Journal of University College of Medicine & Dentistry

Original Article

Frequency, Causes, and Complications of Re-Cannulation After Peripheral Intravenous Catheterization in Surgical Patients: A Cross-Sectional Study

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Submission: 1st October, 2025
First revision: 30th October, 2025
Second revision: 18th November, 2025
Final Revision: 25th December, 2025
Acceptance: 8th January, 2026

DOI: https://doi.org/10.51846/jucmd.v5i1.4712

Cite this article as:

Waqar SH, Khaliq M, Hussain AT, Wajahat H, Khan M, Abidin ZU. Frequency, causes, and complications of re-cannulation after peripheral intravenous catheterization in surgical patients: a cross-sectional study. *J Univ Coll Med Dent*. 2026;5(1): 71-76

Abstract

Objective: To assess the size of the cannulas, frequency, causes, as well as the complications associated with re-cannulations among patients admitted within the surgical wards of the Pakistan Institute of Medical Sciences (PIMS), Islamabad, Pakistan.

Methodology: A cross-sectional study was conducted in the General Surgery Department of PIMS, Islamabad, on 225 cases who received peripheral intravenous fluid from January to March 2025. Patients in the age group of 14 to 75 years administered with intravenous fluid were included in the study, but those referred from other healthcare institutions who already have an established intravenous access were excluded. Demographic information, such as gender, age group, and presence of co-morbidities recorded along with the complications developing in patients after peripheral intravenous catheterization, like phlebitis, infiltration, and extravasation of the fluids. Additionally, the other details, such as the infusion rates of the intravenous fluids, the size of the peripheral intravenous fluid access, the site of the peripheral intravenous fluid access, and the dwell time, are recorded.

Results: A total of 225 patients were studied, with a mean age of 43.96 ± 17.1 years. In IV cannula replacement due to complications, including pain, swelling, and inflammation in 104 patients (46.2%), patients did not undergo additional procedures except for the replacement of the cannula. The 20-G cannula was most commonly used in patients (n = 113; 50.0%). The duration of the cannula was below four days in 212 patients (94.2%), with eight patients (3.6%) over four days, while in five patients (2.2%), duration was unspecified. Regarding the insertion area of the cannula, the arm was the foremost site in 117 patients (52%), while others included the hand in 74 patients (32.8%), antecubital fossa in 11 patients (4.9%), lower limbs in 10 patients (4.4%), and instep in five patients (2.2%).

Conclusion: Swelling with pain was the key clinical outcome associated with the use of peripheral IV catheterization in surgical patients. Patient's age, dwell time, and insertion site were found to be associated factors for the complications of peripheral IV catheterization.

Keywords: Infusions, Intravenous; Continuous Infusion; Intermittent Infusion; Drug Administration Schedule; Catheterization, Peripheral.

Introduction

Peripheral intravenous catheterization is one of the most frequently performed invasive procedures in clinical settings, especially among surgical patients.[1] It is a fundamental component of perioperative care employed for the administration of fluids, drugs, blood products, and nutritional aids. Despite its regular employment, it would seem that simple intervention is not devoid of complications, and its efficiency and safety are significant concerns in patient care and hospital management.[2] In the perioperative setting, peripheral intravenous access cannot be avoided. Surgical patients, by the nature of their condition and the intervention they have, present an increased risk for fluid imbalance, sepsis, drug-related reactions, and other complications that require quick intravenous management.[3] PIVC has an essential role to play in reaching these clinical objectives. However, inappropriate catheter selection, suboptimal insertion site, bad maintenance, and long-term catheter dwell times can give rise to serious adverse effects such as phlebitis, infiltration, obstruction, dislocation, chaos, and catheter-related bloodstream infections.[4] These complications may cause delays in treatment, increasing the patient's discomfort, prolonging hospital stay, and increasing the cost of health care.[5]

Certain studies have identified concerns linked to the use of PIVCs with variable outcomes depending on the demographic data and the level of expertise.[6,7] Although some studies highlight the low complexity rates utilizing standardized care protocols, others underline the difficulties of ensuring successful catheter placement and care. These anomalies are clear in surgical patients, especially in surgical patients due to physical stresses imposed by anaesthesia, tissue trauma, and converted immune responses.[8] Postoperatively, conditions such as hypotension, hypothermia, and immobility lead this patient's population on catheter related issues. In addition, surgical patients often require many drugs that can disturb the vascular endothelium,

which can reduce the risks associated with the PIVC.[9] It remains the most commonly used method to establish vascular access, enabling liquids and drug administration in a wide range of patient groups. It is estimated that about 30% to 80% of hospitalized patients receive a PIVC during their stay.[10,11] A PIVC insertion done immediately after the patient's entry, often in induction or operating room settings. This initial placement facilitates quick handling of fluid management, anaesthetic administration, and perioperative complications. Since the procedure was conducted, the patient is still conscious, primarily due to the administration of anaesthesia, which can be quite associated with discomfort and crisis. Repeated unsuccessful efforts on cannulation can increase anxiety for both patient and healthcare providers, increase local irritation and inflammation, increase the risk of microbial contamination, and require the use of alternative insertion sites that may be technically more difficult or reduce additional risks.[12]

In recent years, the healthcare system has placed an increasing emphasis on patient-focused care, quality improvement, and infection prevention. PIVC-related complications are now considered the major indicator of care, especially in surgical units where vascular access is important. The occurrence, type, and underlying determinants of such complications must be identified to design specific interventions and educational programs. The role of overview studies in this respect is found to be indispensable, allowing real-time observations on practices in the clinical environment, patient response, and outcomes. Based on an assessment of convertible risk factors and general failure modes, these studies have a potential role in making specific clinical practices more effective, with reduced complexity rates and enhanced patient satisfaction.

Methodology

This observational cross-sectional study investigated 225 patients in the General Surgery Department, PIMS, Islamabad, from January to March 2025. Patients aged 14 to 75 years who required intravenous liquid therapy and were admitted to the Department of General Surgery, PIMS, Islamabad, after receiving ethical approval from the Ethics Research Review Board (F-5-2/2024(ERRB)/PIMS dated 1st March 2024) were included. All patients presenting in the general surgery Emergency Room or Outpatient Department who required intravenous access were enrolled by non-probability convenience sampling. Patients referred from other healthcare facilities with already maintained intravenous access, referred/shifted to different departments, and those who left against medical advice were excluded. Data was collected through direct observation and patient record reviews in the post-anesthesia care units of the surgical ward, operating room, and selected hospital. A structured data collection form used for patient demographics, PIVC insertion, as well as any catheter-related complications, including phlebitis, infiltration, and extravasation. IV infusion setting, PIVC catheter size, Insertion site, and Catheter dwell time were recorded. Patients were monitored daily until the catheter was removed.

The data were recorded and analyzed using SPSS version 27. Descriptive figures such as frequencies, percentages, means, and standard deviations are used to summarize patient characteristics and complexity rates. Factors associated with complications after peripheral intravenous catheterization, such as age, comorbidities, IV infusion setting, catheter size, insertion sites, and catheter dwell time, were identified and determined using the Chi-square test (X2) by taking a 95% confidence interval and <5% (0.05) as the level of significance.

Results

The overall mean age was 43.96±17.1 years. Of 225 patients, 144 (64%) were male, and 81 (36%) were female. Patient's distribution based on their age was as follows: 40 (17.8%), 14-30 years, 80 (35.6%), 31-45 years, 56 (24.9%), 46-60 years, and 49 (21.8%), 61-75 years. Of the total 225 patients, an IV Cannula was changed in 104 (46.2%) cases. Swelling and pain were the main reasons for cannula changes, followed by swelling and inflammation in 16 (7.1%) cases. The majority of patients were administered by cannula no 20G 113 (50%), followed by 18G 80 (35%). Diabetes was the major comorbidity found in 48 (21.3%). The majority of patients, 94.2% (n=212), had a catheter dwelling time less than 4 days, followed by 3.6% (n=8) >4 days, and 2.22% (n=5) unknown. The arm was the prominent insertion site used in 117 (52%) patients as catheter insertion sites followed by the hand 74 (32.8%), arm crook 11 (4.9%), leg 10 (4.4%), Head 5 (2.2%), instep 5 (2.2%), and Ankle 3 (1.3%). Demographic and baseline details are presented in Table 1. Figure 1 illustrates the change in the cannula status. Factors associated with complications after peripheral intravenous catheterization are presented in Table 2.

Table 1: Demographic and baseline details (N=225)

Parameters	N (%)
Age (years)	43.96±17.1
Gender	
Male	144 (64%)
Female	81 (36%)
Comorbidities	
Diabetes Mellitus (DM)	48 (21.3%)
Hypertension (HTN)	8 (3.6%)
HTN+DM	16 (7.1%)

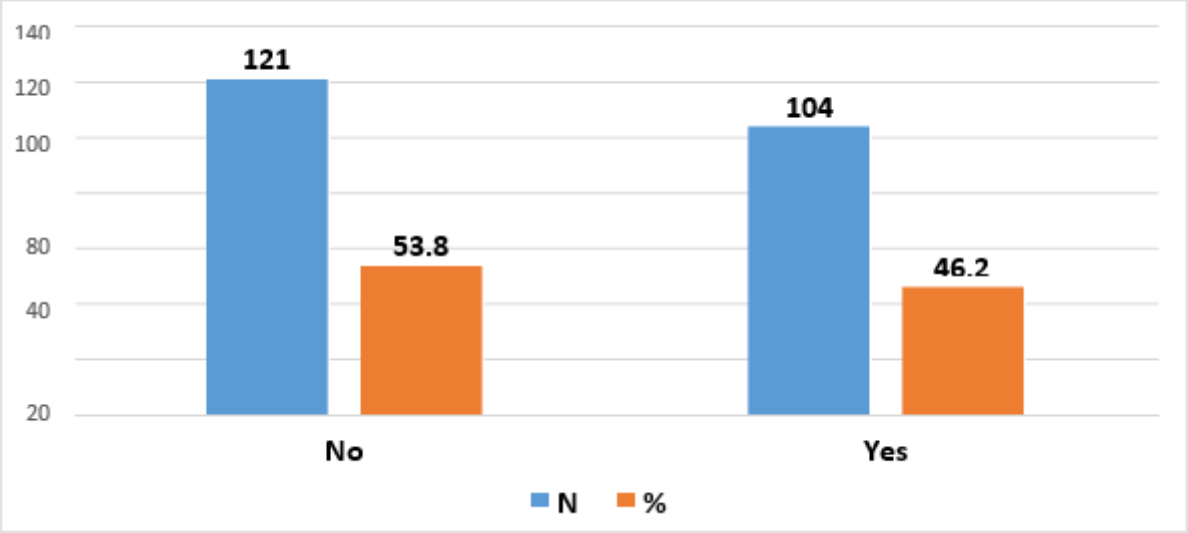

Figure 1: Change of cannula status (N=225)

Table 2: Factors associated with complications after peripheral intravenous catheterization

Parameters/Factors	N (%)	P-value
IV infusion setting		
Continuous	121 (53.8%)	0.184
Intermittent	104 (46.2%)	
Catheter Size		
16 gauge	8 (3.6%)	
18 gauge	80 (35.5%)	
20 gauge	113 (50.2%)	
22 gauge	8 (3.6%)	0.091
24 gauge	16 (7.1%)	
Site		
Arm	117 (52%)	
Hand	74 (32.8%)	
Arm crook	11 (4.9%)	
Leg	10 (4.4%)	
Instep	5 (2.2%)	0.032*
Head	5 (2.2%)	
Ankle	3 (1.3%)	
Dressing		
Sterile	218 (96.9%)	0.268
Nonsterile	7 (3.1%)	
Catheter dwell time		
<4 days	212 (94.2%)	
>4 days	8 (3.6%)	0.001*
Unknown	5 (2.22%)	

*Statistically significant at $p < 0.05$

Discussion

The present study mainly focused on the frequency, causes, and complications of peripheral intravenous catheterization in surgical patients and reported that patient age, catheter dwelling time, and insertion site contribute to the postoperative complications of peripheral intravenous catheterization. Additionally, pain and swelling are other associated factors for peripheral intravenous catheterization in surgical patients. The frequency of cannula changes reported in the present study was 46.2%. Numerous factors, such as insertion site preparation, catheter dwell time, catheter size, dressing types, and infusion types, contributed to the development of complications. In the current study, the majority of PIVCs were inserted in the arm 117 (52%) and the hand 74 (32.8%).

In this study, the average age of patients was 43.96 ± 17.1 years, indicating a diverse patient population consisting of both young adults and the elderly. The majority of patients (35.6%) belonged to the age range 31-45 years, aligning with the prior studies reported statistics that due to higher surgical workload in this age group, requiring cannulated surgeries.[13]

The male population predominance (64%) is also consistent with local and regional trends observed in hospital-based surgical admissions, possibly reflecting gender-related health-seeking behavior or disease distribution patterns.[14] Gender distribution showed a high ratio of male patients (64%) compared to women (36%). While the vein itself may not be a direct factor affecting the catheter results, previous literature suggests that patients often present with prominent veins, potentially allowing easy canals, although it does not always translate into low complexity rates. An earlier study reported similar results in terms of gender distribution.[15]

The reported rate of re-cannulation (46.2%) is notably higher and suggests the substantial burden of IV catheter-related complications. Besides additional workload, re-cannulation increases the patient discomfort and risk of infection.[16,17] The primary causes quoted for replacement were inflammation and pain, which are early symptoms of local tissue irritation and infiltration. Swelling and pain (39.1%) and swelling with inflammation (7.1%) were the main causes of re-cannulation, indicating that phlebitis, infiltration, or extravasation were the predominant underlying complications. Various patient populations align the conclusions with the events already reported - including medical, surgical, and other categories.[18,19]

Regarding the cannula size in the present study, half of the patients (50%) were cannulated with 20G catheters, followed by 35% 18G catheters. For rapid administration of fluid in surgical patients, larger gauge catheters are preferred, but their use increases the risk of endothelial injury in fragile veins, leading to pain and infiltration, which may explain the higher failure rates and the need for re-cannulation. The larger catheter (20G) preference in the current study reflects an attempt to balance flow rate for patient comfort and lower complication risk. Low incidence of complications attributed to the length of the long catheter living within the vein, which limits the catheter movement and reduces the mechanical irritation of the vessel wall.[20,21]

The successful insertion is significantly affected by the insertion site. The arm (52%) and hand (32.8%) were frequently used sites for catheterization. The higher risk of mechanical irritation and movement-related complications is associated with distal sites such as the hand, despite the accessibility. In contrast, an arm provides a stable site, potentially reducing the dislodgment, but is vulnerable to phlebitis if the catheter remains for prolonged durations. Previous studies have demonstrated similar trends, where the choice of site significantly influenced the longevity and complication rates of peripheral IV lines.[22]

The majority of patients (94.2%) had a catheter dwelling time less than 4 days, which aligned with recommendations by current guidelines, according to which regular assessment and replacement within 72-96 hours reduce the risk of phlebitis and infections. Nevertheless, some complications were also observed within the target time interval, indicating that, in addition to its duration, other factors such as aseptic practices, patient-related factors, and the method of catheter placement can also have an important bearing on the integrity. The study recognized diabetes mellitus as the highest prevalence of comorbidities, with 21.3% occurrence in patients. It is already known that diabetic patients affect the integrity of the vascular system and the ability of tissues to treat infection, where infiltration, infection, and inflammation caused by the catheter pose a delaying factor in the recovery process from infiltration, infection, or inflammation. Research supports that there are definitely influences on the outcomes from the catheter, which form part of the patient evaluation process, due to these comorbid conditions. Active steps, such as regular site evaluation, miniaturized cannulas if appropriate, and possibly initial infection for alternative solutions for the vascular access devices, are recommended for these patients in the event of complications. Several complications, including swelling and inflammation in 29.72%, have been recorded in earlier research within the first 24 hours after it occurred.[23]

This proves the relevance of personal care in the peripheral IV catheterization procedure. The improvement in the high penetration rate because of complications like inflammation and pain has emphasized the importance of catheter care techniques. Optimal insertion techniques, regular inspection protocols, and training of clinical staff on patient education can reduce adverse outcomes related to early signs of complications. In addition, findings suggest a possible advantage in developing the risk stratification devices that include age, comorbidity, and venous conditions to direct the selection of cannula site and size. The use of vein visualization technologies and safe equipment can also contribute to reducing the catheter failure rates, especially in patients at high risk.

Limitations

This study was limited by its cross-sectional design, which restricts causal inference. There is a potential selection bias in convenience sampling. Also, a single-center design may limit generalizability. Furthermore, the inserter's skill and experience level, as well as whether IV fluids were aseptically or non-aseptically inserted, were not evaluated that might alter results. A stronger study design, like a prospective study design, would include looking at complications and catheter dwell time.

Conclusion

The contributing factors to post-procedure complications identified in the current study are patient age, dwell time, and the site of insertion for peripheral IV catheterization. Factors such as the type of catheter used and the patient's condition contribute to a high incidence of cannula replacement due to pain, swelling, and inflammation, as well as the typical use of 20G cannulas. The risks associated with a higher incidence of phlebitis, the dwelling time for the cannula, and the presence of other diseases such as diabetes and hypertension in the patients.

Authors' Contributions: SHW conceptualized and designed the study, interpreted the data, critically revised the manuscript, and approved the final version. MK contributed to the study design, performed data analysis, drafted the manuscript, and approved the

final version. ATH was involved in data acquisition, interpretation, statistical analysis, manuscript drafting, and final approval. HW participated in data acquisition and analysis, contributed to manuscript drafting, and approved the final version. ZA assisted with data acquisition and analysis, contributed to manuscript drafting. All authors approved the final manuscript and are accountable for all aspects of the work.

Acknowledgements: We acknowledge the work of the statistician for statistical analysis and the computer operator for the write-up.

Source of Funding: None

Conflict of interest: None

Data Availability Statement: The data that support the findings of this study, apart from the data already presented in the results section, are available from the corresponding author upon reasonable request.

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