# Evaluation of Nurses' Competence in the Prevention of Peripheral Intravenous Cannula-Related Infections in Sub-County Hospitals, Eldoret, Kenya

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**ABSTRACT**

***Context:*** Peripheral intravascular cannula, commonly used in inpatient settings for intravenous treatments, are frequently linked to complications such as infections, which can harm patient health and increase healthcare costs.

***Aim:*** This study aimed to evaluate the competence of nurses in the prevention of -related infections in newly upgraded sub-county hospitals.

***Methods:*** An Analytical cross-sectional design was employed across four sub-county facilities, with a quantitative approach used to describe and analyze the knowledge and skills of 86 nurses during the census. Direct observation was also conducted to determine whether nurses applied their theoretical knowledge and skills in practice. A structured questionnaire and observational checklist were used.

***Results:*** The study found that most nurses (87%) demonstrated adequate knowledge, correctly answering≥50% of the 10 knowledge items. The highest awareness was observed in areas such as skin preparation before cannula insertion (100%) and the use of non-sterile gloves and adherence to aseptic technique (97.7%). However, only 36.1% correctly knew the recommended time for cannula removal (12–72 hours), indicating a significant knowledge gap. Most nurses (70%) were skilled in performing intravenous therapy, including inserting, removing, and caring for a peripheral intravenous cannula. The overall competence was 66.3% in nurses who scored >50% in both knowledge and skills. Logistic regression further revealed that nurses with ≥10 years of experience were 1.53 times more likely to be competent (OR = 1.53; 95% CI: 1.36–1.72; $p$<0.001), and those with 5–9 years had 1.22 times greater odds (OR = 1.22; 95% CI: 1.17–1.81; $p$=0.050) compared to nurses with <5 years of experience.

***Conclusion:*** The study concluded that most nurses had adequate knowledge, particularly in key infection prevention practices such as skin preparation and aseptic technique. Notable gaps exist in specific areas of knowledge of the recommended cannula dwell time. Nursing experience was significantly associated with higher competence, underscoring the importance of continuous training and mentorship to bridge identified gaps. Enhancing nurses' clinical competence and knowledge in IV cannulation through improved training, regular audits, and interdisciplinary collaboration is recommended. It also highlights the need to bridge the gap between theory and practice to ensure effective infection prevention in the insertion, removal, and care of intravenous cannula.

***Keywords:*** Peripheral intravenous cannula, infection, prevention, nurses' competence

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## 1. Introduction

Peripheral intravenous cannulation (IV) is a fundamental nursing procedure that involves inserting a temporary plastic tube into a patient's vein, typically in the lower arm or the metacarpal vein, to facilitate intravenous therapy *(Siddique et al., 2023).* This intervention is ubiquitous in medical and surgical units, with global data indicating that 59% of hospitalized patients require peripheral IV access *(Osti et al., 2019).* IV cannulation compromises skin integrity and introduces foreign material, creating potential entry points for pathogens such as Staphylococcus aureus, coagulase-negative staphylococci, and Candida species, thereby increasing the risk of significant cannula-related bloodstream infections *(O'grady et al., 2011).* Gram-negative bacteria contribute to 19-21% of such infections *(Shahnaz et al., 2021),* with prevalence rates ranging from 2% to 80% for phlebitis *(Zhang et al., 2016)* and 19% for IV-related infections overall *(de Souza et al., 2015).*

Infection prevention relies on strict aseptic techniques during insertion, maintenance, and removal, alongside proper hand hygiene, equipment disinfection, and waste management *(Vincent et al., 2021).* Prolonged cannulation (>72 hours) increases contamination risks, particularly at the hub, necessitating regular replacement. Complications

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such as thrombophlebitis, septicemia, and localized infections are well-documented, with failure rates exceeding 90% in some cases due to phlebitis or systemic infections. Patient-specific risk factors, including immunosuppression (e.g., HIV/AIDS, neutropenia), prolonged hospitalization, and breaches in aseptic protocols, further elevate susceptibility *(Nickel, 2020).*

Nurses play a pivotal role in IV management, from insertion to daily assessment and removal. However, studies highlight inconsistent adherence to guidelines, with only 60% of nurses receiving periodic competency evaluations despite the procedure's ubiquity *(Osti et al., 2019).* Institutional policies often lack enforcement, and ongoing education is inadequate, leading to variability in practice *(Ray-Barruel & Alexander, 2023).*

The clinical and economic burden of IV-related infections underscores the need for standardized training, regular audits, and adherence to protocols such as those of the Nursing Council of Kenya. With approximately 2,080 annual IV insertions in local hospitals, improving nurse competency could significantly reduce infection rates *(George et al., 2019).* Future efforts must prioritize periodic assessments, simulation-based training, and policy reinforcement to mitigate risks associated with this indispensable but high-stakes procedure.

## 2. Significance of the study

The use of a peripheral intravenous cannula (PIVC) is among the most common invasive procedures performed in hospitals. However, it remains one of the leading sources of hospital-acquired infections when not properly managed. In Kenya, PIVC insertion and care are routinely performed by nurses in all levels of health facilities, including newly upgraded sub-county hospitals. Despite the high volume of PIVC use, approximately 60% of hospitalized patients require intravenous therapy during admission *(Osti et al., 2019)*. In Uasin Gishu County hospitals, over 50% of patients with IV cannulas exhibit signs of infection at admission, yet few studies assess nurses' competence in infection prevention.

There is limited published data on nurses' competence in preventing cannula-related infections in Kenya. Local hospital surveillance reports from Uasin Gishu County indicate that more than half of admitted patients with cannula develop signs of local infection. However, there are no structured periodic assessments to evaluate nurses' competence or reinforce infection prevention practices.

This study addresses this gap by focusing on nurses' knowledge and practical skills regarding PIVC insertion, care, and removal within sub-county hospitals. By highlighting existing strengths and deficiencies, the findings will inform targeted continuous professional development programs, guide supportive supervision, and strengthen policy enforcement on adherence to the Nursing Council of Kenya clinical procedures manual. Ultimately, the study will contribute to reducing healthcare-associated infections, improving patient safety, and supporting Kenya's broader goal of enhancing quality of care as outlined in the Ministry of Health Quality Assurance Framework.

## 3. Aim of the study

The main objective was to evaluate nurses' competence in preventing cannula-related infections in newly upgraded sub-county hospitals. The specific objectives of this study were: to assess nurses' knowledge on preventive interventions for peripheral intravenous cannula–related infections; to determine their skills in inserting, removing, and caring for peripheral intravenous cannula; and to analyze the overall level of nurses' competence in implementing preventive interventions aimed at reducing peripheral intravenous cannula–related infections.

### 3.1. Operational definition

*Competence* is used in this study to encompass the assessment of nurses' knowledge of preventive interventions for peripheral intravenous cannula–related infections and their clinical practical skills in inserting, removing, and caring for peripheral intravenous cannula.

## 4. Subjects & Methods

### *4.1. Research Design*

The study used an analytical cross-sectional design. The data were collected at a specific point in time and then analyzed as a representative subset of the population. It was then used to describe the population's knowledge and clinical competence, and to examine the relationship between the selected demographic data and the population's clinical competence. The study, therefore, aimed to describe the practices of nurses that prevent intravascular cannula-related infections.

This research applied a quantitative approach. The quantitative approach described and analyzed the research subjects' knowledge of how to prevent intravascular cannula-related infections. Direct observation was used to determine whether the research subjects applied the knowledge and skills from the theory in their clinical practice to prevent intravascular cannula-related infections. To minimize the risk of observation bias (Hawthorne effect), facility in-charges were informed about the study for administrative clearance, but individual staff members were not notified of the specific observation schedule. This process ensured that observations were unannounced, thereby reducing the likelihood that nurses would alter their usual practices in response to being observed.

### *4.2. Study Setting*

Four sub-county hospitals — Kesses, Burnt Forest, Turbo, and Ziwa — were study sites in Uasin Gishu County, which had recently been upgraded from health centers to hospitals. The study settings are located in semi-urban and rural settings; these facilities operate under the Ministry of Health through the County Department of Health and serve predominantly rural and peri-urban populations.

They provide outpatient, maternal and child health, immunization, minor surgical, laboratory, inpatient medical and surgical services, and emergency stabilization before referral to level 5 and 6 facilities. Patient flow is highest in outpatient departments, with moderate inpatient

caseloads. Services are subsidized by the public health system and the Social Health Authority, with no user fees. Although infrastructure has been improved to meet sub-county hospital standards, the hospitals remain modest, with limited resources and staffing compared to larger referral facilities.

A census was conducted for all recently upgraded health centers that had been elevated to sub-county hospital status. A census of all four newly upgraded sub-county hospitals was applied instead of sampling to minimize selection bias by including all facilities with similar upgrade status, rather than selectively sampling a few. Given the small number of eligible hospitals, it was feasible to include the entire population, thereby improving representativeness.

### *4.3. Subjects*

The study targeted all nurses working in four newly upgraded sub-county hospitals within Uasin Gishu County, Kenya. The total number of eligible nurses across these facilities was relatively small (N = 88). A census sampling method was therefore applied to enhance the reliability of findings by providing a comprehensive and representative picture of nurses' competence across the upgraded facilities. This approach also ensured comparability, as each hospital serves a different catchment area but operates within the same county health system.

A list of nurses from each facility was obtained from the respective hospital administrations, and the sample was proportionally distributed, with about 22–25 nurses drawn from each of the four hospitals. All eligible nurses were included based on the inclusion criteria of having at least 6 months of clinical experience in settings where peripheral intravenous cannula (PIVCs) are frequently used and possessing a valid practicing license from the Nursing Council of Kenya.

Nurses with less than six months' experience were excluded because they are usually in the orientation or probation phase, still receiving mentorship and learning hospital policies and procedures, and therefore may not yet reflect independent practice. In addition, nurses who declined to give informed consent were excluded to uphold ethical standards and respect for participant autonomy. The census was conducted for all 88 staff working at the sub-county facilities. Two data collection tools were incomplete and were therefore excluded. The final sample population was 86.

### *4.4. Tools of Data Collection*

Data collection involved a multi-step process. The data collection tools were in English.

#### 4.4.1. Self-Administered Demographic Questionnaire

The demographic questionnaire was a researcher-developed, structured tool designed to capture baseline characteristics of the nursing staff. It aimed to provide background information on variables that may influence competence in the management of PIC. The tool consisted of four main components: years of service <5, 5–<10, ≥10 years), educational level (certificate, Diploma, degree, master's), department (medical or surgical), and professional position (Nursing Officer III, II, or I). All questions were closed-ended, multiple-choice for ease of analysis.

#### 4.4.2. Knowledge Assessment Questionnaire on Evidence-Based Guidelines for PIVC-Related Infection Prevention

This questionnaire was researcher-developed and adapted from international infection prevention and vascular access guidelines based on CDC and the Infusion Nurses' Society *(O'Grady, 2011)*. The aim was to assess nurses' knowledge of evidence-based practices related to PIVC insertion, care, and removal. The tool comprised 10 items, each with a yes/no/I do not know response format. The questions covered areas such as the choice of cannula gauge, appropriate veins for cannulation, the recommended duration of cannula use, recognition of phlebitis, the effects of environmental cleanliness, hand hygiene, glove use, skin preparation, and risk factors for infection.

*Scoring system*

'Yes' responses were considered as correct answer to the statements. Each correct answer was scored 1 point, while incorrect or "I do not know" responses were scored 0, for a total possible score of 10 points. Nurses who scored correctly in (≥50%) or greater than five on knowledge items were considered knowledgeable, and those who scored (<50%) less than five were not knowledgeable.

#### 4.4.3. Observation Checklist for PIVC Insertion, Care, and Removal

The observation checklist was a structured non-participant observation tool, adapted from international guidelines *(O'Grady, 2011)* and the Kenya Ministry of Health clinical procedures manual *(Nursing Council of Kenya, 2019)*. It aimed to assess actual nursing practices in real-time, minimizing self-report bias. The tool consisted of 61 items grouped into major activity domains: preparation (e.g., indication, consent, equipment gathering, hand hygiene), insertion (e.g., aseptic technique, site selection, tourniquet application, cannula insertion), post-insertion care (e.g., dressing, flushing, documentation), and removal or replacement.

*Scoring system*

Each nurse was observed once during routine clinical PIC care using the unannounced Observation Checklist and filled out the Knowledge Questionnaire on the same day. A score of ≥50% showed adequate knowledge. The cut-off was based on the Nursing Council for Professional Registration of Nurses in Kenya *(Nyangena et al., 2013)*. Observed skills items were scored one if the practice was performed and zero if not, yielding an overall skills score ranging from 0 to 61; scores of 50% or more indicate adequate clinical skill.

Competence was analyzed by combining scores from the Knowledge Assessment Questionnaire (10 items, maximum score 10) and the Observation Checklist (61 items, maximum score 61). A nurse was said to be

competent if she achieved both thresholds (knowledge ≥50 and skills ≥50), while those not meeting one or both thresholds were said not to be competent.

#### 4.4.4. Self-Reported Clinical Skill Questionnaire

The perceived clinical skill questionnaire was a researcher-developed, structured self-report tool based on the *Nursing Council of Kenya Procedure Manual (2019)* and adapted from standard nursing procedural guidelines and clinical practice standards. It aimed to measure the frequency and consistency with which nurses apply evidence-based practices in PIVC insertion, care, and removal. The tool contained 10 items, each rated on a 3-point Likert scale (Always = 2, Sometimes = 1, Not at all = 0). The items covered practices such as replacing cannula within 72 hours, managing phlebitis, securing with a transparent dressing, documenting, using administration sets, awareness of complications, adherence to aseptic technique, skin preparation, knowledge of risk factors, and adherence to hospital policies. The maximum possible score was 20 points, with higher scores indicating greater competence.

### *4.5. Procedures*

Ethical issues were addressed by obtaining informed consent from all participants, ensuring they were fully aware of the study's nature, the voluntary nature of their participation, and their right to withdraw without repercussions. Confidentiality was maintained by anonymizing data and securing it against unauthorized access. The study adhered to principles of respect and beneficence, focusing on participants' rights and welfare. Ethical approval was granted by the Masinde Muliro University of Science and Technology Research and Ethical Committee [approval number MMU/COR.403012(7)] and NACOSTI (reference number NACOSTI/P/18/30556/21286).

Data collection occurred between March 19 and May 19, 2018, and each interview lasted approximately 14 to 15 minutes. The study tools underwent rigorous reliability and validity checks to ensure the accuracy and consistency of the findings. Content validity was established through expert review by nursing educators, infection prevention specialists, and clinical practitioners, who evaluated each tool for clarity, relevance, and alignment with evidence-based guidelines. The demographic tool was face-validated to confirm the appropriateness of the categories. The knowledge and clinical competence questionnaires were pretested and refined for clarity, with internal consistency.

Techniques to Minimize Bias and Errors: A pilot study involving 10 nurses was conducted to assess the validity and reliability of the study tools. Feedback from the pilot participants was instrumental in refining the data collection instruments, improving clarity, relevance, and comprehensiveness, thereby enhancing content validity. The content validity index (CVI) was 0.89 for a questionnaire assessing nurses' knowledge and skills in the prevention of peripheral intravenous catheter (PIC)-related infections, indicating content validity. Face validity was confirmed through participants' reports that the tools were clear and understandable. Reliability was assessed using the test-retest method with a subset of 5 participants over a 1-week interval, yielding a Cronbach's alpha of 0.82, indicating good internal consistency in the pilot study. It was obtained using the same questionnaires used to assess nurses' knowledge and skills in preventing PIC-related infections.

The data collection process began with the training of research assistants, who were oriented on the study objective, ethical considerations, and uniform administration of all tools to ensure consistency and minimize bias. They were also trained on confidentiality procedures, participant consent, and accurate recording of responses. Data collection was conducted in two phases.

In the first phase, participants were recruited purposively, applying inclusion and exclusion criteria (excluding nurses with less than six months of work experience). After obtaining informed consent, each nurse was assigned a unique identifier code to maintain confidentiality. Two tools were then administered sequentially in a quiet space within the hospital; the third tool, the observation checklist, was filled in by the researcher in the clinical setting during nurses' work:

Tool 1: Demographic questionnaire – a structured self-administered form capturing years of service, department of work, educational level, and job position, completed under the guidance of a research assistant.

Tool 2: Knowledge questionnaire – a 10-item structured questionnaire on evidence-based guidelines for preventing peripheral intravenous cannula-related infections, with closed-ended responses ("Yes," "No," "I do not know"). Nurses' knowledge was further classified into knowledgeable and not knowledgeable based on the Nursing Council of Kenya clinical assessment pass grade *(St. Luke, 2021)*. Guidelines for preventing intravascular cannula infections have been updated by the Healthcare Infection Control Practices Advisory Committee (HICPAC) and the Centers for Disease Control and Prevention (CDC) *(Greene, 2021)*.

Tool 4: Self-reported clinical competence– a 10-item self-administered tool using a three-point Likert-type scale ("Always," "Sometimes," "Not at all"), assessing competence in cannula insertion, care, and removal.

In the second phase, Tool 3: Direct observation checklist was applied through unannounced observations of nurses during routine practice. To minimize the Hawthorne effect, only hospital in-charges were notified of the study schedule, while staff were unaware of the exact timing of observations. The 61-item checklist, adapted from WHO, CDC, and INS guidelines, was completed by an unidentified research assistant trained in infection prevention. Nurses who correctly performed (≥50%) on skill items were considered to be skilled on prevention of peripheral intravenous cannula-related infection, and those who correctly performed (<50%) were not skilled *(Nyangena et al., 2013)*.

Analyzing the level of competence in preventing PIC-related infections: Observations captured whether key procedures in cannula insertion, care, and removal were evaluated using a dichotomous scale of "Done" or "Not done." Each nurse was observed once during the study period. For a nurse to be considered competent in

preventive interventions for peripheral intravenous cannula-related infections, she must be both knowledgeable and skilled. Nurses who correctly performed (≥50%) on skill items and those who knew (≥50%) on knowledge items were considered to have been competent. Those who performed correctly (<50%) in the practiced skills and those who scored (<50%) on the knowledge assessment were considered not competent. Level of skill scores ranged from 1- 45. The overall mean skill was 42.3. For quality assurance, the principal investigator reviewed completed forms daily to ensure completeness and consistency.

### 4.6. Study Limitation

One limitation of this study is the potential for social desirability bias, as part of the data was collected via a structured, self-reported questionnaire. Participants may have overstated their knowledge or adherence to infection prevention practices to align with expected professional standards, thereby inflating results. To minimize this risk, the study also employed an observation checklist adapted from international guidelines, allowing real-time assessment of actual practices in peripheral IV cannulation, care, and removal.

### 4.7. Data Analysis

Data entry and analysis were carried out using SPSS version 29. Descriptive statistics, such as frequencies, means, and standard deviations, were used to summarize the data. Inferential statistics, including Chi-square tests and logistic regression, were used to explore associations between demographic characteristics and competence levels. These methods ensured a rigorous analytical process that minimized bias and error, thereby enhancing the overall reliability and validity of the study's findings.

Nurses who scored correctly on 50% or more of the knowledge items were considered knowledgeable, setting the competence cut-off at 50% for both knowledge and skills assessments. This classification aligns broadly with the NCK's licensure threshold for pass marks (just above 49.5%) *(St. Lukes, 2025).*

Logistic regression was employed for additional analysis to evaluate the correlation between demographic characteristics and knowledge level (p-value < 0.05). Descriptive statistics were used to generate frequency distributions and to assess performance in inserting, removing, and caring for peripheral intravenous cannula.

To be competent, as discussed, one must be skilled and knowledgeable. Descriptive statistics were used to generate a frequency distribution of competence levels. The chi-square test was used to assess the association between nurses' competence levels and demographic characteristics. The level of significance was set at $P \leq 0.05$. The analysed data were presented in charts and tables.

## 5. Results

The demographic characteristics of all nurses are shown in Table 1. Of the 86 participants, more than half (58.1%) had less than 5 years of experience in the nursing profession. Nearly three-quarters (73.3%) were diploma-level nurses, and most respondents (59.3%) worked in Medical Wards. A higher proportion of participants were Grade III Nursing Officers (62.8%), while Nursing Officer I was the least represented (11.6%).

Table 2 presents the nurses' knowledge of preventive interventions for peripheral intravenous cannula–related infections. Most nurses showed good knowledge of peripheral intravenous cannulation, with the majority identifying appropriate cannula sizes (79.1%), correct vein sites (70.9%), and the recommended 48–72-hour usage guideline (70.9%). Nearly all understood the importance of aseptic technique (97.7%), site preparation (100%), and glove use (97.7%). However, some confusion remained about the recommended cannula replacement interval (only 36.1% answered correctly). Most participants also recognized that environmental cleanliness (86.1%) and multiple cannulation attempts (84.9%) increase the risk of infection.

Figure 1 illustrates the overall level of nurses' knowledge on evidence-based guidelines for preventive interventions for peripheral intravenous cannula-related infections. The majority (87%) of the nurses were knowledgeable about evidence-based guidelines for preventive interventions for peripheral intravenous cannula-related infections, while 13% were not.

Table 3 shows that nearly half of the nurses (45.3%) demonstrated adequate skills in PIC insertion, care, and removal, reflecting a positive level of competence among many participants. However, with 54.7% showing lower skill levels, there remains an opportunity to further strengthen nurses' practical skills.

Figure 2 illustrates the overall competence level (knowledge and practice skills) on preventive interventions for peripheral intravenous cannula–related infections. Nearly two-thirds (66.3%) were competent in preventing peripheral venous cannula-related infections, while the remaining 33.7% were not.

Table 4 reveals nurses' self-reported application of evidence-based practices during PIVC insertion, care, and removal. The majority of nurses are always aware of the factors that influence the risk of infection (95.4%), the importance of performing skin preparation before IV cannula insertion (93.3%), and the complications of IV cannulation, such as infiltration, phlebitis, and extravasation (90.7%). However, only 5.8% and 9.3% always change the IV cannula after 72 hours of insertion or always follow the hospital's IV cannulation guidelines, respectively. The results suggest higher awareness but lower levels of correct practice.

Figure 3 illustrates the self-reported practice level of the studied nurses as revealed by the observation checklists. Skill level evaluation was classified skill level into skilled and not skilled based on the Nursing Council of Kenya clinical assessment pass grade, using 61 items assessed. Most nurses (70%) were skilled in performing intravenous therapy, including inserting, removing, and caring for a peripheral intravenous cannula, whereas 30% were not.

Table 5 shows that nurses with more years of experience were more likely to be skilled in preventing PIC-related infections. Those with 5–<10 years and 10

years or more of experience had significantly higher odds of being skilled compared to those with less than 5 years of experience ($p < 0.05$). Similarly, nurses with higher levels of education, especially those holding diplomas or master's degrees, demonstrated greater skill competence than certificate holders, indicating that education positively influences practice. There were no significant associations between skill level and department, suggesting that experience and education play a more crucial role in determining nursing competence in PIC care than the work unit.

Table 6 presents the univariate analysis of the association between demographic factors and nurses' competence in preventive interventions for peripheral intravenous cannula–related infections. In a univariate analysis using the chi-square test, demographic factors were associated with nurses' competence in preventive interventions for peripheral intravenous cannula–related infections. Only the years of experience and education were significantly associated at P = 0.05.

Table 7 presents the logistic regression analysis showing a cluster difference in nurses' competence with evidence-based guidelines for preventive interventions for peripheral intravenous cannula-related infections. Nurses who had over 10 years of experience working experience and 5-9 years of experience (OR = 1.53, 95% CI: 1.36-1.72; $p$=<0.001 and OR = 1.22, 95% CI: 1.17-1.81; $p$< 0.05) were 1.53 times and 1.22 times respectively more competent as compared to those had less than 5 years' experience.

Similarly, nurses who were holders of master's degree and Diploma were 1.64 times and 1.43 times more skilled on evidence-based guidelines for preventive interventions for peripheral intravenous cannula-related infections (OR = 1.26, 95% CI: 1.10-1.45; $p$<0.001) (OR = 1.43, 95% CI: 1.04-1.97; P= 0.029) respectively than those were certificate holders. In addition, Nursing Officer II were 23% (OR = 0.77, 95% CI: 0.59-1.02; $p$=0.041) less likely to be competent on preventive interventions for peripheral intravenous cannula-related infections than Nursing Officer I.

## 6. Discussion

Preventing healthcare-associated infections remains a critical global priority, particularly in resource-constrained settings where infection control systems may be underdeveloped and staffing levels inadequate (WHO, 2024). Peripheral intravenous cannulation is one of the most common invasive procedures performed by nurses. However, it carries a significant risk of infection if not performed and maintained in accordance with standard guidelines *(Greene, 2021).* This study aimed to evaluate nurses' competence in preventing cannula-related infections in newly upgraded sub-county hospitals.

The study revealed that more than half of the participants had less than 5 years of nursing experience, highlighting the relatively young workforce in the setting. This finding is similar to *Odonkor and Frimpong (2020),* who found that 52.1% of nurses in Ghana were between 20 and 30 years of age, reflecting a predominance of early-career nurses in Sub-Saharan Africa. Such a trend is linked to high enrollment and rapid absorption of diploma-trained nurses into the workforce to address staffing shortages in resource-limited settings.

In terms of educational background, the majority of participants held diploma qualifications rather than bachelor's degrees. This finding contrasts with regional trends, as diploma programs remain more prevalent in Sub-Saharan Africa due to their shorter duration and affordability, enabling countries to train larger cohorts of nurses within limited budgets. In contrast, studies from high-income countries report higher proportions of degree-prepared nurses. For example, *Heidari et al. (2022)* reported that 95.6% of nurses in their Iranian study held bachelor's degrees, reflecting the global emphasis on higher nursing education in more developed contexts.

**Table (1): Frequency and percentage distribution of demographic characteristics of the studied nurses (n-86).**

| Variables | No. | % |
|---|---|---|
| **Years of Service** | | |
| 1–<5 | 50 | 58.1 |
| 5-<10 | 33 | 38.4 |
| ≥10 | 3 | 3.5 |
| **Educational level** | | |
| Certificate | 7 | 8.1 |
| Diploma | 63 | 73.3 |
| Degree | 15 | 17.4 |
| Masters | 1 | 1.2 |
| **Department** | | |
| Medical | 51 | 59.3 |
| Surgical | 35 | 40.7 |
| **Position** | | |
| Nursing Officer III | 54 | 62.8 |
| Nursing Officer II | 22 | 25.6 |
| Nursing Officer I | 10 | 11.6 |

**Table (2): Knowledge on preventive interventions for peripheral intravenous cannula-related infections (n=86).**

| Variables | No. | % |
|---|---|---|
| **Cannulas with gauges 14G, 16G, 18G, and 20G are suitable for peripheral intravenous cannulation.** | | |
| Yes | 68 | 79.1 |
| No | 5 | 5.8 |
| Do not know | 13 | 15.1 |
| **The veins used for intravenous cannulation are typically located in the metacarpal, cephalic, and basilic regions of the upper extremities.** | | |
| Yes | 61 | 70.9 |
| No | 23 | 26.7 |
| Do not know | 2 | 2.3 |
| **After insertion, the peripheral IV cannula needs to be removed every 12 to 72 hours.** | | |
| Yes | 31 | 36.1 |
| No | 55 | 63.9 |
| **According to UIC guidelines, an IV cannula can be used for 48 to 72 hours if there are no indications of a problem.** | | |
| Yes | 61 | 70.9 |
| No | 25 | 29.1 |
| **The most recognizable infection associated with IV cannulation is phlebitis.** | | |
| Yes | 54 | 62.8 |
| No | 32 | 37.2 |
| **Will the state of the environment (such as cleanliness) affect the risk of infection associated with IV cannulation?** | | |
| Yes | 74 | 86.1 |
| No | 12 | 13.9 |
| **Will infection occur if aseptic technique is maintained only during IV cannula insertion?** | | |
| Yes | 84 | 97.7 |
| No | 2 | 2.3 |
| **It is recommended to wear non-sterile gloves when inserting an IV cannula.** | | |
| Yes | 84 | 97.7 |
| No | 2 | 2.3 |
| **Before inserting the IV cannula, the insertion site must be prepared.** | | |
| Yes | 86 | 100.0 |
| No | 0 | 0.0 |
| **An increase in cannulation attempts will increase the risk of infection.** | | |
| Yes | 73 | 84.9 |
| No | 13 | 15.1 |

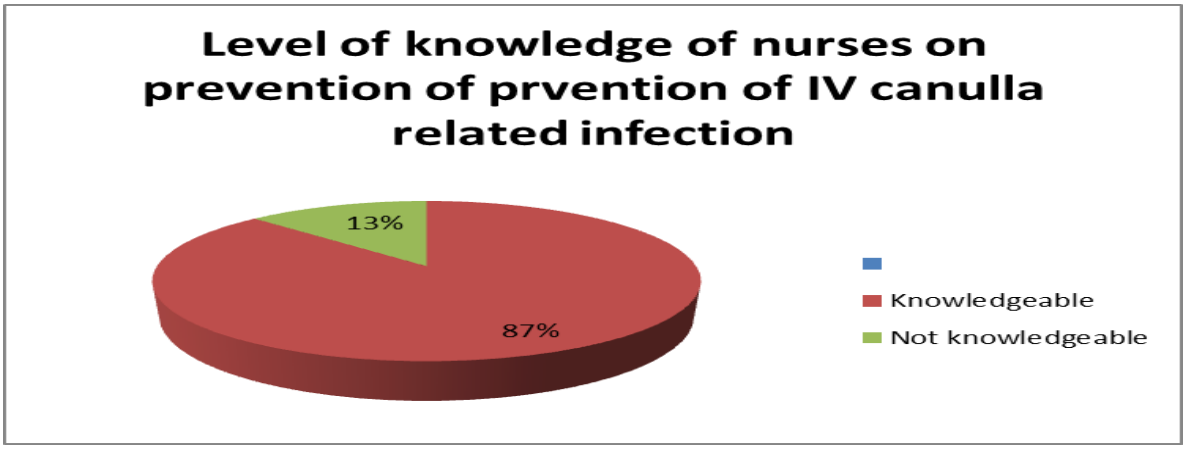


**Figure (1): Percentage distribution of nurses' knowledge level on preventive interventions for IV cannula-related infections (n=86).**

**Table (3): Frequency and percentage distribution of observed procedural skills of studied nurses in PIVC insertion, care, and removal (n=86).**

| Skill Category | Score Range (%) | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Low Skill | 0–49 | 47 | 54.7 |
| Adequate Skill | 50–100 | 39 | 45.3 |
| Total | — | 86 | 100 |

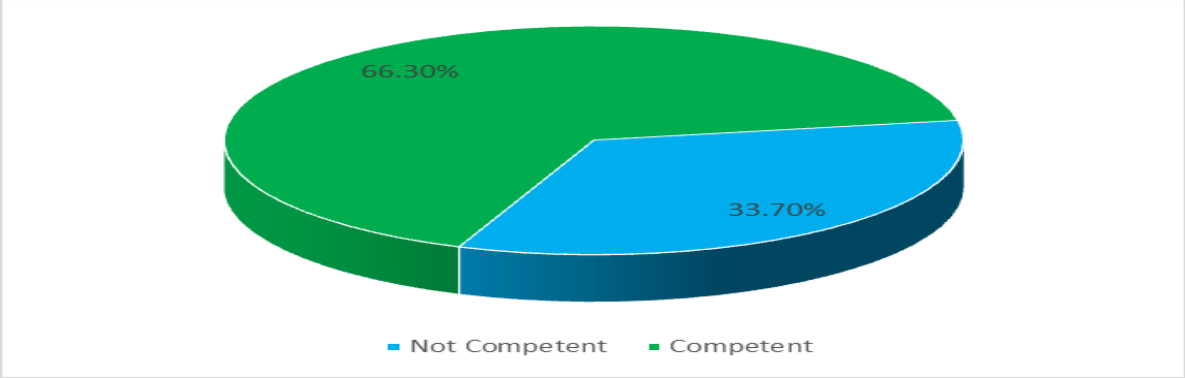


**Figure (2): Percentage distribution of overall nurses' competence on preventive interventions for peripheral intravenous cannula–related infections (n=86).**

**Table (4): Frequency and percentage distribution of self-reported clinical skills in inserting, removing, and caring for a peripheral intravenous cannula (n=86).**

| Variable | No. | % |
|---|---|---|
| **I always replace the IV cannula 72 hours after insertion.** | | |
| Always | 5 | 5.8 |
| Sometimes | 81 | 94.2 |
| Not all | 0 | 0.0 |
| **As soon as I noticed a phlebitis symptom, I switched the IV cannula to the unaffected area.** | | |
| Always | 61 | 70.9 |
| Sometimes | 12 | 14.0 |
| Not all | 13 | 15.1 |
| **I always secure the IV cannula using a transparent dressing.** | | |
| Always | 14 | 16.3 |
| Sometimes | 72 | 83.7 |
| Not all | 0 | 0.0 |
| **I always include the date, time, location, size, change in the due date, and the name of the person being cannulated.** | | |
| Always | 9 | 10.5 |
| Sometimes | 77 | 89.5 |
| Not all | 0 | 0.0 |
| **I use IV cannula administration sets within 72 hours of their use.** | | |
| Always | 16 | 18.6 |
| Sometimes | 45 | 52.3 |
| Not all | 25 | 29.1 |
| **I am aware that IV cannulation can result in complications such as infiltration, phlebitis, and extravasation.** | | |
| Always | 78 | 90.7 |
| Sometimes | 8 | 9.3 |
| Not all | 0 | 0.0 |
| **I always prepare, insert, and remove IV cannulas using aseptic technique.** | | |
| Always | 22 | 25.6 |
| Sometimes | 64 | 74.4 |
| Not all | 0 | 0.0 |
| **I understand how crucial it is to prepare the skin before inserting the IV cannula.** | | |
| Always | 80 | 93.0 |
| Sometimes | 6 | 7.0 |
| Not all | 0 | 0.0 |
| **I am aware of the variables that affect the likelihood of contracting an infection.** | | |
| Always | 82 | 95.4 |
| Sometimes | 4 | 4.6 |
| Not all | 0 | 0.0 |
| **I always perform IV cannulation according to the instructions provided by my hospital** | | |
| Always | 8 | 9.3 |
| Sometimes | 78 | 90.7 |
| Not all | 0 | 0.0 |

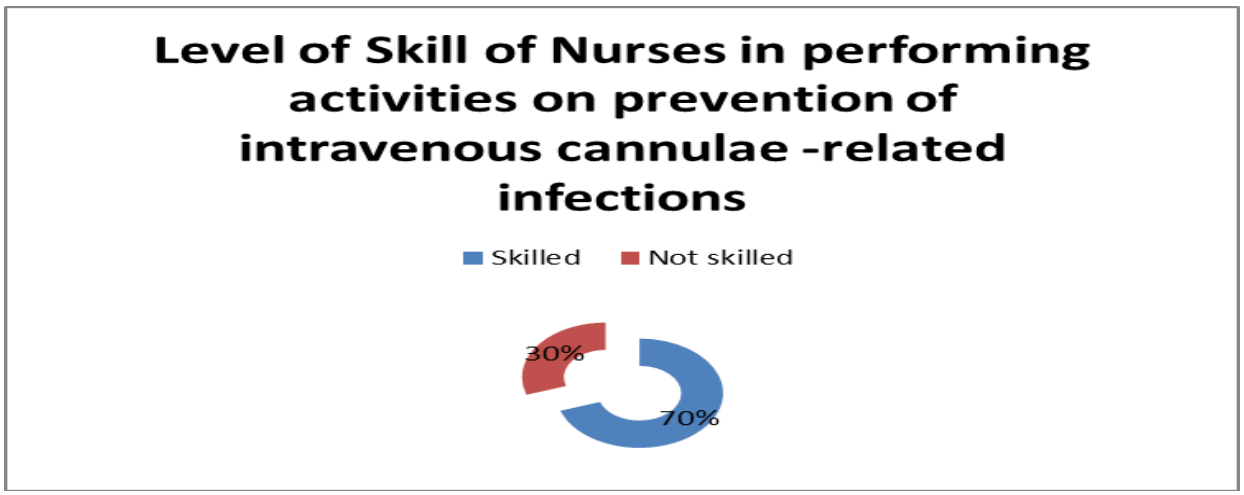


**Figure (3): Percentage distribution of overall self-reported clinical skill on preventive interventions for peripheral intravenous cannula–related infections (n=86).**

**Table (5): Predictors of observed nurses' skill level in preventive IV cannula infection guidelines (n=86).**

| Factor | skilled | Not skilled | OR (95% CI) | P-value |
|---|---|---|---|---|
| **Years of experience** | | | | |
| 10 years and over | 3 | 0 | 1.73(1.69-1.89) | <0.000 |
| 5-<10 years | 27 | 6 | 1.82(1.67-1.91) | 0.020 |
| 1-<5 years | 20 | 30 | Ref | |
| **Educational level** | | | | |
| Masters | 1 | 0 | 1.66(1.17-2.35) | <0.001 |
| Degree | 12 | 3 | 1.5(0.96-2.33) | 0.100 |
| Diploma | 42 | 21 | 1.42(1.02-1.97) | 0.040 |
| Certificate | 4 | 3 | Ref | |
| **Department** | | | | |
| Surgical | 30 | 5 | 1.07(0.89-1.3) | 0.520 |
| Medical | 29 | 22 | Ref | |
| **Position** | | | | |
| Nursing officer III | 35 | 19 | 0.9(0.69-1.17) | 0.480 |
| Nursing officer II | 15 | 7 | 0.83(0.63-1.11) | 0.280 |
| Nursing officer I | 9 | 1 | Ref | |

**Table (6): Univariate analysis of demographic factors influencing nurses' competence in IV cannula infection prevention (n=86).**

| Demographic characteristics | Competence | | | | Chi square | P-value |
|---|---|---|---|---|---|---|
| | Not Competent | | Competent | | | |
| | No | % | No | % | | |
| **Years of experience** | | | | | | |
| 1–<5 | 12 | 24.0 | 38 | 76.0 | | |
| 5-<10 | 17 | 51.5 | 16 | 48.5 | 8.32 | 0.02 |
| ≥10 | 0 | 0.0 | 3 | 100 | | |
| **Education** | | | | | | |
| Certificate | 4 | 57.1 | 3 | 42.9 | | 0.05 |
| Diploma | 21 | 29.6 | 50 | 70.4 | 5.21 | |
| Degree | 4 | 50.0 | 4 | 50.0 | | |
| **Department** | | | | | | |
| Medical | 19 | 37.3 | 32 | 62.7 | 0.76 | |
| Surgical | 10 | 29.6 | 25 | 70.4 | | 0.68 |
| **Position** | | | | | | |
| Nursing officer I | 2 | 20.0 | 8 | 80.0 | | |
| Nursing officer II | 14 | 46.7 | 16 | 53.3 | 3.76 | 0.16 |
| Nursing officer III | 13 | 28.3 | 33 | 71.7 | | |

**Table (7): Predictors of Nurses' Competence in IV Cannula Infection Prevention (n=86).**

| Factor | Competent | Not competent | OR (95% Cl) | p value |
|---|---|---|---|---|
| **Years of experience** | | | | |
| ≥10 | 3 | 0 | 1.53(1.36-1.72) | <0.001 |
| 5-<10 | 26 | 7 | 1.22(1.17-1.81) | 0.05 |
| 1–<5 | 21 | 29 | Ref | |
| **Educational level** | | | | |
| Masters | 1 | 0 | 1.26(1.10-1.45) | <0.001 |
| Degree | 12 | 3 | 1.5(0.96-6.33) | 0.10 |
| Diploma | 44 | 19 | 1.43(1.04-1.97) | 0.029 |
| Certificate | 4 | 3 | Ref | |
| **Department** | | | | |
| Surgical | 31 | 4 | 1.27(0.59-2.3) | 0.73 |
| Medical | 29 | 22 | Ref | |
| **Position** | | | | |
| Nursing officer III | 36 | 18 | 0.84(0.65-1.09) | 0.186 |
| Nursing officer II | 16 | 16 | 0.77(0.59-1.02) | 0.041 |
| Nursing officer I | 9 | 1 | Ref | |

This study reveals that nurses demonstrated strong knowledge of key infection prevention practices, with all participants correctly identifying the importance of skin preparation before peripheral IV cannula insertion. This finding is encouraging, as proper skin antisepsis is a cornerstone of reducing catheter-related bloodstream infections. It aligns with *García-Expósito et al. (2021),* who reported that 70.7% of nurses in Spain were aware of the appropriate chlorhexidine concentration for skin antisepsis, highlighting consistency across settings in recognizing this essential step.

However, disparities in knowledge levels are evident when comparing with studies from other regions. For instance, *Thresiamma et al. (2021)* found that 68.8% of nurses in their Indian study demonstrated only average knowledge of infection prevention, while 20.8% exhibited poor knowledge, underscoring variability in competency levels globally. The present findings therefore suggest that, while basic knowledge of infection prevention among nurses in this setting is relatively strong, global evidence reveals substantial gaps in other low- and middle-income countries. This finding emphasizes the need for ongoing education and structured training programs to ensure that knowledge translates into consistent practice and improved patient safety outcomes.

This study reveals notable variations in nurses' knowledge regarding peripheral intravenous (IV) cannulation and related infection prevention measures. A majority of participants correctly identified that cannula sizes 14G, 16G, 18G, and 20G are suitable for peripheral IV access, consistent with international guidelines that recommend gauge selection based on vein size and infusion purpose *(O'Grady et al., 2011).* However, several respondents reported not knowing the appropriate gauge, highlighting a gap that may compromise clinical judgment in emergency or critical care situations, as also noted by *Jacobs (2022),* who found that confidence in catheter selection was strongly linked to competence.

Regarding venous access sites, most participants correctly identified metacarpal, cephalic, and basilic veins as typical sites for cannulation. This finding is similar to those of *Osti et al. (2019)* in Nepal, where most participants correctly identified peripheral veins. Nonetheless, more than a quarter of respondents in the present study provided incorrect responses, indicating persistent gaps in anatomical knowledge, which could increase the risk of multiple failed attempts, a factor associated with higher infection rates *(Zhang et al., 2016).*

Knowledge about cannula dwell time reveals some misconceptions. While most agreed that IV cannula should be routinely removed every 12–72 hours, 36.1% still believed they should be replaced more frequently than necessary. Evidence-based guidelines, such as those by the CDC and INS, recommend dwell times of 48–72 hours if no complications are observed *(Ray-Barruel & Alexander, 2023).* This confusion mirrors gaps observed by *Siddique et al. (2023),* who found that nurses demonstrated inconsistent understanding of dwell time, suggesting a need to reinforce current best practices.

Phlebitis was correctly recognized by most as the most common infection-related complication of IV cannulation. Studies by *Shahnaz et al. (2021)* and *de Souza et al. (2015)* also highlighted phlebitis as the most frequently observed complication, with prevalence ranging from 25% to 70% in some hospital settings. However, over one-third of nurses in this study failed to identify phlebitis, a concern since early detection is vital for preventing bloodstream infections *(Nickel, 2020).*

Environmental cleanliness was overwhelmingly recognized as a determinant of infection risk, consistent with *Vincent et al. (2021),* who found that most Nigerian nurses associated environmental factors with infection control. Similarly, nearly all participants recognized that aseptic technique must extend beyond insertion alone, reflecting good awareness of ongoing catheter maintenance, consistent with INS and CDC guidelines *(O'Grady et al., 2011).*

Furthermore, almost all respondents affirmed the recommendation to use non-sterile gloves during insertion and unanimously agreed that the insertion site must be prepared prior to cannulation. These findings echo *García-Expósito et al. (2021)*, who demonstrated similar awareness

among nursing students, and *Raynak et al. (2020),* who noted that glove use and site preparation were among the most widely understood aspects of PIVC care across reviewed studies.

Finally, most of the participants correctly indicated that multiple cannulation attempts increase the risk of infection. This finding is well supported by evidence: repeated punctures damage the endothelium, raising the likelihood of phlebitis and bloodstream infections *(Nickel, 2020).* However, 15.1% did not recognize this risk, suggesting the need for stronger emphasis on "first-stick success" training in nursing practice.

The findings from this study highlight that while nurses demonstrated strong awareness of key infection prevention practices such as aseptic technique, glove use, and site preparation, significant knowledge gaps persist in critical areas, including cannula dwell time, recognition of phlebitis, and identification of appropriate veins for cannulation. These gaps are not merely academic but have important implications for patient safety. For example, a misunderstanding of dwell time may lead to either premature removal, causing unnecessary patient discomfort and increased healthcare costs, or prolonged retention, which raises the risk of bloodstream infections. Similarly, failure to recognize phlebitis early may delay intervention, predisposing patients to more severe catheter-related infections.

The strong knowledge observed in aseptic practices and environmental control suggests that infection prevention training and policy implementation at the county level have been effective, aligning with global guidelines *(O'Grady et al., 2011).* However, the variability in responses indicates that training may not be uniform or consistently reinforced across all facilities. This finding is consistent with studies in other low- and middle-income countries *(Siddique et al., 2023),* where structural and resource-related challenges often result in uneven dissemination of evidence-based practices.

Furthermore, the fact that nearly one in four nurses lacked correct knowledge on vein selection and that a third misinterpreted dwell time points to the need for more hands-on competency-based training, particularly since multiple cannulation attempts were acknowledged as a risk by most participants. This paradox — awareness of infection risk from multiple attempts but insufficient knowledge of vein selection — suggests a disconnect between theoretical knowledge and practical application, a challenge also noted by *Jacobs (2022)* and *García-Expósito et al. (2021).*

The interpretation of these findings is that while baseline knowledge is strong in some domains, critical knowledge deficits remain that could directly influence patient outcomes. These gaps underscore the importance of continuous professional development, routine refresher training, and incorporation of updated guidelines into daily practice. Addressing these deficiencies would enhance not only individual nurse competence but also overall patient safety within sub-county hospital settings.

The study evaluated nurses' clinical skills in preventing PIC-related infections. Observations reveal variability in practice: some nurses demonstrated skill, while others did not. These findings underscore the importance of hands-on training and supervision to ensure uniform adherence to best practices. By addressing these gaps through targeted education and policy enforcement, healthcare facilities can enhance patient safety and reduce the incidence of IV cannula-related infections.

The study's findings show a discrepancy between knowledge and skill. In comparison with the study by *Raynak et al. (2020),* 93.3% of the nurses reported being always aware of the critical importance of skin preparation before inserting an IV cannula *(Raynak et al., 2020).* The study illustrated significant gaps between nurses' theoretical knowledge, self-reported competence, and actual clinical practice regarding peripheral intravenous cannulation. *Raynak et al. (2020)* reported that 95.4% of nurses were aware of infection risk factors during IV cannulation, only 5.8% consistently followed the 72-hour cannula change protocol, and only 9.3% fully adhered to hospital IV initiation guidelines. This stark knowledge-practice discrepancy persists despite 93.3% of nurses recognizing the critical importance of skin antisepsis. Regarding practical skills, 70% demonstrated competence in infection prevention, contrasting with *Thresiamma and Rani's (2021)* findings, which showed that only 33.3% exhibited good skills and 10.4% performed poorly in cannula management.

Competency assessments show that around two-thirds of the studied nurses performed adequately during observed insertions and removals. In comparison, one-third lacked essential skills, a gap that could be reduced through simulation-based training. These findings collectively underscore the urgent need for targeted, hands-on training and regular competency evaluations to bridge the persistent gap between nurses' infection control knowledge and its clinical application in peripheral IV therapy.

This study shows that hospitals need to strengthen ongoing education and training programs to help nurses prevent infections associated with peripheral intravenous catheters (PICs). Training should focus on following aseptic techniques, changing cannulas on time, disinfecting properly, and maintaining good hand hygiene. When nurses improve their skills in these areas and hospitals conduct regular audits and provide feedback, infection rates can decrease, and patient outcomes can improve.

The study adds to existing knowledge on infection prevention and control (IPC) by showing a gap between what nurses know and what they actually do in practice. It supports the idea that true competence in nursing goes beyond knowledge—it involves consistently applying evidence-based guidelines. This finding aligns with prior studies *(Ray-Barruel & Alexander, 2023; Osti et al., 2019),* which found that failing to follow standard protocols increases infection risk.

In practice, the study points out specific training and skill gaps among nurses in recently upgraded sub-county hospitals. These findings can guide hospital leaders in planning continuous professional development (CPD), mentorship, and supervision programs. Regular audits in accordance with the Nursing Council of Kenya's Clinical Procedures Manual are also recommended. By improving

nurses' competence, hospitals can lower infection rates, reduce patient illness, and cut healthcare costs, while closing the gap between classroom learning and real-life practice in PIC care.

Level of education is significantly correlated with competence, underscoring the importance of formal education in infection prevention. Both experience and educational level are associated with competence in preventing PIC-related infections. Nurses with over 10 years of experience exhibited 100% competency, suggesting that mid-level experience (5-9 years) would benefit from additional professional development.

Most nurses demonstrated adequate knowledge of preventive interventions for PIC-related infections. After every nurse had observed and completed the knowledge data collection tool, the results showed fair competence in preventing PIC-related infections. Many nurses struggle to follow recommended infection prevention practices even after receiving formal training, a finding attributed to several factors, including level of education and years of experience.

## 7. Conclusion

As per the first objective, most nurses had adequate knowledge of the fundamental principles of IPC, but there were knowledge gaps regarding the appropriate duration of cannula use and adherence to institutional policies. Regarding the second objective, the majority of the nurses were not proficient at changing PIC after 72 hours or at adhering to hospital protocols. In analyzing the knowledge and skills of nurses, it was noted that there was a high level of competence among nurses with more years of experience and higher levels of education.

## 8. Recommendations

Based on these findings, it would be important to enhance nurses' competence and reduce peripheral intravenous cannula-related infections; several measures are recommended.

- Reinforce education on cannula gauge selection and aseptic techniques, and implement standardized protocols for IV cannula insertion and maintenance in healthcare.
- Provide targeted training, enhance infection control resources, and conduct regular knowledge assessments.
- Address the gaps identified in clinical competence through improved training programs, regular audits, and continuous education.
- Encourage hospitals to prioritize ongoing clinical practice and formal education, integrating workshops, simulations, and evidence-based training.
- Further research should explore the impact of targeted professional development and institutional support on nurses' long-term competence and patient outcomes.

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