	12	1	409	0.985	0.143	0.971	0.128
Swelling >1 cm from insertion site	362	36	11	409	0.953	0.379	0.912	0.332
Warmth at insertion site	363	44	2	409	0.943	0.083	0.892	0.026
Purulence	408	1	0	409	0.999	0.000	0.998	-0.001
Streak/red line along the vein	361	46	2	409	0.940	0.080	0.888	0.020
Induration, hardness of tissue	389	19	1	409	0.976	0.095	0.954	0.071
Palpable hard vein beyond tip	321	76	12	409	0.894	0.240	0.814	0.134
Partial/complete dislodgement	393	15	1	409	0.981	0.118	0.963	0.099
Soiled with blood or fluids	234	75	100	409	0.862	0.727	0.817	0.589
Loose or lifting dressing edges	198	157	54	409	0.716	0.408	0.616	0.124
Fixed with tape only	232	39	138	409	0.922	0.876	0.905	0.799
Blood in line	140	117	152	409	0.705	0.722	0.714	0.427
Insertion date not documented on PIVC dressing	203	138	68	409	0.746	0.496	0.663	0.243
Indication unknown	393	5	11	409	0.994	0.815	0.988	0.808

\*The 15 items are exclusive of 'date of PIVC insertion lacking in chart' as this item was not a part of the PIVC procedure at Dhulikhel Hospital. PIVC, peripheral intravenous catheter; PIVC-miniQ, PIVC-mini Questionnaire.

the incidence of CABSIs.<sup>7</sup> However, at Dhulikhel Hospital, opaque tape was used for fixation of PIVCs in some patients. This could be because sterile, transparent dressings are more expensive, and the patients must pay for medical equipment themselves. This could be a potential barrier to the future improvement of PIVCs. The use of opaque tape may lead to the delayed detection of infection at the PIVC insertion site, leading to BSI and sepsis and high costs related to infections and morbidity. A study in American hospitals estimated that the cost per BSI was between US\$35 000 and US\$56 000.<sup>2</sup> In Nepal, such complications are difficult to treat due to the high incidence rate of antibiotic-resistant bacteria.<sup>22 23</sup>

More than half of the PIVC dressings were soiled with blood or fluids and/or had lifting edges, making the prevalence of soiled dressings in this study higher than that worldwide. Reportedly, 21% of dressings worldwide are moist, soiled and/or lifted off the skin, with Africa, Australia and New Zealand having the highest frequency of compromised dressings (25%).<sup>6</sup> Thus, in our hospital the PIVC dressing and equipment should be changed more often. Training and focus for this matter is a low-cost

measure that can potentially improve PIVC quality at the hospital.

PIVCs were placed close to the joints in 35.2% of the cases in this study, compared with 50% in the study by Høvik *et al*.<sup>8</sup> This rate was close to that found worldwide by Alexandrou *et al*.<sup>6</sup> The date of PIVC insertion was documented in 66.5% of PIVC dressings, and there was no documentation on PIVC insertion in the patient charts about how long they had been inserted. Data on dwell time were collected by asking the patient or their relatives about the insertion date. According to the guidelines at Dhulikhel Hospital, the PIVC insertion date should be noted on the PIVC dressing, not in the patient chart, and it should not be in place for more than 96 hours. If the dressing is changed and the insertion date is not transferred to the new dressing, it is difficult for the staff to change the PIVC according to the guidelines of the hospital. Furthermore, it will be difficult to trace complications back to an undocumented PIVC. Our study suggests the need to revise the current Dhulikhel Hospital guidelines for PIVC insertion, for which a record must be kept in patient charts.



## Strength and limitations

The strength of our study includes the observation of several cases of PIVC insertion in a country with low income. However, our study also has several limitations, one of which is that we did not have enough information to evaluate why the overall inter-rater agreement was poorer than the subgroup agreement. However, our study shows that the PIVC-miniQ<sup>9</sup> can be used to monitor PIVC quality over time by Nepalese nurses. The use of the PIVC-miniQ to assess quality over time will lead to improved PIVC care in Nepal. Another limitation is that the data on many items regarding the insertion site were missing as the PIVCs were fixed with opaque tape. This may contribute to the low inter-rater agreement and bias towards a lower PIVC quality than the true quality. The missing data thus shed light on an important PIVC-related quality problem in Nepal: it should be addressed at a political and hospital level to ensure that every patient receives a transparent dressing.

## CONCLUSION

In summary, this study shows that the PIVC-miniQ can be a feasible and reliable tool to measure PIVC quality improvements over time in Nepal and that there is a need for such tools that support quality improvement projects. Our study revealed gaps in PIVC quality and care that could be improved by providing transparent PIVC dressings for all patients and requiring all PIVC insertions to be documented in patient charts.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not required.

**Ethics approval** The study was approved in Norway by the Regional Committee for Medical and Health Research Ethics (REK No. 32272), and in Nepal by the Institutional Review Committee at Kathmandu University School of Medical Sciences (IRC-KUSMS 285/19). All patients gave verbal informed consent to participate in the study.

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**Data availability statement** Data are available upon reasonable request.

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