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A Quality Improvement Approach to Reduce Peripheral Intravenous Catheter-Induced Thrombophlebitis: Improving Healthcare Outcomes in a Resource-Limited Setting

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Abstract

Background: *Peripheral intravenous catheter (PIVC)-induced thrombophlebitis is a common complication that poses significant healthcare challenges, particularly in resource-limited settings where access to sterile equipment can be a challenge. This study aimed to enhance hand hygiene practices and improve the overall management of PIVCs in a secondary care hospital in southern India, with the goal of reducing the incidence of thrombophlebitis.*

Methods: *A quality improvement approach was adopted using a Plan-Do-Study-Act (PDSA) cycle to implement structured interventions. These interventions included staff training on hand hygiene, PIVC insertion techniques, and adherence monitoring. Data were collected through direct observations of clinical practice, along with pre-and post-intervention assessments. Paired t-tests were employed to evaluate the statistical significance of changes in compliance rates across the study period.*

Results: *Initial improvements in hand hygiene practices were noted, but compliance remained suboptimal throughout the study period. Statistically, significant improvements were achieved in workspace preparation, PIVC insertion techniques, and skin disinfection protocols. The incidence of PIVC-induced thrombophlebitis decreased over time, indicating the potential benefits of the interventions in reducing infection rates.*

Conclusion: *While the implemented interventions successfully enhanced technical skills and procedural adherence, the persistence of low hand hygiene compliance highlights a critical area for further improvement. Continuous education, monitoring, and reinforcement of hand hygiene practices are essential to ensure sustainable improvements in PIVC management and overall patient outcomes.*

Keywords: *thrombophlebitis, peripheral intravenous catheter, hand hygiene, sterility, quality improvement, resource-limited settings.*

Introduction

Peripheral intravenous catheters (PIVCs) are essential for vascular access in various medical settings, enabling the administration of fluids, medications, and blood products.[1] However, their use is often associated with complications, particularly thrombophlebitis, an inflammation of the vein accompanied by thrombus formation.[2] Thrombophlebitis not only causes significant patient discomfort but may also lead to severe complications, including skin necrosis, infective endocarditis, and extended hospital stays.[3]

In our 50-bed secondary care hospital, located in a tribal region of southern India, we identified a high incidence of PIVC-induced thrombophlebitis. The hospital primarily serves more than 20,000 Adivasis, classified as Particularly Vulnerable Tribal Groups, spread across 320 hamlets in the Gudalur Valley of the Nilgiri Hills, South India. The hospital, operated by a charitable society, employs tribals trained in healthcare, comprising about 75% of the nursing and support staff. Funded through government schemes and donations, the hospital offers subsidized care, addressing a wide range of medical, surgical, gynecological, and emergency cases. On average, it manages approximately 2,000 patients monthly, with around 175 inpatient treatments

Our hospital employs 31 trained nurses with diverse qualifications. These include the Bharat Sevak Samaj (BSS) Diploma in Patient Care, which is equivalent to a Certified Nursing Assistant (CNA) qualification in many countries, and the General Nursing and Midwifery (GNM) Diploma, which is roughly comparable to a Registered Nurse (RN) with a diploma in the international context. Additionally, many nurses hold Bachelor's degrees in Nursing (BSc. Nursing), aligning with Bachelor of Science in Nursing (BSN) qualifications globally, while a few possess Master's degrees in Nursing (MSc. Nursing), equivalent to Master's in Nursing (MSN) internationally. A significant portion of these nurses are from the tribal communities the hospital serves, contributing to culturally appropriate care for the local population.

Despite handling a diverse range of cases, the hospital lacked a systematic approach to the early detection and documentation of thrombophlebitis. Consequently, exact incidence data was unavailable. However, based on cases requiring treatment, we recorded four cases of thrombophlebitis from 47 cannulations in June 2024, indicating an approximate incidence rate of 8.5%. Contributing factors included gaps in sterility protocols, limited availability of sterile materials, and inadequate staff training. These issues resulted in suboptimal patient outcomes, increased healthcare costs, and treatment delays

The need for this study is particularly acute in our setting, where the patients are predominantly from extremely poor and underprivileged backgrounds. The hospital operates on limited funds, serving a large population with scarce resources. Any additional morbidity caused by hospital-acquired conditions such as thrombophlebitis places a significant financial burden on both the patients and the institution. For the patients, who struggle to afford even subsidized care, complications like thrombophlebitis can lead to increased hospital bills, prolonged stays, and additional treatments. For the hospital, which relies on donations and government aid to continue its mission of serving the needy, these preventable complications consume precious resources, undermining its ability to provide care for others in need. Therefore, reducing the incidence of thrombophlebitis is crucial not only for improving patient outcomes but also for ensuring the sustainability of the hospital's mission to serve this vulnerable population.

Previous studies have reported thrombophlebitis rates ranging from 2.3% to 67.2%, influenced by factors such as catheter material, insertion technique, and maintenance practices.[4,5] Quality improvement initiatives, such as those by Abolfotouh et al. and Malm et al., have

successfully reduced complications through staff training and standardized protocols.[6,7]

This study aimed to reduce the incidence of PIVC-induced thrombophlebitis by addressing key gaps in sterility and hand hygiene protocols through targeted interventions. Using the Plan-Do-Study-Act (PDSA) cycle, we implemented a series of interventions focused on education, monitoring, and procedural adherence, with the goal of improving patient outcomes and reducing healthcare costs.[8,9]

The study was conducted in two phases. The first phase included hand hygiene training, PIVC insertion techniques, and adherence monitoring. The second phase will introduce transparent dressings and implement the VIP score to enhance thrombophlebitis detection and management. This paper reports on the results from the first phase, with further interventions planned for subsequent implementation

This project has three primary objectives. The first is to assess current practices related to PIVC insertion and maintenance at a tribal hospital in southern India. The second is to implement and evaluate a series of targeted interventions designed to improve PIVC management. The third is to measure the impact of these interventions on the incidence of thrombophlebitis and overall practice quality.

The primary outcome was the incidence of clinically significant thrombophlebitis, while secondary outcomes included compliance with hand hygiene protocols, workspace and equipment preparation, glove application, skin disinfection, and adherence to sterility protocols.

Materials and Methods

The project was implemented at a secondary care tribal hospital in southern India, where limited resources and infrastructure posed significant challenges. Key contextual elements included resource constraints of limited access to sterile equipment and materials, training gaps in the understanding and adherence to PIVC insertion and maintenance protocols among healthcare workers and the lack of standardized protocols for PIVC insertion. These factors were essential in designing and implementing interventions that were both feasible and relevant to the local setting

Based on pre-assessment findings, a comprehensive care bundle was developed using the WHO's 'Guidelines for the Prevention of Bloodstream Infections and Other Infections Associated with the Use of Intravascular Catheters'.[10,11]

The hand hygiene training and reinforcement sessions were held with emphasize on the critical role of proper hand hygiene practices in ensuring patient safety, particularly during peripheral intravenous catheter (PIVC) insertion. Training sessions were conducted using WHO hand hygiene tools, focusing on the '5 Moments for Hand Hygiene'[12] and their application at specific points during PIVC insertion.[13] Participants were not only educated on the theoretical aspects of hand hygiene but also engaged in practical demonstrations. This allowed them to observe and practice the correct aseptic techniques in a controlled environment. To evaluate the effectiveness of the training, baseline knowledge and practices were assessed through pre-intervention tests, followed by post-training evaluations. (Figure 3) Compliance with hand hygiene during PIVC insertions was monitored through observational assessments using standardized checklists.

Sterility maintenance during PIVC insertion was reinforced through guidelines and instructions on the proper usage of sterile trays and handling of PIVC materials. A video was circulated to demonstrate each step of the insertion process and encourage adherence to sterile practices. Observational assessments and feedback sessions were conducted to ensure that the principles of sterility were consistently followed.

The introduction of low-cost sterilized trays marks another important step toward improving sterility during PIVC insertion. These trays, sterilized with

spirit before and after each use, serve as an economical alternative to the sterile packs recommended by WHO.[10] In conjunction with this, healthcare workers will be trained in the Aseptic Non-Touch Technique (ANTT), and their compliance assessed through observational checklists.

Another key intervention involves transitioning to transparent sterile occlusive dressings, which allows for better visibility and protection of the IV site. This change requires negotiations with hospital management to procure the necessary materials, and the effectiveness of the new dressings will be continually monitored through feedback mechanisms.

The introduction of the Visual Infusion Phlebitis (VIP) score aims to enhance the monitoring of PIVC sites.(2,14,15) Nurses will be trained to assess the sites daily at fixed intervals using the VIP score, which will help guide decisions on catheter removal. This standardized assessment method will ensure consistent and accurate evaluation of the PIVC sites.

Lastly, the use of sterilized cotton for site disinfection represented a significant improvement in infection control. Non-sterile cotton is currently being used, but after negotiations with hospital management, autoclaved sterile cotton will be adopted. Compliance with the new disinfection protocols will be closely monitored to ensure adherence to the highest standards of care.

All 31 nurses in the hospital participated in the hand hygiene training and were subsequently observed over the intervention period. A checklist was developed based on insights from the WHO Guidelines for the Prevention of Bloodstream Infections and Other Infections Associated with the Use of Intravascular Catheters.(10) (Figure I) This checklist was utilized during PIVC insertions and administered by a medical officer at the hospital. Seven PIVC insertions were randomly (every 3rd PIVC insertion) selected for observation, and the process was documented using the checklist. The collected data was then tabulated and analyzed to assess adherence to the recommended protocols and the impact of the training

Online quizzes with multiple-choice questions were administered pre- and post-training to assess the impact on knowledge. (Figure II). PIVC insertions were directly observed, and adherence to insertion protocols was documented using a checklist developed from WHO guidelines.

Results relating to continuous variables were expressed as mean and standard deviation and that of categorical variables were expressed as counts and percentages. The differences between quantitative variables were analyzed using the Paired t-test. P value < 0.005 was considered statistically significant. Analysis was carried out using the SPSS 26.0 version.

Figure III illustrates the timeline of all interventions implemented in the study over a one-month period, along with the corresponding PDSA cycles.

Results

In this study, a comprehensive analysis was conducted to assess the impact of multiple interventions on the hygiene practices of nurses. Table 1 presents the overall scores at four distinct time points: the baseline and the three interventions. The results reveal a progressive improvement in scores over time, with baseline scores indicating suboptimal adherence to hygiene standards. Following the first intervention, the mean score increased slightly, though the improvement was not statistically significant. By the second intervention, a significant increase was observed ($p=0.003$), highlighting the impact of the ongoing interventions. By the third intervention, there was a further statistically significant improvement in scores ($p=0.001$).

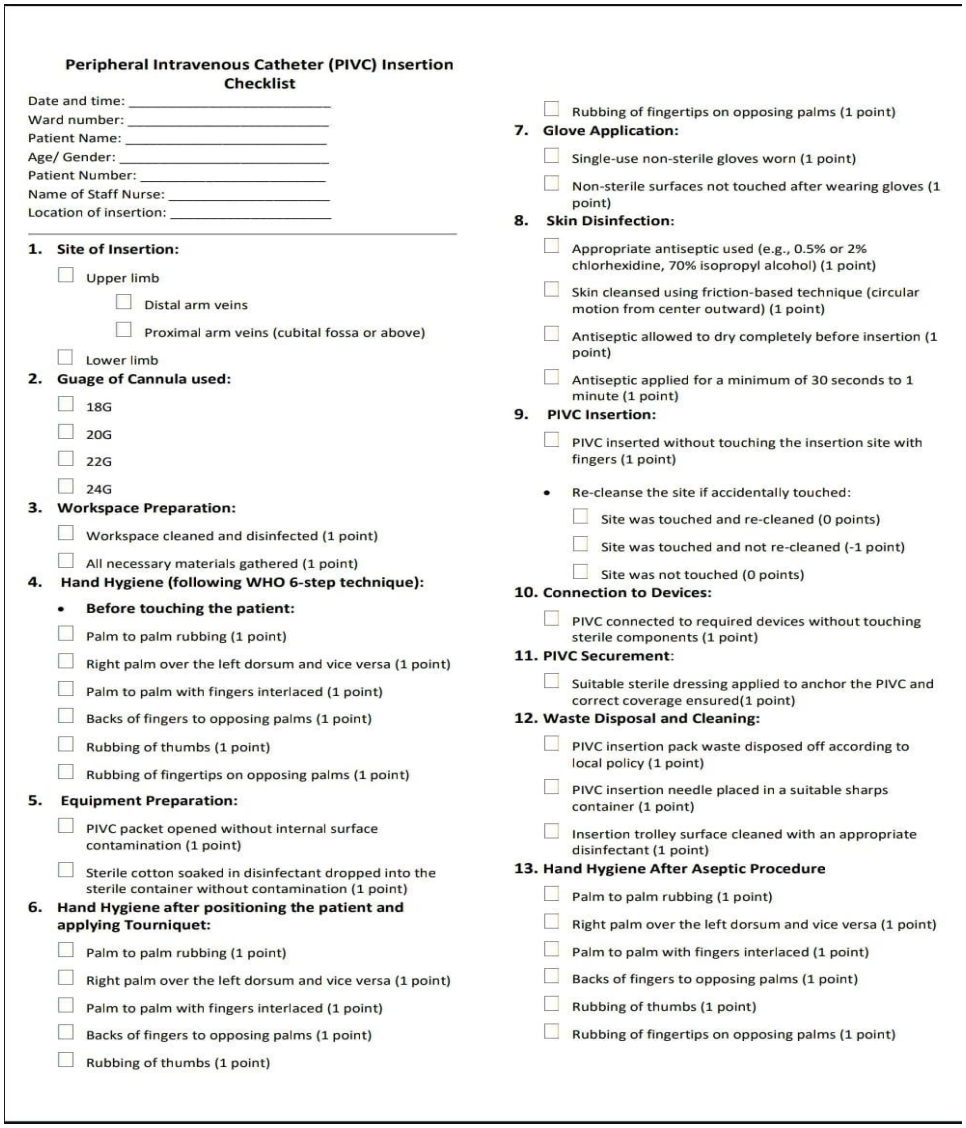
Table 1 also presents the total hand hygiene scores. The baseline scores reflect a low level of compliance with hygiene standards. Although the mean hand hygiene scores increased slightly over the first two interventions, improvement was not

statistically significant. A statistically significant improvement in hand hygiene compliance was observed only after the third intervention.

Table 1: Mean total score and mean hand hygiene score over the interventions

	Score (Mean ± Standard Deviation)				p value
	Baseline 1	Intervention 1	Intervention 2	Intervention 3	
Total Score	7.43 ± 1.902*+	10.14 ± 3.237	15.57 ± 4.504*	26.86 ±4.451+	<0.005
Total Hand hygiene score	0.86 ± 2.268#	3.57 ± 2.878	6.71 ± 4.608	14.71 ± 3.402#	<0.005

Significant improvement in total score compared to the baseline ($p<0.05$) was noted at interventions 2 and 3. Significant improvement in total hand hygiene scores compared to the baseline ($p<0.05$) was noted at interventions 3 only



Peripheral Intravenous Catheter (PIVC) Insertion Checklist

Date and time: _____
Ward number: _____
Patient Name: _____
Age/ Gender: _____
Patient Number: _____
Name of Staff Nurse: _____
Location of insertion: _____

1. **Site of Insertion:**
   - ☐ Upper limb
     - ☐ Distal arm veins
     - ☐ Proximal arm veins (cubital fossa or above)
   - ☐ Lower limb
2. **Guage of Cannula used:**
   - ☐ 18G
   - ☐ 20G
   - ☐ 22G
   - ☐ 24G
3. **Workspace Preparation:**
   - ☐ Workspace cleaned and disinfected (1 point)
   - ☐ All necessary materials gathered (1 point)
4. **Hand Hygiene (following WHO 6-step technique):**
   - **Before touching the patient:**
   - ☐ Palm to palm rubbing (1 point)
   - ☐ Right palm over the left dorsum and vice versa (1 point)
   - ☐ Palm to palm with fingers interlaced (1 point)
   - ☐ Backs of fingers to opposing palms (1 point)
   - ☐ Rubbing of thumbs (1 point)
   - ☐ Rubbing of fingertips on opposing palms (1 point)
5. **Equipment Preparation:**
   - ☐ PIVC packet opened without internal surface contamination (1 point)
   - ☐ Sterile cotton soaked in disinfectant dropped into the sterile container without contamination (1 point)
6. **Hand Hygiene after positioning the patient and applying Tourniquet:**
   - ☐ Palm to palm rubbing (1 point)
   - ☐ Right palm over the left dorsum and vice versa (1 point)
   - ☐ Palm to palm with fingers interlaced (1 point)
   - ☐ Backs of fingers to opposing palms (1 point)
   - ☐ Rubbing of thumbs (1 point)
   - ☐ Rubbing of fingertips on opposing palms (1 point)
7. **Glove Application:**
   - ☐ Single-use non-sterile gloves worn (1 point)
   - ☐ Non-sterile surfaces not touched after wearing gloves (1 point)
8. **Skin Disinfection:**
   - ☐ Appropriate antiseptic used (e.g., 0.5% or 2% chlorhexidine, 70% isopropyl alcohol) (1 point)
   - ☐ Skin cleansed using friction-based technique (circular motion from center outward) (1 point)
   - ☐ Antiseptic allowed to dry completely before insertion (1 point)
   - ☐ Antiseptic applied for a minimum of 30 seconds to 1 minute (1 point)
9. **PIVC Insertion:**
   - ☐ PIVC inserted without touching the insertion site with fingers (1 point)
   - Re-cleanse the site if accidentally touched:
     - ☐ Site was touched and re-cleaned (0 points)
     - ☐ Site was touched and not re-cleaned (-1 point)
     - ☐ Site was not touched (0 points)
10. **Connection to Devices:**
    - ☐ PIVC connected to required devices without touching sterile components (1 point)
11. **PIVC Securement:**
    - ☐ Suitable sterile dressing applied to anchor the PIVC and correct coverage ensured(1 point)
12. **Waste Disposal and Cleaning:**
    - ☐ PIVC insertion pack waste disposed off according to local policy (1 point)
    - ☐ PIVC insertion needle placed in a suitable sharps container (1 point)
    - ☐ Insertion trolley surface cleaned with an appropriate disinfectant (1 point)
13. **Hand Hygiene After Aseptic Procedure**
    - ☐ Palm to palm rubbing (1 point)
    - ☐ Right palm over the left dorsum and vice versa (1 point)
    - ☐ Palm to palm with fingers interlaced (1 point)
    - ☐ Backs of fingers to opposing palms (1 point)
    - ☐ Rubbing of thumbs (1 point)
    - ☐ Rubbing of fingertips on opposing palms (1 point)

Figure I: Checklist for PIVC insertion, developed based on insights from the WHO Guidelines for the Prevention of Bloodstream Infections and Other Infections Associated with the Use of Intravascular Catheters.

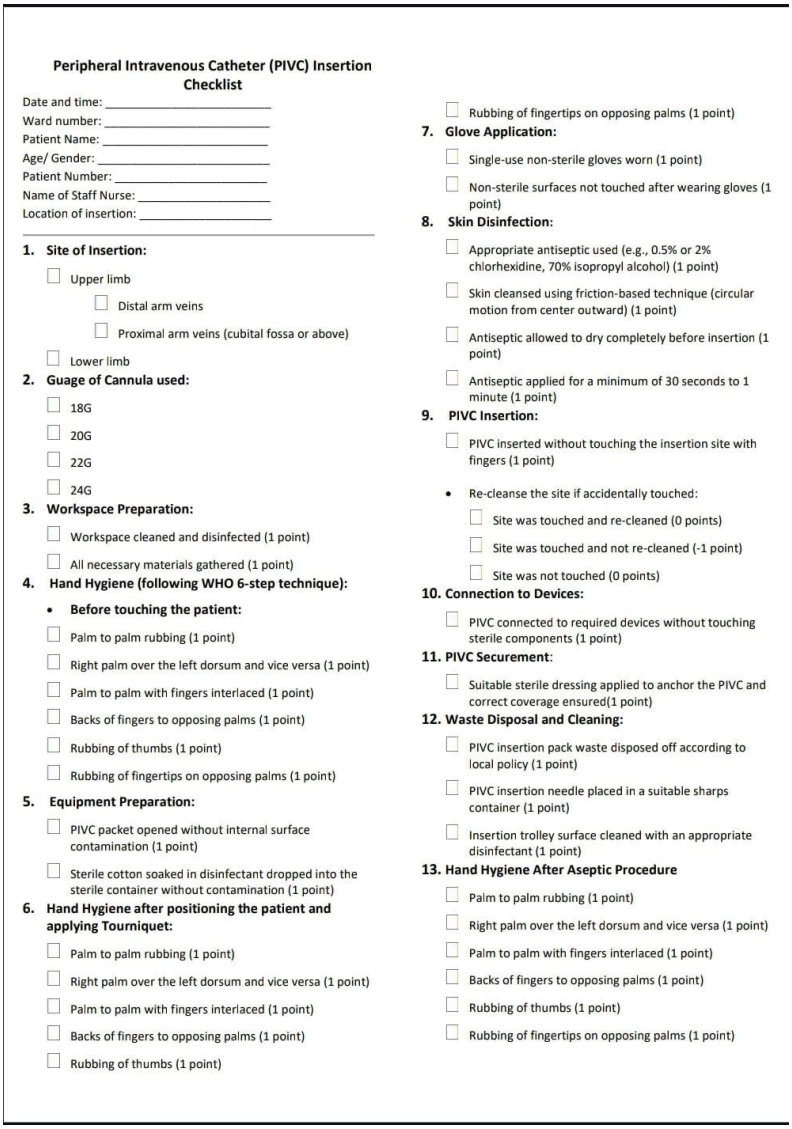


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Figure II: Hand hygiene assessment

This quiz was used to assess nurses' knowledge after training in hand hygiene.

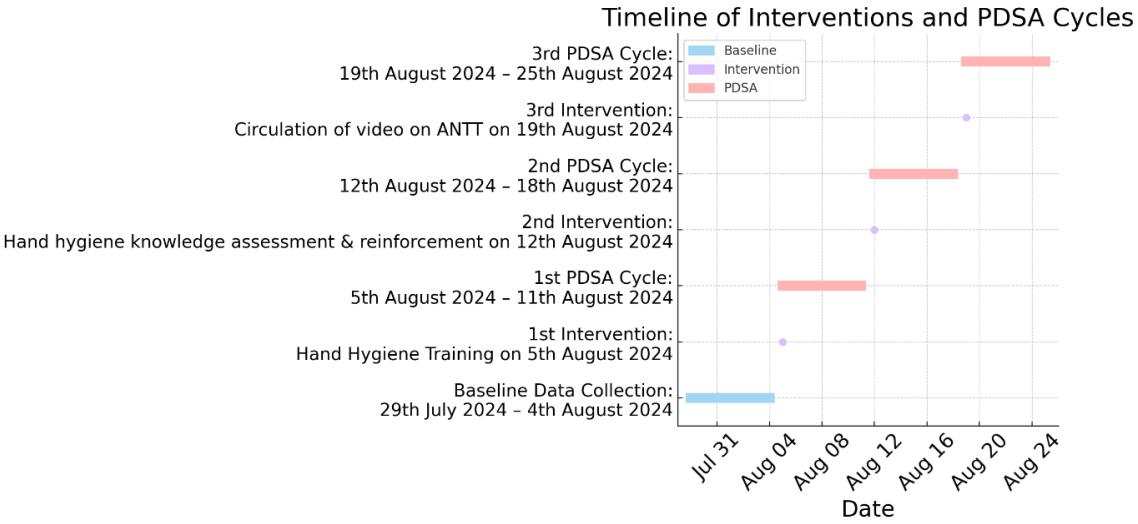

Figure 1: Timeline of interventions (over one month)

Discussion

The findings from this quality improvement initiative reveal both successes and ongoing challenges in improving hand hygiene compliance and reducing peripheral intravenous catheter (PIVC)-induced thrombophlebitis in a resource-limited hospital setting. While the intervention led to measurable improvements in workspace preparation, glove application, and skin disinfection, hand hygiene compliance remained critically low even after multiple phases of the intervention. These mixed results underscore the complexity of behavior change in healthcare settings and highlight the need for sustained educational efforts, cultural change, and possibly more structural interventions to ensure consistent adherence to infection control practices. It is noteworthy that none of the insertions performed during the intervention period, as well as in the month following, resulted in thrombophlebitis.

One of the most striking results of the study was the continued difficulty in improving hand hygiene compliance, with only 42.9% of nurses achieving full compliance by the third intervention. This aligns with numerous studies in both high- and low-resource settings that underscore the challenges in promoting hand hygiene behaviors.[16,17] Factors such as insufficient access to hygiene supplies, ingrained work habits, and the perception of time pressures in clinical environments all likely contributed to these low compliance rates.[18] The persistent low compliance, even after multiple interventions, suggests that further steps must be taken to create an environment where hand hygiene is seamlessly integrated into daily practice.

To overcome these barriers, future interventions will need to address both structural and behavioral challenges. Providing consistent access to hand hygiene resources such as alcohol-based hand rubs, combined with reminders at the point of care, could help improve compliance. Moreover, fostering a cultural shift where hand hygiene is prioritized-perhaps through peer-led initiatives or leadership-driven campaigns-will be crucial. Continuous education, as well as regular monitoring and feedback, will likely be necessary to sustain improvements in this critical area of infection prevention.[17]

In contrast to hand hygiene, the project observed marked improvements in procedural aspects of PIVC management, particularly workspace preparation, glove application, and skin disinfection. By the third intervention, 85.7% of nurses achieved full compliance with workspace preparation and skin disinfection protocols, compared to only 28.6% at baseline. This significant improvement suggests that certain aspects of procedural adherence, especially those that involve observable, task-based steps, may be easier to influence through targeted interventions than behaviors like hand hygiene, which are more dependent on individual habits and perception of risk.

One reason for the success in procedural compliance may be the direct and immediate nature of the tasks involved. Activities such as workspace preparation and glove application are concrete actions that are clearly tied to patient safety during the insertion procedure. Nurses may find it easier to integrate these steps into their routine, especially when the tasks are clearly linked to visible outcomes, such as preventing infection during PIVC insertion. Additionally, the use of checklists and direct observation during the intervention phases likely reinforced the importance of these procedural steps, further improving compliance.

The improvements in workspace preparation and skin disinfection are critical for reducing the risk of PIVC-induced thrombophlebitis. Previous studies have shown that thorough disinfection and adherence to aseptic technique significantly reduce the incidence of catheter-related infections and complications including thrombophlebitis.[19] In this study, the improved adherence to these practices likely contributed to the observed reduction in thrombophlebitis rates, although the

study did not formally document the Visual Infusion Phlebitis (VIP) score during this phase. Introducing transparent dressings and consistently using the VIP score in future phases could further enhance the early detection and management of thrombophlebitis, potentially reducing its incidence even further.

The mixed outcomes of this study highlight the importance of ongoing education and continuous monitoring to reinforce best practices in infection control. Although improvements were seen in some areas, the persistence of low hand hygiene compliance suggests that a single round of training is insufficient to instil lasting behavior change. Continuous education, combined with regular audits and feedback, may be necessary to ensure that the lessons learned from the intervention are consistently applied in daily practice. In addition to formal education, healthcare workers may benefit from peer-led initiatives where more experienced or compliant staff members model proper hand hygiene and aseptic techniques. This form of peer reinforcement, combined with visual reminders and accessible hand hygiene supplies, could help create a culture where infection control practices are prioritized and normalized within the hospital environment.[20]

Conclusion

This quality improvement study in a resource-limited hospital demonstrates successes in improving peripheral intravenous catheter (PIVC) management using the Plan-Do-Study-Act (PDSA) approach. Significant gains were made in workspace preparation, glove use, and skin disinfection, contributing to reduced PIVC-induced thrombophlebitis. However, low hand hygiene compliance persists despite multiple interventions, highlighting the challenge of behavior change in healthcare. Sustainable hand hygiene improvements will require continuous education, cultural shifts, leadership involvement, and regular monitoring and feedback.

Several limitations of this study must be acknowledged. The small sample size limits the generalizability of the findings, as the results may not reflect the broader challenges faced in other healthcare settings. A larger study population would provide a more comprehensive understanding of the factors influencing hygiene compliance and procedural adherence in resource-limited environments. Additionally, the lack of formal documentation of thrombophlebitis rates using the VIP score makes it difficult to quantitatively assess the impact of the intervention on clinical outcomes. Future studies should prioritize the implementation of transparent dressings and the consistent use of the VIP score to better monitor and manage thrombophlebitis.

In terms of future interventions, addressing the structural barriers to hand hygiene, such as improving access to hand rubs and soap, could help facilitate compliance. Moreover, introducing automated reminders or prompts for hand hygiene at key moments during care, such as before and after PIVC insertion, may further reinforce compliance. A multi-faceted approach, combining education, structural improvements, and ongoing monitoring, is likely necessary to achieve sustained behavior change

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