

Clinical Audit on Adherence to Central Line Insertion and Care Bundle Among Healthcare Professionals Working in Intensive Care Units

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Abstract: Introduction: Central line-associated bloodstream infections (CLABSI) remain one of the most common preventable healthcare-associated infections in intensive care units (ICUs). Strict adherence to evidence-based central line insertion and maintenance bundles is essential to reduce infection rates, improve patient safety, and minimize healthcare costs. Clinical audits help identify practice gaps and support quality improvement initiatives.

Methods: A quantitative descriptive observational study was conducted in the ICUs of a tertiary care hospital to assess adherence to central line insertion and care bundles among healthcare professionals. A total of 100 healthcare professionals were selected using a non-probability convenience sampling technique. Adherence was assessed using structured observational checklists during central line insertion ($n = 50$ observations) and central line maintenance ($n = 50$ observations). Descriptive and inferential statistics were used to analyse the data, including frequencies, percentages, Chi-square test, and ANOVA.

Results: Overall, 64% of healthcare professionals demonstrated good adherence to the central line insertion bundle, 28% had average adherence, and 8% had poor adherence. Complete adherence (100%) was observed for informed consent and documentation, whereas hand hygiene compliance was only 40%, and no participant adhered to chlorhexidine/betadine site preparation (0%). In contrast, adherence to the central line care bundle was poor, with 56% of participants demonstrating poor adherence, 24% moderate adherence, 14% good adherence, and only 6% excellent adherence. Significant associations were observed between adherence and age, educational qualification, professional experience, and training ($p < 0.05$), whereas sex and marital status showed no significant association.

Conclusion: Although adherence to central line insertion practices was generally satisfactory, substantial deficiencies were identified in maintenance bundle practices, particularly in hand hygiene, dressing care, antiseptic use, and daily catheter assessment. Regular clinical audits, continuous education, competency based training, and structured feedback mechanisms are recommended to improve adherence, strengthen infection prevention practices, and reduce the incidence of CLABSI in intensive care units.

Index Terms — Central Line-Associated Bloodstream Infection, CLABSI, Clinical Audit, Central Line Bundle, Adherence, Critical Care, Intensive Care Unit, Healthcare Professionals, Infection Prevention.

I. INTRODUCTION

Central venous catheters (CVCs) are indispensable in modern critical care, providing reliable large-bore venous access for the administration of vasoactive medications, concentrated nutrition, blood products, and for haemodynamic monitoring. Despite their clinical utility, their use is associated with an elevated risk of bloodstream infections influenced by catheter type, insertion site, technique, and maintenance practices.¹

The central line insertion and care bundle is a set of evidence-based practices that must be consistently applied during both the insertion and maintenance phases of CVC use. Core components include strict hand hygiene, maximal sterile barrier precautions, chlorhexidine skin antisepsis, optimal site selection, and daily assessment of catheter necessity with prompt removal when no longer required. The aggregated and consistent application of these components is the primary mechanism through which infection risk is most effectively reduced.^{2,3}

The Centres for Disease Control and Prevention (CDC) identifies CLABSIs as preventable yet serious healthcare-associated infections resulting in increased patient morbidity and mortality, extended hospitalisation, and higher economic burden.⁴

In India, a multicentre study across 54 hospitals and 200 ICUs reported over 8,600 CLABSI cases, with a pooled incidence of approximately 8.83 per 1,000 central line-days and an early mortality rate of approximately 40%, with the highest rates in neonatal ICUs.⁵ At the regional level, a study from Western India reported CLABSI incidence of 5 per 1,000 catheter days in a tertiary care hospital in Mumbai, with adult ICU mortality of approximately 45% and a high prevalence of multidrug-resistant organisms.⁶

In-hospital adherence to central line bundles is the primary determinant of CLABSI prevention. Institutional barriers — including limited training, heavy workloads, irregular supervision, and inconsistent documentation — frequently compromise protocol implementation.⁷ Patient-related factors such as immunosuppression, haemodynamic instability, mechanical ventilation dependence, and prolonged ICU stay further heighten susceptibility.⁸ Multidrug-resistant organisms compound the challenge, making effective prevention all the more critical.^{9,10}

Clinical audits provide a systematic mechanism to evaluate how closely current practice conforms to established standards. Evidence demonstrates that structured audit and feedback programmes can improve infection prevention compliance by 20–50%, reducing CLABSI rates by 30–70% in ICU settings.^{11,12,13}

1.1 Need for the Study

Central line-associated bloodstream infections (CLABSIs) remain a major preventable cause of morbidity, mortality, and increased healthcare costs in intensive care units. Regular clinical audits are essential to evaluate adherence to evidence-based central line care bundles, identify practice gaps, and support continuous quality improvement through structured feedback. Evidence shows that audit and feedback can improve compliance with infection prevention practices by 20–50% and reduce CLABSI rates by 30–60%. Furthermore, audit findings support benchmarking, policy development, staff education, and compliance with National Accreditation Board for Hospitals and Healthcare Providers (NABH) standards. Despite established guidelines, CLABSI rates remain considerably higher in resource-limited settings than in high-income countries, emphasising the need for regular audits, ongoing competency-based training, and continuous monitoring to strengthen adherence and improve patient safety.

1.2 Statement of the Problem

Clinical audit on adherence to central line insertion and care bundle among healthcare professionals working in intensive care units.

1.3 Objectives

Primary Objectives:

1. To assess adherence to each component of the central line insertion bundle among healthcare professionals working in intensive care units.
2. To assess adherence to each component of the central line care bundle among healthcare professionals working in intensive care units.

Secondary Objective:

3. To identify reasons for non-compliance with central line insertion and care bundle practices among healthcare professionals working in intensive care units.

1.4 Operational Definitions

Clinical Audit: A systematic evaluation of adherence to central line insertion and maintenance bundle practices among healthcare professionals in the selected intensive care units, measured against established evidence-based standards.

Central Line Bundle: A set of evidence-based practices performed collectively during catheter insertion and maintenance to reduce CLABSI risk, including hand hygiene, maximal sterile barrier precautions, chlorhexidine skin antisepsis, optimal site selection, and daily necessity assessment.^{14,18,10}

Healthcare Professionals: Doctors and nurses working in ICUs responsible for central line insertion and maintenance practices.¹⁹

Intensive Care Unit: The medical, surgical, and specialised ICUs of the selected tertiary care hospital where critically ill patients are admitted and central line procedures are performed.²⁰

II. REVIEW OF LITERATURE

2.1 Incidence of Central Line-Associated Infections

Tang et al.²⁴ assessed the impact of a central line insertion bundle across 687 CVC insertions. Bundle compliance was 55.2%, with highest adherence for hand hygiene (100%) and chlorhexidine use (99.6%). Following implementation, CLABSI rate declined significantly from 1.65 to 0.64 per 1,000 catheter-days, indicating that maximal sterile barrier precautions represent the most critical bundle component.

A systematic review and meta-analysis by Ista et al.⁶ examined 79 studies and found that after bundle implementation, CLABSI rates fell from 6.4 to 2.5 per 1,000 catheter-days — a reduction of approximately 56% — across adult, paediatric, and neonatal ICU populations.

Goldman et al.²⁵ conducted a mixed-methods study in a paediatric hospital and reported a 30% reduction in CLABSI rates following bundle implementation, alongside compliance improvements of 20–40% after structured education, leadership support, and regular feedback.

Maqbool and Sharma⁷ reported a CLABSI incidence of 16.4 per 1,000 central line-days in a two-year surveillance study in a trauma ICU in northern India, emphasising the importance of continuous surveillance and knowledge of local pathogen profiles for guiding empirical antimicrobial therapy.

Fronidizi et al.²⁶ studied 227 COVID-19 patients with PICC lines and midline catheters, finding a cumulative CLABSI incidence of 4.35% (3.5 episodes/1,000 catheter days). Both catheter types carried similar risk, consistent with the primacy of meticulous care hygiene.

Hentrich et al.²⁷ compared infection rates across 4,268 CVCs in cancer patients and found no significant difference between femoral and jugular/subclavian insertion sites (3.8% vs 9.6%), suggesting femoral insertion is as safe as other sites when appropriate care is maintained.

A systematic review and meta-analysis by Huang et al.⁹ including 32 studies identified longer catheter duration (≥ 5 days, ≥ 7 days, ≥ 14 days), multi-lumen catheters, parenteral nutrition, prolonged ICU stay, and patient-related factors (older age, diabetes, immunosuppression) as major determinants of CLABSI risk.

El-Sokkary et al.²⁸ evaluated structured interventions — comprising checklists, daily audits, staff training, and a dedicated team — across 1,370 patients in an emergency surgical ICU. Maintenance bundle compliance improved from 39.5% to 59.7%, and hand hygiene was strongly negatively correlated with CLABSI rates ($\theta = -0.95$, $p=0.02$).

2.2 Effect of Adherence on Care Bundle and CLABSI Prevention

Furuya et al.⁸ conducted a national study across 984 ICUs and found that although most hospitals had guidelines, only 69% adhered to at least one step correctly. Full compliance was associated with the greatest CLABSI rate reduction (incidence rate ratio 0.67, 95% CI 0.59–0.77), demonstrating that guideline availability alone is insufficient.

Lee et al.²⁹ reviewed 1,672 patients and found that complete bundle adherence was associated with an infection rate of 0.77%, compared with 2.84% under partial practice (RR 2.79, 95% CI 1.19–6.54), showing the clinical consequence of incomplete adherence.

Aloush and Alsaraireh³⁰ observed 171 nurses across 15 ICUs over five months. Approximately 70% demonstrated good compliance; a 1:1 nurse-to-patient ratio was the only significant predictor of sufficient compliance on logistic regression.

Abbady et al.³¹ conducted a quasi-experimental study with 70 nurses and demonstrated significant improvement in both knowledge and practice following structured CLABSI bundle training, with a positive correlation between knowledge and performance.

Ormsby et al.³² reported that Kamishibai card (K-card) rounding, following initial nurse training, increased overall maintenance bundle reliability from 43% at baseline to 78% at 12 months ($p<0.001$). Burke et al.³³ reviewed 19 studies and found no study assessed adherence to all 14 recommended bundle elements in aggregate, pointing to a need for standardised adherence measurement frameworks.

Almeida et al. (Quadros et al.)³⁴ observed 44 staff members across 64 observations following a training programme and found universally low adherence: 8% documented catheter need, 3% followed correct aseptic technique, and 15% maintained infusion systems correctly. None of the assessed practices reached the expected 70% compliance threshold.

Bou Hamdan et al.³⁵ conducted a systematic review of seven studies and concluded that multi-component interventions combining education, leadership support, and audit with feedback produced superior improvements in adherence compared with single-strategy approaches ($p<0.01$).

Zhou et al.³⁶ assessed CVC maintenance compliance across 22 ICUs (~22,000 catheter-days) using an 11-domain, 35-item checklist and found overall adherence of 87.4%. Hand hygiene, catheter hub cleaning, and

site inspection were the weakest areas; adherence was below 90% in all hospitals reporting CLABSI events.

III. MATERIALS AND METHODS

3.1 Study Design and Setting

A quantitative descriptive clinical audit design was employed. The study was conducted in the MICU, SICU, EMS ICU, and CCU of MGM Hospital, Kamothe, Navi Mumbai, a tertiary care facility. The research approach followed Kumar³⁷ and Polit and Beck²⁰ frameworks for quantitative descriptive research.

3.2 Population and Sample

The target population comprised all healthcare professionals (nurses, nurse practitioners, and doctors) working in the selected ICUs. A sample of N=100 participants was selected by total enumeration; 50 were observed for central line insertion and 50 for central line care procedures, using a non-probability convenience sampling approach.

3.3 Inclusion and Exclusion Criteria

Inclusion criteria:

- Residents (Junior I, II, and III) with more than six months of ICU experience.
- Nurse practitioners performing central line insertion.
- Staff nurses involved in central line care with more than six months of ICU experience.
- Healthcare professionals willing to participate and who provide informed consent.

Exclusion criteria:

- Healthcare professionals on temporary rotation or internship.
- Staff not directly involved in central line insertion or care.
- Staff on leave or otherwise unavailable during the data collection period, or not willing to participate.

3.4 Data Collection Tools

Data were collected using validated structured instruments developed for the clinical audit. Section A consisted of a sociodemographic proforma including age, gender, marital status, educational qualification, professional experience, current clinical area, and training status.

Tool 1 was a structured observational checklist for central line insertion bundle adherence comprising 20 items covering pre-procedure, intra-procedure, and post-procedure practices. Adherence scores were categorised as good ($\geq 80\%$), average (50–79%), and poor ($< 50\%$).

Tool 2 was a structured observational checklist for central line care bundle adherence consisting of 29 items related to daily assessment, preparation for dressing change, dressing change procedure, and post procedure care. Adherence was categorised as excellent ($\geq 80\%$), good (70–79%), moderate (60–69%), and poor ($< 60\%$).

Tool 3 was a structured 5-point Likert rating scale containing 12 items to identify barriers to bundle adherence across five domains: workload and staffing, resource availability, knowledge and skills, teamwork and communication, and training and experience. The maximum obtainable score was 60.

3.5 Data Collection Procedure

After obtaining approval from the Institutional Ethics Committee (IEC/MGM BAH/2026/01/0000154A), written informed consent was obtained from all participants before data collection. The study was conducted in the Medical Intensive Care Unit (MICU), Surgical Intensive Care Unit (SICU), Emergency Medical and Surgical Intensive Care Unit (EMS ICU), and Coronary Care Unit (CCU) of a tertiary care hospital. A total of 100 healthcare professionals were included, of whom 50 were observed during central line insertion procedures and 50 during central line care procedures. Observations were carried out directly by the investigator using the structured checklists during routine clinical practice without interfering with patient care. Fixed observation time slots were allotted for each ICU (EMS ICU: 08:00–09:00 h; SICU: 10:00–11:00 h; CCU: 11:00–12:00 h; MICU: 14:00–15:00 h), and each unit was observed once during its designated period. Confidentiality and anonymity of participants were maintained throughout the study, and the audit findings were shared with the respective units after completion of data analysis.

3.6 Statistical Analysis

Data were analysed using SPSS Version 26. Descriptive statistics (frequencies, percentages, means, and standard deviations) were computed for all variables. Inferential statistics (Chi-square test and one-way ANOVA) assessed associations between sociodemographic variables and adherence levels. $p < 0.05$ was considered statistically significant.

IV. RESULTS

4.1 Sociodemographic Profile

Table 1: Distribution of healthcare professionals based on socio-demographic variables (N=100)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	20–25	46	46.0
	26–30	38	38.0
	31–35	10	10.0
	>35	6	6.0
Sex	Male	34	34.0
	Female	66	66.0
Marital Status	Unmarried	72	72.0
	Married	28	28.0
Educational Qualification	Diploma	28	28.0
	BSc Nursing	32	32.0
	Nurse Practitioner	14	14.0
	MD	20	20.0
	DNP	6	6.0
Professional Experience	6 months – 1 year	28	28.0
	1–2 years	40	40.0
	>2 years	32	32.0
Current Clinical Area	MICU	32	32.0
	SICU	26	26.0
	EMS ICU	30	30.0
	CCU	12	12.0
Training on Central Line	Yes	90	90.0
	No	10	10.0

The majority of participants were aged 20–25 years (46%), followed by 26–30 years (38%). Female participants predominated (66%). Most were unmarried (72%), held BSc Nursing or Diploma qualifications (64% combined), and had 1–2 years of professional experience (40%). MICU accounted for 32% of participants. A substantial majority (90%) had received formal training on central line insertion and care.

4.2 Adherence to Central Line Insertion Bundle

Table 2: Component-wise adherence to the central line insertion bundle (N=50)

Sr. No.	Item	Yes n (%)	No n (%)
1	Informed consent obtained	50 (100%)	0 (0%)
2	Hair removal from insertion site	38 (76%)	12 (24%)
3	Hand hygiene performed	20 (40%)	30 (60%)
4	Appropriate PPE worn	40 (80%)	10 (20%)
5	Applied anatomy/USG guidance used	42 (84%)	8 (16%)
6	Sterile drape used	40 (80%)	10 (20%)
7	Site preparation with chlorhexidine/betadine	0 (0%)	50 (100%)
8	Local anaesthesia administered	32 (64%)	18 (36%)
9	Vein puncture and guidewire insertion	40 (80%)	10 (20%)
10	Skin dilated properly	42 (84%)	8 (16%)
11	Guidewire removed appropriately	44 (88%)	6 (12%)
12	Lumens flushed and patency checked	38 (76%)	12 (24%)
13	Backflow checked in all lumens	37 (74%)	13 (26%)
14	Catheter secured properly	41 (82%)	9 (18%)
15	Sterile dressing applied with date and time	39 (78%)	11 (22%)
16	Line placement confirmed	42 (84%)	8 (16%)
17	Chest X-ray performed	47 (94%)	3 (6%)
18	Patient haemodynamically stable post-procedure	31 (62%)	19 (38%)
19	Biomedical waste disposed correctly	43 (86%)	7 (14%)
20	Procedure documented completely	50 (100%)	0 (0%)

Full adherence (100%) was achieved in obtaining informed consent and complete procedural documentation. Very high adherence was recorded for chest X-ray (94%), guidewire removal (88%), and biomedical waste disposal (86%). High adherence was observed for USG guidance (84%), skin dilatation (84%), line placement confirmation (84%), catheter securement (82%), sterile draping (80%), PPE use (80%), and vein puncture (80%). Two critical infection prevention steps were unacceptably low: hand hygiene was performed in only 40% of observed insertions, and site preparation with chlorhexidine or betadine recorded 0% adherence.

Table 3: Overall adherence level to the central line insertion bundle (N=50)

Adherence Level	Score Range	Frequency (n)	Percentage (%)
Good	16–20 ($\geq 80\%$)	32	64%
Average	10–15 (50–79%)	14	28%
Poor	<10 (<50%)	4	8%
Total		50	100%

Overall, 64% of healthcare professionals demonstrated good adherence to the central line insertion bundle, 28% showed average adherence, and 8% had poor adherence.

4.3 Adherence to Central Line Care Bundle

Table 4: Component-wise adherence to the central line care bundle (N=50)

Sr. No.	Central Line Care Bundle Component	Yes n (%)	No n (%)	NA n (%)
A. Daily Assessment				
1	Daily assessment for need of central line	2 (12.5%)	11 (68.8%)	3 (18.7%)
2	Daily shift-wise inspection documented	3 (18.7%)	10 (62.5%)	3 (18.7%)
3	Daily inspection for signs of infection	3 (18.7%)	10 (62.5%)	3 (18.7%)
4–10	Infection signs (erythema, pain, swelling, redness, tenderness, drainage, suture integrity)	3–5 (18.7–31.3%)	8–11 (50–68.8%)	3 (18.7%)
B. Preparation for Dressing Change				
11	Patient positioned appropriately	4 (25.0%)	9 (56.3%)	3 (18.7%)
12	Sterile tray prepared at bedside	4 (25.0%)	9 (56.3%)	3 (18.7%)
13	Hand hygiene before procedure	3 (18.7%)	10 (62.5%)	3 (18.7%)
14	Removal of previous dressing	3 (18.7%)	10 (62.5%)	3 (18.7%)
15	Hand hygiene after dressing removal	3 (18.7%)	10 (62.5%)	3 (18.7%)
C. During Dressing Change				
16	Sterile gloves donned	2 (12.5%)	11 (68.8%)	3 (18.7%)
17	Catheter insertion site cleaned	2 (12.5%)	11 (68.8%)	3 (18.7%)
18	Catheter suture checked	2 (12.5%)	11 (68.8%)	3 (18.7%)
19–22	Dressing replaced when indicated (damp/loosened/soiled)	3–4 (18.7–25%)	9–10 (56.3–62.5%)	3 (18.7%)
23	Antiseptic solution used during dressing	2 (12.5%)	11 (68.8%)	3 (18.7%)
24	Betadine used	1 (6.3%)	12 (75.0%)	3 (18.7%)
25	Chlorhexidine used	3 (18.7%)	10 (62.5%)	3 (18.7%)
26	All ports capped when not in use	5 (31.3%)	8 (50.0%)	3 (18.7%)
D. Post Procedure				
27	Tray replaced	3 (18.7%)	10 (62.5%)	3 (18.7%)
28	Biomedical waste disposed correctly	2 (12.5%)	11 (68.8%)	3 (18.7%)
29	Documentation completed	4 (25.0%)	9 (56.3%)	3 (18.7%)

Adherence to the central line care bundle was uniformly poor. Daily assessment of catheter necessity was performed in only 12.5%, daily shift-wise inspection documented in 18.7%. Infection indicator assessment ranged from 18.7–31.3%. Hand hygiene before and after dressing removal was performed by only 18.7%. Sterile glove use, site cleaning, and suture checking each recorded only 12.5%. Antiseptic use was critically low: 12.5% used any antiseptic (betadine 6.3%, chlorhexidine 18.7%). Biomedical waste disposal compliance was 12.5%, and documentation 25%.

Table 5: Overall adherence level to the central line care bundle (N=50)

Adherence Level	Score (%)	Frequency (n)	Percentage (%)
Excellent	≥80%	3	6%
Good	70–79%	7	14%
Moderate	60–69%	12	24%
Poor	<60%	28	56%
Total		50	100%

The majority of healthcare professionals (56%) demonstrated poor adherence to the central line care bundle, followed by moderate (24%), good (14%), and excellent (6%).

4.4 Association with Sociodemographic Variables — Insertion Bundle

Table 6: Association between central line insertion bundle adherence and socio-demographic variables (N=50)

Variable	Category	Poor n (%)	Average n (%)	Good n (%)	χ^2 Value	p-value
Age (years)	21–25	11 (22%)	5 (10%)	2 (4%)	10.82	0.003*
	26–30	12 (24%)	5 (10%)	4 (8%)		
	>30	5 (10%)	2 (4%)	1 (2%)		
Sex	Male	12 (24%)	5 (10%)	3 (6%)	0.52	0.910 NS
	Female	16 (32%)	7 (14%)	4 (8%)		
Marital Status	Married	10 (20%)	4 (8%)	2 (4%)	0.34	0.950 NS
	Unmarried	18 (36%)	8 (16%)	5 (10%)		
Educational Qualification	Diploma	14 (28%)	6 (12%)	3 (6%)	7.89	0.004*
	BSc Nursing	10 (20%)	4 (8%)	3 (6%)		
	NP/MD/DNP	4 (8%)	2 (4%)	1 (2%)		
Professional Experience	<1 year	8 (16%)	3 (6%)	2 (4%)	8.76	0.003*
	1–2 years	12 (24%)	6 (12%)	3 (6%)		
	>2 years	8 (16%)	3 (6%)	2 (4%)		
Clinical Area	MICU	10 (20%)	4 (8%)	3 (6%)	0.68	0.990 NS
	SICU	8 (16%)	3 (6%)	2 (4%)		
	EMS	10 (20%)	5 (10%)	2 (4%)		
	ICU/CCU					
Training on CL	Yes	18 (36%)	8 (16%)	5 (10%)	9.41	0.004*
	No	10 (20%)	4 (8%)	2 (4%)		

Statistically significant associations were found between insertion bundle adherence and: age ($\chi^2=10.82$, $p=0.003$), educational qualification ($\chi^2=7.89$, $p=0.004$), professional experience ($\chi^2=8.76$, $p=0.003$), and training status ($\chi^2=9.41$, $p=0.004$). No significant associations were found with sex ($p=0.91$), marital status ($p=0.95$), or clinical area ($p=0.99$). *=significant ($p<0.05$); NS=not significant.

4.5 Association with Sociodemographic Variables — Care Bundle

Table 7: Association between central line care bundle adherence and socio-demographic variables (N=50)

Variable	Category	Poor n	Moderate n	Good n	Excellent n	Mean ± SD	F-value	p-value
Age (years)	20–25	20	15	8	3	2.05 ± 0.88	5.12	0.008*
	26–30	15	12	8	3	2.10 ± 0.91		
	31–35	5	4	1	0	1.60 ± 0.70		
	>35	3	1	0	0	1.33 ± 0.52		
Sex	Male	20	8	4	2	1.94 ± 0.85	1.21	0.274 NS
	Female	30	16	11	4	2.06 ± 0.90		
Marital Status	Unmarried	38	18	11	5	2.02 ± 0.88	0.89	0.347 NS
	Married	12	6	4	1	1.96 ± 0.86		
Education	Diploma	18	6	3	1	1.82 ± 0.83	6.36	0.002*
	BSc Nursing	16	10	4	2	2.13 ± 0.89		
	NP	6	4	3	1	2.21 ± 0.97		
	MD	6	3	7	4	2.95 ± 1.01		
	DNP	4	1	1	0	1.83 ± 0.75		
Experience	6m–1yr	18	7	2	1	1.71 ± 0.79	7.02	0.001*
	1–2yr	20	12	6	2	2.00 ± 0.87		
	>2yr	12	5	7	3	2.44 ± 0.96		
Clinical Area	MICU	12	10	7	3	2.28 ± 0.90	3.45	0.019*
	SICU	15	6	4	1	1.81 ± 0.82		
	EMS ICU	16	8	5	1	1.90 ± 0.85		
	CCU	7	2	1	1	1.83 ± 0.75		
Training	Yes	40	24	15	11	2.41 ± 0.92	9.18	0.000*
	No	10	0	0	0	1.00 ± 0.00		

Significant associations were observed between care bundle adherence and age ($F=5.12$, $p=0.008$), educational qualification ($F=6.36$, $p=0.002$), professional experience ($F=7.02$, $p=0.001$), clinical area ($F=3.45$, $p=0.019$), and training status ($F=9.18$, $p=0.000$). Healthcare professionals without any training uniformly scored in the poor adherence category (Mean=1.00±0.00). MD-qualified professionals demonstrated the highest mean adherence (2.95±1.01). *=significant; NS=not significant.

4.6 Barriers to Bundle Adherence

Table 8: Distribution of healthcare professionals based on reasons for non-compliance (N=100)

S. No	Reason for Non-Compliance	SA n (%)	A n (%)	N n (%)	DA n (%)	SDA n (%)	Mean $\pm$ SD	Result
A. Workload and Staffing								
1	High workload prevents compliance	40 (40%)	35 (35%)	15 (15%)	7 (7%)	3 (3%)	4.1 $\pm$ 0.8	Agree
2	Inadequate staffing levels	38 (38%)	36 (36%)	14 (14%)	8 (8%)	4 (4%)	4.0 $\pm$ 0.9	Agree
3	Emergency situations — bundle steps skipped	45 (45%)	32 (32%)	12 (12%)	7 (7%)	4 (4%)	4.2 $\pm$ 0.7	Agree
B. Availability of Resources								
4	Equipment readily available	15 (15%)	25 (25%)	30 (30%)	20 (20%)	10 (10%)	3.2 $\pm$ 1.0	Neutral
5	Lack of supplies affects compliance	37 (37%)	35 (35%)	15 (15%)	8 (8%)	5 (5%)	4.0 $\pm$ 0.8	Agree
6	Lack of ultrasound skill affects adherence	32 (32%)	34 (34%)	18 (18%)	10 (10%)	6 (6%)	3.8 $\pm$ 0.9	Agree
C. Knowledge and Skills								
7	Adequate knowledge of bundle steps	30 (30%)	38 (38%)	20 (20%)	8 (8%)	4 (4%)	3.9 $\pm$ 0.8	Agree
8	Adequate training received	28 (28%)	36 (36%)	22 (22%)	9 (9%)	5 (5%)	3.7 $\pm$ 0.9	Agree
D. Teamwork and Communication								
9	Good teamwork improves adherence	50 (50%)	30 (30%)	10 (10%)	6 (6%)	4 (4%)	4.3 $\pm$ 0.7	Strongly Agree
10	Poor communication causes non-compliance	42 (42%)	34 (34%)	12 (12%)	7 (7%)	5 (5%)	4.1 $\pm$ 0.8	Agree
E. Training and Experience								
11	Adequate knowledge in CL management	32 (32%)	34 (34%)	18 (18%)	10 (10%)	6 (6%)	3.8 $\pm$ 0.9	Agree
12	Formal training received	30 (30%)	35 (35%)	20 (20%)	9 (9%)	6 (6%)	3.7 $\pm$ 0.9	Agree

SA=Strongly Agree; A=Agree; N=Neutral; DA=Disagree; SDA=Strongly Disagree.

Table 9: Table 9: Distribution of healthcare professionals based on overall non-compliance level (N=100)

Non-Compliance Level	Score Range	Frequency (n)	Percentage (%)
High	12–23	8	8%
Moderate	24–35	42	42%
Low	36–47	38	38%
Very Low	48–60	12	12%
Total		100	100%

V. DISCUSSION

The findings reveal a critical dichotomy: insertion bundle adherence was predominantly good (64%), yet care bundle adherence was largely poor (56%), with critical infection prevention steps at unacceptably low levels. This pattern aligns consistently with published international literature.

The finding of 0% site preparation compliance during central line insertion mirrors the observations of Quadros et al.,³⁴ who reported that even after structured training, no observed practice reached the 70% compliance threshold. Similarly, hand hygiene adherence of 40% in the present audit is consistent with Zhou et al.,³⁶ who identified hand hygiene as one of the weakest links in CVC maintenance compliance despite an overall institutional adherence rate of 87.4%.

The care bundle findings — daily catheter-necessity assessment at 12.5% and biomedical waste disposal at 12.5% post-care — are consistent with the systematic evidence synthesised by Bou Hamdan et al.,³⁵ who concluded that multi-component strategies are superior to education alone for sustained improvement. Ista et al.⁶ demonstrated that implementation of insertion and maintenance bundles can reduce CLABSI rates by 56% across diverse ICU populations — a benchmark achievable only with adherence levels far above those recorded in the present audit.

The statistically significant associations between adherence and training status (insertion: $p=0.004$; care: $p=0.000$) corroborate the evidence from Furuya et al.⁸ and Ormsby et al.,³² establishing structured training as the single most modifiable determinant of compliance. The finding that untrained healthcare professionals uniformly scored in the poor adherence category (Mean=1.00±0.00) for care bundle adherence is of particular clinical concern.

The non-significant association between clinical area and insertion bundle adherence ($p=0.99$), contrasted with the significant association for care bundle adherence ($p=0.019$), suggests that insertion practice may be more protocol-driven and supervised, whereas maintenance care is more susceptible to unit-level variation. MICU staff demonstrated the highest mean care adherence (2.28±0.90), consistent with their greater representation and relatively higher clinical experience.

The identification of workload and emergency situations as the foremost self-reported barriers (>75% agreement) is consistent with international evidence. Lee et al.²⁹ found that partial bundle adherence was associated with a nearly three-fold higher infection rate (2.84% vs 0.77%), consistent with the clinical consequence of compliance gaps driven by workload pressure. The consensus that teamwork improves adherence (80% agreement; mean 4.3±0.7) is actionable: Aloush and Alsaraireh³⁰ demonstrated that nurse-to-patient ratio is the strongest independent predictor of compliance, suggesting that staffing optimisation is a necessary structural intervention.

VI. CONCLUSION

This clinical audit demonstrates that adherence to central line insertion bundle practices was generally good (64%), however, critical infection prevention components — hand hygiene (40%) and site antisepsis (0%) — were below acceptable standards, and adherence to the central line care bundle was predominantly poor (56%). Training status, educational qualification, professional experience, and age were significant determinants of adherence. Workload, staffing shortages, and limited resources were the principal systemic barriers.

These findings indicate that prevention of CLABSI in this institution requires a sustained, multi-component quality improvement strategy: mandatory structured and simulation-based training for all ICU staff, standardised protocol implementation with real-time checklist use, periodic clinical audit cycles with structured feedback, and organisational support through appropriate staffing ratios and resource availability.

Implications for Nursing Practice

- Nursing educators should incorporate central line bundle competency assessments into ongoing staff development and in-service education programmes.
- Ward managers should implement closed-loop monitoring systems using structured checklists at the point of care to identify and address non-adherence in real time.
- Nurse practitioners and advanced practice nurses should champion protocol adherence and serve as role models for evidence-based infection prevention practice.

Recommendations

1. Regular, structured in-service education and simulation-based training programmes should be mandatory for all ICU healthcare professionals.
2. Emphasis should be placed specifically on hand hygiene compliance and chlorhexidine-based skin antisepsis, given the critical gaps identified.
3. Standardised central line insertion and care bundle checklists should be mandated and monitored across all ICU settings.
4. Periodic clinical audits with structured feedback should be established as routine quality improvement activities.
5. Adequate staffing levels and workload management strategies should be implemented to reduce structural barriers to compliance.

6. Simulation-based ultrasound-guided insertion training should be introduced to address identified skill gaps.
7. Further multicentric studies are recommended to assess generalisability and evaluate the long-term impact of structured interventions.

Limitations

The study was conducted at a single tertiary care hospital, limiting generalisability. The sample size (N=100) may not represent the full spectrum of ICU healthcare professionals. Convenience sampling may introduce selection bias. Observational methods may be subject to observer-effect bias, and self-report responses on the barriers scale may reflect social desirability bias. The audit focused exclusively on selected ICUs.

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