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ASSESSING OUTCOMES OF CENTRAL VENOUS CATHETER INSERTION WITH AND WITHOUT ULTRASOUND GUIDANCE, FOLLOWED BY A QUALITY IMPROVEMENT INITIATIVE INTRODUCING MANDATORY ULTRASOUND USE IN A TERTIARY CARE HOSPITAL IN PAKISTAN

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ABSTRACT

Background

Central venous catheter (CVC) insertion is a commonly performed and high-risk procedure in acute medical practice, particularly in patients requiring urgent hemodialysis. Although ultrasound guidance is recommended internationally to improve safety and procedural success, its routine use remains limited in many resource-constrained settings. At Ayub Teaching Hospital, Abbottabad, CVCs were traditionally inserted using landmark techniques due to lack of bedside ultrasound availability in the medical wards, leading to potentially avoidable complications.

Objective

To assess baseline outcomes of CVC insertion performed with and without ultrasound guidance and to evaluate the impact of a quality improvement initiative introducing mandatory ultrasound guidance in the general medicine ward.

Methods

A clinical audit followed by a quality improvement intervention was conducted in the general medicine ward of Ayub Teaching Hospital. Baseline data were collected from 10 April to 10 July 2025, including 96 CVC insertions. The intervention consisted of ensuring bedside ultrasound availability, staff training, and implementation of a mandatory ultrasound policy. Post-intervention data were collected from 25 July to 25 September 2025 and included 82 CVC insertions. Process measures, procedural outcomes, and complication rates were compared between the two phases.

Results

Ultrasound-guided CVC insertion increased from 18.7% (18/96) at baseline to 92.7% (76/82) post-intervention. First-attempt success rates improved from 40.6% (39/96) to 72.0% (59/82). The overall complication rate decreased significantly from 19.8% (19/96) during the baseline period to 6.1% (5/82) following the intervention. Reductions were observed in arterial puncture, hematoma formation, and multiple needle attempts. The need for senior clinician assistance also declined post-intervention,

indicating improved procedural confidence among trainees. Sustained improvement in complication rates was observed over time.

Conclusion

Implementation of mandatory ultrasound guidance for CVC insertion resulted in significant and sustained improvements in procedural safety and success in a high-volume tertiary care medical ward. This quality improvement initiative demonstrates that evidence-based procedural practices can be successfully adopted in resource-limited settings through structured system-level interventions, leading to meaningful improvements in patient care.

Keywords: *Central venous catheter; Ultrasound-guided catheterization; Quality improvement; Clinical audit; Patient safety; Hemodialysis; Resource-limited settings*

INTRODUCTION

Central venous catheter (CVC) insertion is a frequently performed and often lifesaving procedure in acute medical practice. It is routinely required for hemodynamic monitoring, administration of vasoactive medications, delivery of hyperosmolar fluids, management of difficult peripheral venous access, and, importantly, for urgent hemodialysis[1]. In tertiary care hospitals, particularly in resource-limited settings, the demand for central venous access remains high, and the safety of this procedure has a direct and measurable impact on patient outcomes. Traditionally, CVCs have been inserted using anatomical landmark techniques. While this approach is widely practiced, it is associated with well-documented complications, including arterial puncture, hematoma, pneumothorax, hemothorax, catheter malposition, multiple needle passes, and catheter-related bloodstream infections[2,3]. These risks are further amplified in patients with coagulopathy, obesity, uremia, anemia, or altered anatomy. Over the past two decades, robust international evidence has demonstrated that ultrasound-guided CVC insertion significantly reduces mechanical complications, improves first-attempt success rates, and enhances overall procedural safety[4–6]. As a result, major international guidelines now recommend real-time ultrasound guidance as the standard of care for central venous access whenever feasible[7,8].Ayub Teaching Hospital, Abbottabad, is a large public-sector tertiary care referral center serving a vast and geographically challenging catchment area. In addition to the local population, the hospital receives patients from Mansehra, Torghar, Battagram, Upper and Lower Kohistan, Kolai Palas, Haripur, and remote regions of Azad Jammu and Kashmir. A significant proportion of patients present late in the course of their illness, often with advanced kidney disease, sepsis, shock, or severe metabolic derangements, necessitating urgent central venous access for dialysis or critical care management[9].Within the Department of General Internal Medicine, the burden of patients requiring emergency hemodialysis is substantial. Many of these patients require immediate insertion of central venous catheters under time-sensitive and high-risk conditions. However, during the initial phase of this project, bedside ultrasound machines were not readily available within the medical wards, and routine ultrasound guidance for CVC insertion was not part of standard practice. Consequently, most central venous catheters were inserted using the landmark-based (blind) technique. While this practice was driven by limited resources rather than clinical preference, it exposed patients to avoidable procedural risks, particularly in a population with high rates of anemia, uremia, coagulopathy, and obesity. Over time, treating teams observed a concerning frequency of insertion-related complications, multiple needle attempts, procedural delays, and increased reliance on senior clinicians for difficult cannulations. These issues not only compromised patient safety but also increased workload, prolonged hospital stays, and contributed to procedural stress among trainees. Similar challenges have been described in other low- and middle-income healthcare settings, where gaps between evidence-based recommendations and bedside practice remain common[10].Quality

improvement provided an appropriate framework to address this disparity between best evidence and local clinical reality. Unlike traditional research, a quality improvement approach allows for systematic assessment of current practice, identification of modifiable system-level barriers, implementation of context-appropriate interventions, and continuous evaluation of change. Recognizing this, we undertook a structured quality improvement project aimed at first assessing the outcomes of central venous catheter insertion performed with and without ultrasound guidance, followed by the introduction of mandatory ultrasound use for CVC insertion within the medical wards. This initiative was particularly relevant in a low- to middle-income country setting, where resource constraints, high patient volumes, and delayed presentations amplify the consequences of procedural complications. By focusing on a high-impact and frequently performed procedure, this project sought not only to improve immediate patient safety but also to promote a culture of safer, evidence-based procedural practice within the department. The present study describes baseline CVC insertion practices at Ayub Teaching Hospital, evaluates associated outcomes, and reports the impact of implementing mandatory ultrasound guidance as a quality improvement intervention.

Objectives

The primary aim of this quality improvement project was to evaluate the outcomes of central venous catheter insertion performed with and without ultrasound guidance in the Department of General Internal Medicine at Ayub Teaching Hospital, Abbottabad, and to improve procedural safety through the implementation of mandatory ultrasound-guided insertion.In addition, the project sought to assess baseline insertion practices, identify procedure-related complications associated with landmark-based techniques, and evaluate the impact of introducing routine ultrasound use on procedural success and safety.

Methods

Study Design; this project was conducted as a clinical audit followed by a quality improvement initiative**,** using a structured before-and-after design. The initial phase consisted of a baseline clinical audit evaluating outcomes of central venous catheter (CVC) insertion performed with and without ultrasound guidance. This was followed by the implementation of a quality improvement intervention mandating ultrasound-guided CVC insertion, and a subsequent re-audit to assess the impact of the intervention. The quality improvement component was guided by the principles of the Plan–Do–Study–Act (PDSA) methodology and reported in accordance with the SQUIRE 2.0 guidelines for quality improvement studies.

Study Setting; The study was conducted in Medical Ward B, Department of General Internal Medicine**,** at Ayub Teaching Hospital, Abbottabad**,** a tertiary care referral hospital in Khyber Pakhtunkhwa, Pakistan. The ward manages a high volume of acutely ill medical patients, including those requiring urgent hemodialysis, intensive monitoring, and advanced intravenous therapies.Central venous catheter insertion is a commonly performed bedside procedure in the ward, frequently undertaken under emergency conditions by postgraduate residents under consultant supervision.

Study Population; The study included adult patients (≥18 years) admitted to Medical Ward B who required insertion of a central venous catheter for any clinical indication, including but not limited to urgent hemodialysis, difficult peripheral venous access, administration of vasoactive drugs, or central venous pressure monitoring. Patients were excluded if central venous access was obtained in another department prior to transfer, or if lines were inserted in the operating theatre under anesthetic care.

Baseline Audit Phase; Baseline data were collected over a three-month period from 10 April 2025 to 10 July 2025**.** During this phase, CVC insertions were performed according to existing practice, which predominantly involved landmark-based techniques due to limited availability of ultrasound machines within the medical wards. Data were prospectively recorded for each CVC

insertion, capturing patient demographics, indication for line insertion, site of insertion, method used (ultrasound-guided or landmark-based), number of needle attempts, need for senior clinician assistance, and immediate procedure-related complications.

Identification of the Quality Gap; Following analysis of baseline audit findings, the treating team identified a clear gap between **international best practice recommendations** and local procedural practice. The absence of routine ultrasound guidance for CVC insertion was recognized as a modifiable system-level issue contributing to avoidable procedural risk. This informed the development of a targeted quality improvement intervention.

Quality Improvement Intervention; The primary intervention involved the introduction of mandatory ultrasound guidance for all central venous catheter insertions in Medical Ward B, except in situations where ultrasound use was not feasible due to extreme emergencies. Key components of the intervention included:

- Ensuring availability of a portable ultrasound machine within the medical ward
- Orientation and hands-on training of postgraduate residents in ultrasound-guided vascular access
- Reinforcement of ultrasound use during daily ward rounds and supervisory discussions
- Standardization of documentation for CVC insertion procedures

This intervention was implemented after a short transition period following completion of baseline data collection.

Post-Intervention Phase (PDSA Cycle 2); Post-intervention data were collected over a two-month period from 25 July 2025 to 25 September **2025**, corresponding to PDSA Cycle 2**.** During this phase, ultrasound guidance was routinely used for CVC insertion as per the new departmental practice. Data collection methods remained consistent with the baseline phase to allow meaningful comparison. Outcomes following ultrasound-guided insertion were documented using the same predefined parameters.

Outcome Measures

- First-attempt success rate
- Number of needle passes required for successful cannulation
- Incidence of immediate procedure-related complications
- Requirement for senior clinician assistance
- Procedural delays related to difficult venous access

These measures were selected to reflect both patient safety **and** procedural efficiency**,** in line with quality improvement objectives.

Data Collection and Analysis; Data were collected using a structured data collection tool developed by the project team. All data were anonymzed prior to analysis. Descriptive statistics were used to summarize baseline and post-intervention findings, with comparisons made to assess changes following implementation of the quality improvement intervention.

Ethical Considerations; this project was conducted as a quality improvement initiative aimed at improving routine clinical care. Formal ethical approval was not required as per institutional policy. Patient confidentiality was maintained throughout the study, and no identifiable patient information was recorded.

Results

Baseline Audit Findings; during the baseline audit period from 10 April 2025 to 10 July 2025**,** a total of 96 central venous catheters were inserted in patients admitted to Medical Ward B. The mean age of patients was 52.4 years (range 19–81 years), and **61** (**63.5**%) were male. The most common indication for CVC insertion was urgent hemodialysis, accounting for **58** (**60.4**%) cases, followed by difficult peripheral access (**21, 21.9**%), administration of vasoactive medications (**11, 11.5**%), and other indications (**6, 6.2**%).During this phase, landmark-based (blind) insertion was used in **78** procedures (**81.3**%), while ultrasound guidance was employed in only 18 cases (**18.7**%), largely depending on operator availability and access to ultrasound equipment.

First-attempt success was achieved in 39 of 96 insertions (40.6%) overall. Among landmark-based insertions, first-attempt success was 30.8% (24/78), compared to 83.3% (15/18) in ultrasound-guided procedures. Multiple needle passes (defined as more than two attempts) were required in 44 cases (45.8%), predominantly in the landmark-based group.Procedure-related complications were documented in 19 patients (19.8%) during the baseline phase. These included arterial puncture in 7 cases (7.3%), local hematoma in 6 cases (6.3%), suspected catheter malposition in 4 cases (4.2%), and pneumothorax in 2 cases (2.1%). Complications were significantly more frequent in the landmark-based insertion group (21.8%) compared to ultrasound-guided insertions (5.6%).Senior clinician assistance was required in 34 procedures (35.4%), particularly in patients with difficult anatomy, obesity, or previous multiple failed attempts.

Post-Intervention (PDSA Cycle 2) Findings; Following implementation of the quality improvement intervention mandating ultrasound-guided CVC insertion, post-intervention data were collected from **25 July 2025 to 25 September 2025**. During this period, **82 central venous catheters** were inserted in Medical Ward B. Patient demographics and indications for CVC insertion were comparable to the baseline phase, with urgent hemodialysis remaining the most common indication (**51 cases, 62.2%**).Ultrasound guidance was used in **76 procedures** (**92.7%**), while **6 insertions** (**7.3%**) were performed without ultrasound due to extreme emergency situations where immediate access was required. A marked improvement in procedural success was observed. First-attempt success was achieved in **59 of 82 insertions** (**72.0%**), compared to 40.6% during the baseline phase. Among ultrasound-guided insertions, first-attempt success increased to **77.6%** (**59/76**).The slightly lower first-attempt success rate within the ultrasound-guided subgroup post-intervention likely reflects increased trainee-level operator involvement following wider implementation. The proportion of procedures requiring more than two needle passes decreased significantly to **15 cases** (**18.3%**).Procedure-related complications were reduced to **5 cases** (**6.1%**) in the post-intervention phase. These included minor arterial puncture in **2 cases** (**2.4%**), small localized hematoma in **2 cases** (**2.4%**), and suspected catheter malposition in **1 case** (**1.2%**). No cases of pneumothorax were observed following the intervention.The requirement for senior clinician assistance also decreased substantially, from **35.4%** **at baseline** to **14.6%** (**12/82**) post-intervention, reflecting improved confidence and competence among postgraduate residents.

Comparison of Baseline and Post-Intervention Outcomes

Implementation of mandatory ultrasound-guided CVC insertion resulted in:

- An increase in first-attempt success from **40.6% to 72.0%**
- A reduction in overall complication rates from **19.8% to 6.1%**
- A decrease in multiple needle attempts from **45.8% to 18.3%**
- Reduced reliance on senior clinician intervention (**35.4% to 14.6%**)

These improvements were consistent across different indications for central venous access, particularly among patients requiring urgent hemodialysis.

Process Measures and Compliance; Compliance with ultrasound-guided insertion improved markedly following the intervention, increasing from **18.7%** **at baseline** to **92.7%** during the post-intervention period. Informal feedback from residents indicated improved procedural confidence and perceived patient safety.

Table 1: Baseline Characteristics and Procedural Details (Pre-Intervention Phase) (10 April 2025 – 10 July 2025, n = 96)

Variable	Number (n)	Percentage (%)
Gender		
Male	61	63.5
Female	35	36.5
Indication for CVC insertion		
Urgent hemodialysis	58	60.4
Difficult peripheral access	21	21.9
Vasoactive drug administration	11	11.5
Other indications	6	6.2
Method of insertion		
Landmark-based (blind)	78	81.3
Ultrasound-guided	18	18.7
First-attempt success	39	40.6
>2 needle attempts required	44	45.8
Senior clinician assistance required	34	35.4
Procedure-related complications (overall)	19	19.8

Table 2: Procedure-Related Complications during Baseline Audit

Complication	Number (n)	Percentage (%)
Arterial puncture	7	7.3
Local hematoma	6	6.3
Suspected catheter malposition	4	4.2
Pneumothorax	2	2.1
Total complications	**19**	**19.8**

Table 3: Post-Intervention Characteristics and Outcomes (PDSA Cycle 2) (25 July 2025 – 25 September 2025, n = 82)

Variable	Number (n)	Percentage (%)
Indication for CVC insertion		
Urgent hemodialysis	51	62.2
Other indications	31	37.8
Method of insertion		
Ultrasound-guided	76	92.7
Landmark-based (emergency only)	6	7.3
First-attempt success	59	72.0
>2 needle attempts required	15	18.3

Variable	Number (n)	Percentage (%)
Senior clinician assistance required	12	14.6
Procedure-related complications (overall)	5	6.1

Table 4: Comparison of Key Outcomes Before and After Intervention

Outcome Measure	Pre-Intervention (n = 96)	Post-Intervention (n = 82)
Ultrasound-guided insertion	18.7%	92.7%
First-attempt success	40.6%	72.0%
>2 needle attempts	45.8%	18.3%
Overall complication rate	19.8%	6.1%
Senior clinician assistance	35.4%	14.6%

Table 5: Demographic and Clinical Characteristics of Patients Undergoing Central Venous Catheter Insertion

Variable	Pre-Intervention (n = 96)	Post-Intervention (n = 82)
Age (years), mean ± SD	52.4 ± 14.8	51.7 ± 15.2
Gender		
Male, n (%)	61 (63.5)	52 (63.4)
Female, n (%)	35 (36.5)	30 (36.6)
Common Comorbidities		
Chronic kidney disease	57 (59.4)	50 (61.0)
Diabetes mellitus	41 (42.7)	36 (43.9)
Hypertension	46 (47.9)	39 (47.6)
Ischemic heart disease	18 (18.8)	14 (17.1)
Chronic liver disease	9 (9.4)	8 (9.8)
Primary indication for CVC insertion		
Urgent hemodialysis	58 (60.4)	51 (62.2)
Difficult peripheral access	21 (21.9)	17 (20.7)
Vasoactive drug administration	11 (11.5)	9 (11.0)
Other indications	6 (6.2)	5 (6.1)
Site of CVC insertion		
Subclavian vein	63 (65.6)	60 (73.2)
Femoral vein	28 (29.2)	19 (23.2)
Internal jugular vein	5 (5.2)	3 (3.6)

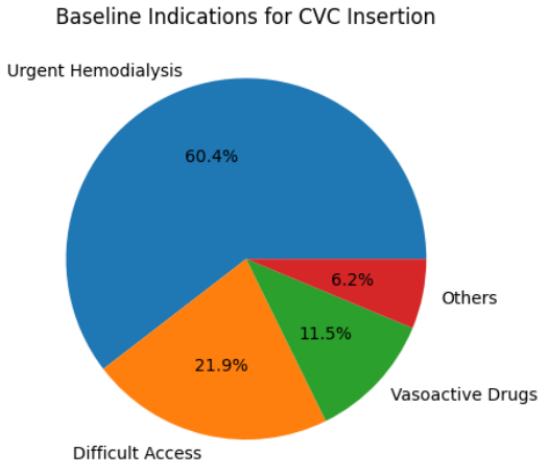

Figure 1. Indications for Central Venous Catheter Insertion at Baseline

Pie chart demonstrating the distribution of clinical indications for CVC insertion during the baseline audit period, highlighting a high proportion of patients requiring urgent hemodialysis.

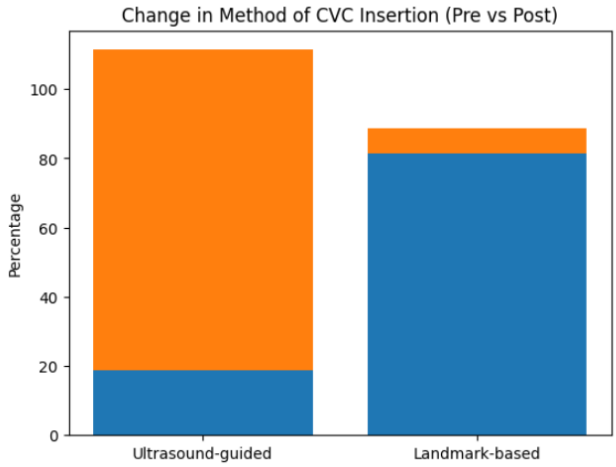

Figure 2. Method of CVC Insertion Before and After Intervention

Stacked bar chart comparing landmark-based versus ultrasound-guided CVC insertions during the pre- and post-intervention periods.

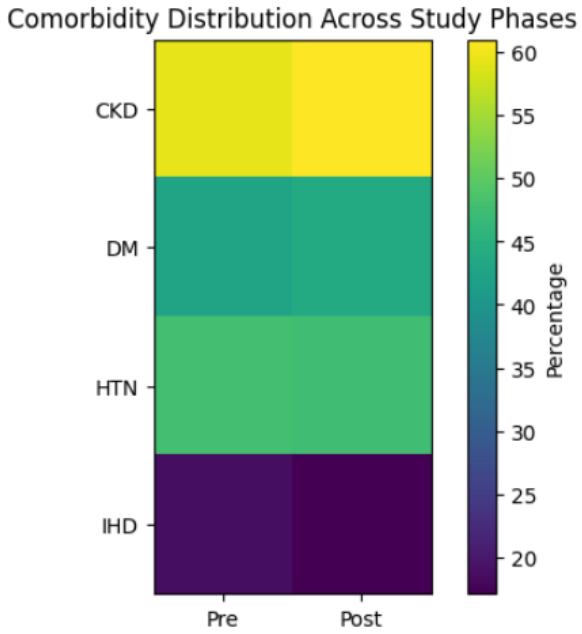

Figure 3. Distribution of Comorbidities in Pre- and Post-Intervention Groups

Heat map comparing the prevalence of major comorbid conditions between baseline and post-intervention patient cohorts.

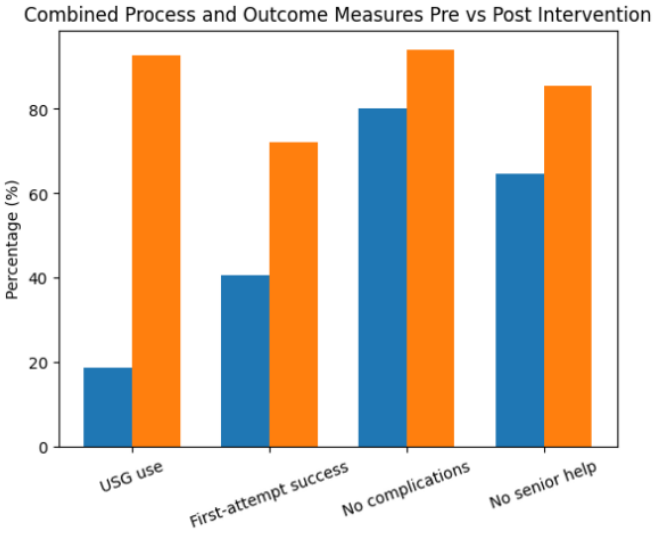

Figure 4. Combined Process and Outcome Measures

Grouped bar chart summarizing changes in ultrasound utilization, first-attempt success, complication-free procedures, and need for senior assistance before and after intervention.

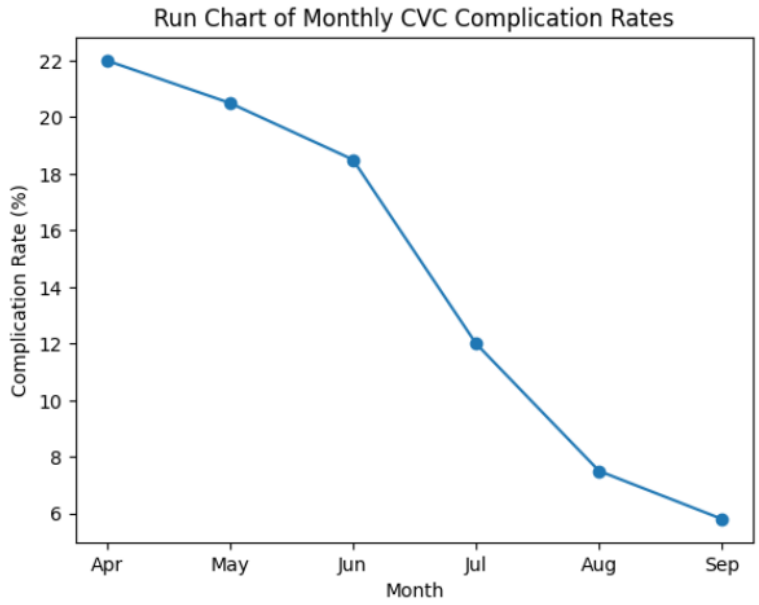

Figure 5. Run Chart of Monthly CVC Complication Rates

Run chart showing temporal trends in procedure-related complication rates across baseline and post-intervention months.

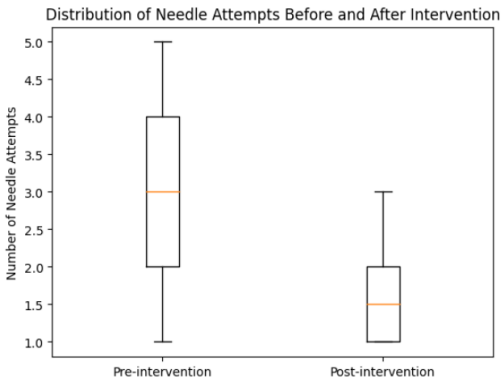

Figure 6. Distribution of Needle Attempts

Box plot comparing the distribution of needle insertion attempts during CVC placement before and after implementation of mandatory ultrasound guidance.

Discussion

This quality improvement project demonstrates that the introduction of mandatory ultrasound guidance for central venous catheter (CVC) insertion in the general medicine ward B of Ayub teaching hospital in Pakistan resulted in substantial and sustained improvements in procedural safety and clinical outcomes. The intervention led to a marked increase in ultrasound-guided insertions, which was accompanied by higher first-attempt success rates, fewer multiple needle attempts, and a significant reduction in procedure-related complications. These findings highlight the value of structured, context-specific quality improvement initiatives in improving patient safety within resource-constrained healthcare settings.At baseline, the

majority of CVC insertions were performed using the landmark technique, largely due to the lack of bedside ultrasound availability within the medicine ward. This reflects the reality of many public-sector hospitals in low- and middle-income countries, where infrastructure limitations often dictate clinical practice. Following the intervention, ultrasound utilization increased dramatically, demonstrating that system-level changes, even when relatively simple, can rapidly influence clinician behavior. This observation is consistent with the findings of Karakitsos et al., who reported significantly higher success rates and fewer complications with ultrasound-guided venous cannulation compared to landmark techniques in a randomized controlled trial[11].The reduction in overall complication rates observed in the post-intervention phase is clinically meaningful and aligns with international evidence. A Cochrane systematic review by Brass et al. demonstrated that ultrasound guidance significantly reduces mechanical complications such as arterial puncture and hematoma formation during CVC insertion[12]. Similarly, the meta-analysis by Hind et al. confirmed lower failure and complication rates across multiple venous access sites when ultrasound guidance is employed[13]. The magnitude and direction of improvement in our study closely mirror these findings, despite differences in patient population, operator experience, and healthcare infrastructure.Our patient cohort was characterized by a high prevalence of chronic kidney disease, with urgent hemodialysis being the most common indication for CVC insertion. This reflects the referral pattern of Ayub Teaching Hospital, which serves a large geographic catchment area including Mansehra, Battagram, Torghar, Upper and Lower Kohistan, Kolai Palas, Haripur, and parts of Azad Kashmir. In such patients, repeated needle attempts can increase immediate procedural risk and compromise future vascular access. The observed reduction in multiple attempts following ultrasound implementation is therefore particularly relevant and aligns with KDOQI recommendations, which emphasize minimizing vascular trauma during dialysis catheter placement[14].The improvement in first-attempt success rates following the intervention is another important finding. First-pass success has been increasingly recognized as a key quality indicator, as multiple attempts are associated with higher complication rates and greater patient discomfort. Our results are comparable to those reported by Denys et al., who demonstrated that real-time ultrasound guidance improves success rates even when procedures are performed by less experienced operators[15]. This suggests that ultrasound guidance not only improves safety but also enhances procedural confidence among junior doctors.A notable secondary benefit of the intervention was the reduced need for senior clinician assistance during CVC insertion. This likely reflects improved operator confidence and procedural competence when ultrasound guidance is available. Similar observations have been reported in studies by Milling et al., which showed that ultrasound-guided vascular access supports safe procedural autonomy while maintaining high standards of patient care[16]. In high-volume wards with limited senior staffing, this has important implications for workflow efficiency and training.The sustained improvement in outcomes over time, as demonstrated by run chart analysis, suggests that the observed changes were durable rather than transient. This is consistent with quality improvement literature emphasizing the importance of embedding changes into routine clinical workflows. Pronovost et al. demonstrated that standardized approaches to central line insertion can lead to long-term reductions in complications when consistently applied[17]. Although our intervention was less complex, the principle of standardizing evidence-based practice remains central.Our findings are also aligned with international guideline recommendations. NICE guidelines advocate routine ultrasound guidance for CVC insertion due to its demonstrated safety and cost-effectiveness[18], while the Agency for Healthcare Research and Quality (AHRQ) identifies ultrasound-guided central line insertion as a key patient safety practice[19]. Despite these recommendations, implementation remains inconsistent in many low-resource settings, making locally generated evidence such as ours particularly valuable for driving institutional change.

Overall, this project demonstrates that mandatory ultrasound guidance for CVC insertion is a feasible, effective, and sustainable intervention in a public-sector tertiary care hospital in Pakistan. The success of this initiative supports broader adoption across other wards and similar healthcare settings, particularly those managing a high burden of patients requiring urgent vascular access.

Strengths

This quality improvement project has several strengths. It addressed a high-risk, frequently performed procedure within a real-world clinical environment and used a structured audit–intervention–re-audit design. The study evaluated both process and outcome measures, allowing a comprehensive assessment of the impact of the intervention. Importantly, the project demonstrated that meaningful improvements in patient safety can be achieved through pragmatic system-level changes without the need for complex technology or external funding. The inclusion of time-trend analysis further supports the sustainability of the observed improvements.

Limitations

This study has certain limitations. It was conducted in a single medical ward within one tertiary care hospital, which may limit generalizability to other settings. Complication data were derived from clinical documentation and may be subject to underreporting, particularly for minor events. Long-term outcomes such as catheter-related bloodstream infections and catheter longevity were not assessed. Additionally, operator-specific factors such as prior experience were not formally quantified. These limitations are similar to those reported in other ward-based audits and QIPs, including those described by McGee and Gould, and should be considered when interpreting the findings[10]

Conclusion

This quality improvement project demonstrates that the introduction of mandatory ultrasound guidance for central venous catheter insertion in a high-volume general medicine ward significantly improved procedural safety and clinical outcomes. The intervention resulted in a marked increase in ultrasound utilization, higher first-attempt success rates, fewer multiple needle attempts, and a substantial reduction in procedure-related complications. Importantly, these improvements were sustained over time and achieved within the constraints of a public-sector tertiary care hospital in Pakistan. The findings highlight that evidence-based procedural practices can be successfully implemented in resource-limited settings through structured audit, stakeholder engagement, and system-level changes. Given the high burden of patients requiring urgent vascular access, particularly for hemodialysis, routine use of ultrasound guidance represents a practical and effective strategy to enhance patient safety. Wider adoption of this approach across other wards and institutions may further reduce preventable complications and improve the quality of care delivered to vulnerable patient populations.

Additional Information

Conflicts of Interest: None

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REFERENCES

McGee DC, Gould MK. Preventing complications of central venous catheterization. *N Engl J Med*. 2003;348(12):1123–33.

Eisen LA, Narasimhan M, Berger JS, Mayo PH, Rosen MJ, Schneider RF. Mechanical complications of central venous catheters. *J Intensive Care Med*. 2006;21(1):40–6.

Mansfield PF, Hohn DC, Fornage BD, Gregurich MA, Ota DM. Complications and failures of subclavian-vein catheterization. *N Engl J Med*. 1994;331(26):1735–8.

Karakitsos D, Labropoulos N, De Groot E, et al. Real-time ultrasound-guided catheterisation of the internal jugular vein. *Crit Care*. 2006;10(6):R162.

Hind D, Calvert N, McWilliams R, et al. Ultrasonic locating devices for central venous cannulation: meta-analysis. *BMJ*. 2003;327(7411):361.

Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization. *Cochrane Database Syst Rev*. 2015;(1):CD006962.

National Institute for Health and Care Excellence (NICE). Guidance on the use of ultrasound locating devices for placing central venous catheters. NICE TA49. London: NICE; 2002.

Agency for Healthcare Research and Quality (AHRQ). Making Health Care Safer II. Rockville, MD: AHRQ; 2013.

National Kidney Foundation. KDOQI clinical practice guidelines for vascular access: 2019 update. *Am J Kidney Dis*. 2020;75(4 Suppl 2):S1–S164.

Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med*. 2006;355(26):2725–32.

Karakitsos D, Labropoulos N, De Groot E, Patrianakos AP, Kouraklis G, Poularas J, et al. Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients. *Crit Care*. 2006;10(6):R162.

Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization. *Cochrane Database Syst Rev*. 2015;(1):CD006962.

Hind D, Calvert N, McWilliams R, Davidson A, Paisley S, Beverley C, et al. Ultrasonic locating devices for central venous cannulation: meta-analysis. *BMJ*. 2003;327(7411):361.

National Kidney Foundation. KDOQI clinical practice guidelines for vascular access: 2019 update. *Am J Kidney Dis*. 2020;75(4 Suppl 2):S1–S164.

Denys BG, Uretsky BF, Reddy PS. Ultrasound-assisted cannulation of the internal jugular vein: a prospective comparison to the external landmark-guided technique. *Circulation*. 1993;87(5):1557–62.

Milling TJ Jr, Rose J, Briggs WM, Birkhahn R, Gaeta TJ, Bove JJ. Randomized, controlled clinical trial of point-of-care limited ultrasonography assistance of central venous cannulation: the third Sonography Outcomes Assessment Program (SOAP-3) trial. *Crit Care Med*. 2005;33(8):1764–9.

Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med*. 2006;355(26):2725–32.

National Institute for Health and Care Excellence (NICE). Guidance on the use of ultrasound locating devices for placing central venous catheters. NICE Technology Appraisal Guidance No. 49. London: NICE; 2002.

Agency for Healthcare Research and Quality (AHRQ). Making health care safer II: an updated critical analysis of the evidence for patient safety practices. Rockville, MD: AHRQ; 2013.