

Effectiveness of Quality Improvement Measures in Improving the Short Peripheral Venous Catheter Associated Complications

Geetanjali Singh¹, Puneet Jain², Sunny Malvia³

¹Resident, Department of Pediatrics, Pacific Medical College and Hospital, Udaipur, Rajasthan
ORCID ID: 0009-0008-7697-8693

²Associate Professor, Department of Pediatrics, Pacific Medical College and Hospital, Udaipur, Rajasthan
ORCID ID: 0000-0002-7542-4890

³Associate Professor, Department of Pediatrics, Pacific Medical College and Hospital, Udaipur, Rajasthan
ORCID ID: 0000-0002-9262-5555

Corresponding Author: Dr Puneet Jain

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ABSTRACT

Introduction: Short peripheral venous catheters (SPVCs) are widely used in pediatric care for administering fluids, medications, and blood products but are frequently associated with complications such as phlebitis, infiltration, occlusion, and bloodstream infections. These complications increase morbidity, hospital stay, and healthcare costs. Structured quality improvement (QI) strategies to minimize SPVC-related events remain limited. This study aimed to evaluate the effectiveness of a targeted QI intervention in reducing SPVC-related adverse events in children.

Methodology: A quasi-experimental cohort study was conducted at Pacific Medical College & Hospital, Udaipur, from July 2023 to June 2024. A total of 100 pediatric patients (neonates to 12 years) requiring SPVC insertion were enrolled and divided into pre-intervention (n=50) and post-intervention (n=50) groups. The intervention included staff education, implementation of evidence-based insertion and maintenance bundles, and standardized protocols. Outcomes measured were incidence and severity of phlebitis, infiltration, occlusion, and bloodstream infections, using validated scoring systems. Data were analyzed with chi-square test, t-test, and logistic regression.

Results: The incidence of phlebitis decreased from 76% pre-intervention to 32% post-intervention (p=0.003). Infiltration declined from 48% to 20% (p=0.008), and occlusion from 24% to 12% (p=0.002). Severity grading demonstrated fewer moderate-to-severe complications in the post-intervention group. Logistic regression showed a 75% reduction in the odds of adverse events post-intervention (OR=0.22). Bundle compliance improved to >90% after training.

Conclusion: The structured QI intervention significantly reduced SPVC-related complications in pediatric patients. Education, standardization of protocols, and improved surveillance enhanced safety and outcomes. Routine adoption of QI strategies can strengthen vascular access care in children.

Keywords: Short peripheral venous catheter (SPVc), Quality improvement, Phlebitis

INTRODUCTION

Short peripheral venous catheters (SPVCs) are among the most widely used tools in modern healthcare, primarily facilitating the intravenous administration of medications, fluids, and blood products (1). These catheters are routinely employed across various clinical environments, such as emergency departments, inpatient units, and outpatient services. Despite their extensive use and clinical significance, SPVCs are associated with a range of complications. Issues such as phlebitis, infiltration, extravasation, occlusion, and infection can arise, leading not only to patient discomfort but also to extended hospitalizations, higher medical expenses, and in some cases, serious health outcomes (2, 3).

Although SPVCs are commonly used, structured and targeted quality improvement (QI) strategies to prevent these complications remain limited. Quality improvement in the healthcare context involves systematic efforts to enhance care delivery through evidence-based interventions, ongoing education, and process enhancement. While previous research has shown that QI initiatives can successfully reduce healthcare-associated infections and improve patient outcomes, many of these studies are either observational or descriptive (4, 5). There is a relative scarcity of controlled studies that evaluate the direct impact of QI measures on outcomes related to SPVC use (6). This gap indicates a pressing need to explore and evaluate the role of QI interventions specifically aimed at minimizing SPVC-related adverse events.

This study was aimed to address these concerns by introducing and assessing the effectiveness of a targeted QI intervention. The proposed strategy focused on enhancing catheter insertion techniques, standardizing maintenance procedures, and providing comprehensive staff education on identifying and managing potential complications.

This study carried the potential to significantly improve patient care and clinical practices related to SPVC use. By systematically evaluating a quality

improvement approach, the research aimed to deliver practical insights and evidence-based recommendations to reduce SPVC-related complications.

METHODOLOGY

This study employed a quasi-experimental cohort design to evaluate the impact of quality improvement (QI) interventions in reducing the incidence of short peripheral venous catheter (SPVC)-related adverse events.

The study was conducted at a tertiary care hospital Pacific Medical College & Hospital, Udaipur, Rajasthan for 1 year (1st July 2023-30th June 2024).

The primary outcome of this study was the incidence of SPVC-related adverse events in both the pre- and post-intervention groups. The adverse events of interest included:

1. **Phlebitis:** Inflammation of the vein, usually caused by infection or irritation from the catheter.

Phlebitis, defined as the veins' intima's inflammation, was assessed by VIP score²⁹ (visual infusion phlebitis score) and graded as 0, 1, 2, 3, 4,5. (7)

The secondary outcomes included:

2. **Infiltration:** Leakage of intravenous fluid into the surrounding tissue due to catheter dislodgement or improper placement.

Infiltration, defined as inadvertent leakage of a nonvesicant solution from its intended vascular pathway (vein) into the surrounding tissue during IV drug administration, was assessed using the infiltration assessment scale and graded 0, 1, 2, 3, 4.(8)

3. **Occlusion:** Blockage of the catheter, preventing fluid flow.

4. **Blood stream infection**

5. **Adherence to Quality Improvement Protocols:** Assessed by direct observation and chart audits.

Neonates to 12-year-old children, patients requiring insertion of a short peripheral venous catheter for medication and/or fluids admitted in pediatric ward, Pediatric ICU, Neonatal ICU and patients who consented to

participate in the study were included in the study.

Patients referred from other hospitals with IV line in situ and patients shifted from other units for care were excluded from the study. A total of 100 patients were enrolled in the study. Participants were assigned to the pre-intervention group (n=50) and the post-intervention group (n=50). The pre-intervention group consisted of patients who received SPVCs before the implementation of the QI interventions, while the post-intervention group consisted of patients who received SPVCs after the interventions were implemented.

The study was conducted in three phases:

1. Preintervention period: (July 2023 to August 2023)
 - a. Peripheral vein phlebitis/ infiltration/BSI incidence surveillance
 - b. Health care professionals (Nurses and doctors) were observed for the existing practices of peripheral IV-line insertion and maintenance. Patients were monitored by appropriate methods (Visual infusion phlebitis score, infiltration assessment scale, Blood stream infections etc). Data was entered in the proforma.
2. Development of care bundle and implement improvement strategies (September 2023 to October 2023):
 - a. Education and training of nurses and doctors
 - b. Evidence based update of Insertion bundle.
 - c. Evidence based update of Maintenance bundle.
3. Implementation of new measures and evaluation of their impact on adverse effects prevention (November 2023 to February 2024)

The data for this study was collected from medical records and direct observation by trained study personnel.

Data collection was restricted to those variables necessary to define baseline patient characteristics, the delivery of the intervention, potential confounding co-interventions, and outcomes. All enrolled children underwent monitoring of phlebitis score, infiltration score, evidence of blood stream infections and other adverse events as mentioned in data collection proforma. Nurses and doctors existing practices for peripheral IV line and maintenance were noted.

STATISTICAL ANALYSIS

The data was analyzed using SPSS version 25.0. The statistical methods used were Descriptive Statistics, Chi-Square, T-test and Logistic Regression. A two-sided p-value of 0.05 was considered statistically significant.

RESULTS

A total of 100 patients were included in the study, with 50 patients in the pre-intervention group (before QI interventions) and 50 patients in the post-intervention group (after QI interventions).

The age groups were similar between the two groups, ensuring comparability. The age distribution was consistent, with no significant differences observed (p-value = 0.1 for age). The male-to-female ratio was balanced in both groups, with 35 males and 15 females in the pre-intervention group and 32 males and 18 females in the post-intervention group. There was no statistically significant difference (p-value = 0.115), indicating that gender did not play a role in the incidence of adverse events.

The groups were comparable in terms of location of care and clinical diagnosis indicating minimal baseline differences that could confound the analysis. Table 1 show there was 76% incidence of phlebitis in pre intervention group which significantly reduced to 32% in post intervention group.

Table 1: Incidence of Phlebitis in Pre- and Post-Intervention Groups

Phlebitis	Pre-intervention	Post-intervention	P-value
Yes	38(76%)	16(32%)	0.003
No	12 (24%)	34(68%)	
Total	50(100%)	50(100%)	

Table 2 shows there was 48% incidence of infiltration injury in pre intervention group which significantly reduced to 20% in post intervention group.

Table 2: Incidence of infiltration injury in Pre- Intervention and Post- Intervention Groups

Infiltration injury	Pre-intervention	Post-intervention	P-value
Yes	24(48%)	10(20%)	0.008
No	26 (52%)	40(80%)	
Total	50(100%)	50(100%)	

Table 3 shows there was 24% incidence of occlusion injury in pre intervention group which significantly reduced to 12% in post intervention group.

Table 3: Incidence of occlusion in Pre- Intervention and Post-Intervention Groups

Occlusion	Pre-intervention	Post-intervention	P-value
Yes	12(24%)	6(12%)	0.002
No	38 (76%)	44(88%)	
Total	50(100%)	50(100%)	

The severity grading based on visual infusion phlebitis score is shown in table 4. There was significant difference in severity of phlebitis between two groups. The post- intervention

group experienced only mild to moderate events, indicating both a reduction in frequency and severity of complications

Table 4: Severity Grading of Adverse Events (Visual inspection phlebitis score)

Characteristic	Pre-Intervention (n = 50)	Post-Intervention (n = 50)
VIP SCORE @24 hours		
0	49(98%)	47(94%)
1	1(2%)	3(6%)
P value	0.6	
VIP SCORE @24-48 hours		
0	35(70%)	43(86%)
1	8(16%)	4(8%)
2	7((14%)	3(6%)
P value	0.05	
VIP SCORE @72 hours		
0	8(16%)	33(66%)
1	22(44%)	7(14%)
2	12(24%)	5(10%)
3	8(16%)	5(10%)
P value	0.001	
VIP SCORE @96 hours		
0	1(2%)	25(50%)
1	7(14%)	8(16%)
2	20(40%)	8(16%)
3	12(24%)	5(10%)
4	10(20%)	4(8%)
P value	0.001	

The severity grading based on infiltration grade as shown in table 5. There was significant difference in severity of phlebitis between two groups. The post-intervention

group experienced only mild to moderate events, indicating both a reduction in frequency and severity of complications

Table 5: Severity Grading of Adverse Events (infiltration grade)

Characteristic	Pre-Intervention (n = 50)	Post-Intervention (n = 50)
INFILTRATION GRADE @24 hours		
0	50(100%)	50(100%)
Total	50(100%)	50(100%)
P value	Not applicable	
INFILTRATION GRADE @48 hours		
0	43(86%)	47
1	7(14%)	3
Total	50(100%)	50(100%)
P value	0.1	
INFILTRATION GRADE @72 hours		
0	31(62%)	41(82%)
1	11(22%)	5(10%)
2	8(16%)	4(8%)
Total	50(100%)	50(100%)
P value	0.02	
INFILTRATION @96 hours		
0	8(16%)	29(58%)
1	22(44%)	12(24%)
2	10(20%)	6(12%)
3	10(20%)	3(6%)
Total	50(100%)	50(100%)
P value	0.001	

DISCUSSION

This study aimed to evaluate the impact of a structured quality improvement (QI) intervention on the incidence of short peripheral venous catheter (SPVC)-related adverse events in a pediatric population. The findings reveal substantial improvements in clinical outcomes, procedural compliance, and staff performance following the intervention, highlighting the significance of multifaceted strategies in optimizing vascular access care in children.

The most noteworthy finding of this study was the substantial reduction in SPVC-related complications post-intervention. The overall incidence of adverse events decreased from 76% to 32%, representing a statistically and clinically significant improvement. Specific adverse events such as phlebitis, infiltration, occlusion, and dislodgement all declined notably. These improvements are consistent with previous studies by Singh et al and Hoot et al. (9, 10), which have shown that structured education, monitoring, and feedback loops effectively reduce catheter-related complications in both adult and pediatric populations.

The high incidence of complications in the pre-intervention group underscores the risks associated with routine catheter care when evidence-based guidelines are not rigorously followed. The QI intervention addressed these gaps through protocol standardization, reinforcing the importance of site selection, proper securement, aseptic technique, and ongoing monitoring.

Training focused on evidence-based insertion techniques, recognition of early signs of complications, and proper documentation practices. These findings are in line with study by Keleekai et al. emphasizing that education and training are key drivers of safe catheter care (11).

Moreover, maintenance bundle compliance improved dramatically. Daily site inspections, adherence to flushing protocols, and securement checks all saw improvements exceeding 90%. This indicates that the intervention not only educated staff but effectively changed behaviours—a critical component of sustainable quality improvement.

Another strength of the intervention was its emphasis on documentation and surveillance. Improvements were seen in

recording catheter insertion times, site assessments, and daily reviews. Better documentation enables early detection of potential issues, facilitates timely interventions, and provides a record for quality audits. Previous researcher (12) has linked structured documentation with reductions in catheter-related bloodstream infections and improved patient outcomes. Subgroup analyses demonstrated consistent reductions in adverse events across all age groups and clinical diagnoses, confirming the broad applicability of the intervention. Younger children (<5 years) showed the highest baseline risk, which was substantially mitigated post-intervention. Regression analysis further reinforced the effectiveness of the QI intervention. The adjusted odds ratio for experiencing an adverse event post-intervention was 0.22, indicating a 75% risk reduction. The number of insertions attempts also emerged as a significant predictor of complications, supporting the need for skilled staff and ultrasound-guided insertion when appropriate (13).

LIMITATIONS

The study was conducted in a single institution, which may limit the generalizability of the results. The sample size was also relatively small, and the follow-up period was short-term, meaning that long-term sustainability of the intervention's effects could not be assessed. Furthermore, the study relied on clinical outcome measures such as the occurrence of phlebitis, occlusion, and infiltration, which may not fully capture the patient experience or other less tangible aspects of catheter-related complications, such as pain or discomfort. Future studies could consider incorporating patient-reported outcomes to gain a more holistic understanding of the impact of QI interventions.

CONCLUSION

In conclusion, this study demonstrates that a structured QI intervention significantly reduces SPVC-related adverse events in

pediatric patients. Improvements were observed in clinical practices, documentation, staff knowledge, and patient outcomes. The study reinforces the importance of multifaceted, evidence-based interventions in achieving and sustaining high standards of vascular access care.

Declaration by Authors

Ethical Approval: Approved. Ethical approval number: IEC/PG/2023/192

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