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Assessment of knowledge and practice of healthcare providers towards peripherally inserted central catheter procedures at King Faisal Hospital Rwanda

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ABSTRACT

INTRODUCTION: Peripherally inserted central catheters (PICCs) provide reliable long-term intravenous access for critically ill patients requiring extended therapy. Despite their clinical importance, limited research exists on healthcare providers' knowledge and practice in PICC management within sub-Saharan Africa. The aim was to assess healthcare providers' knowledge and clinical practices regarding PICC procedures at King Faisal Hospital Rwanda (KFHR).

METHODS: A descriptive cross-sectional study was conducted at KFHR among 100 healthcare providers across six clinical departments using a structured questionnaire. Participants were selected through purposive sampling based on direct patient care involvement. Data analysis employed descriptive statistics using STATA version 18.

RESULTS: Only 3% of participants held formal PICC certification. While 73% understood PICCs' role in long-term therapy, significant knowledge gaps persisted: 46% lacked understanding of proper anatomical placement, 41% incorrectly identified tattoos as contraindications, and 53% believed aseptic technique was only necessary during insertion.

CONCLUSION: Substantial knowledge gaps in PICC procedures were observed among healthcare providers at KFHR. Although PICC is a globally recognized, evidence-based, life-saving intervention, it has not yet been implemented in Rwanda or at KFHR. Further research and pilot implementation are needed to assess feasibility, resource requirements, and training needs in the local context.

Keywords: PICC line, Healthcare provider knowledge, Intravenous access, Catheter-related Infections, Rwanda, Vascular Access

INTRODUCTION

Peripherally inserted central catheters (PICCs) are central vascular access devices widely used for the administration of medications, parenteral nutrition, and other therapies requiring long-term venous access [1,2]. First introduced in clinical practice in the 1970s, PICCs are now a common

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alternative to traditional central venous catheters due to their ease of insertion, reduced complication rates, and suitability for both adult and pediatric populations [3–5]. Globally, more than 2.5 million PICCs are inserted annually in acute care facilities, reflecting their central role in improving treatment delivery and patient outcomes [6]. Insertion is typically performed through the basilic or cephalic veins, with radiographic confirmation of catheter tip placement in the superior vena cava [7,8].

In Europe and Asia, PICCs are well established in critical care, oncology, and Neonatal Intensive care Units, where they reduce the need for repeated venipuncture and provide safe, reliable access for hyperosmolar or vesicant therapies [9,10]. Their role in neonatal and pediatric populations is especially important, as they enable the prolonged delivery of antibiotics, chemotherapy, and parenteral nutrition with fewer complications compared to peripheral intravenous devices [11,12]. In high-income countries, structured nurse-led training programs and standardized protocols have enhanced the safety and effectiveness of PICC insertion and maintenance [5,13]. In contrast, evidence from sub-Saharan Africa indicates more limited uptake and inconsistent outcomes, often linked to inadequate training and lack of institutional guidelines [14].

Like many resource-limited countries, Rwanda continues to face significant healthcare challenges. KFHR, as the national referral hospital, offers the most advanced medical services in the country and aspires to become a center of excellence. PICCs provide a less invasive and safer option for vascular access in critically ill patients and neonates, yet their utilization remains limited in Rwanda. To date, no published evidence exists on the knowledge and practices of healthcare providers regarding PICC procedures in the Rwandan context. Addressing this gap is essential for advancing patient care, informing training needs, and strengthening the capacity to deliver high-quality services. This study aims to assess the knowledge and practices of healthcare providers regarding PICC procedures at King Faisal Hospital Rwanda (KFHR), with the goal of informing structured training and evidence-based protocols. Strengthening PICC implementation has the potential to improve patient safety, enhance treatment outcomes, and support the delivery of high-quality care in Rwanda.

METHODS

Study Design and Setting

This descriptive cross-sectional study was conducted at KFHR, a 212-bed, multi-specialty, quaternary teaching and referral hospital in Kigali. The comprehensive services provided at KFHR can be found on the hospital's website and include, but are not limited to, intensive care, oncology, pediatrics, specialized surgery, kidney transplantation, cardiothoracic surgery, mental health, and interventional cardiology [15]. Data collection took place over two months (March–April 2025).

Participants and Sampling

The study population comprised healthcare providers directly involved in patient care across six clinical departments at KFHR: Neonatal Intensive Care Unit (NICU), Adult and Pediatric Intensive Care Units (ICU), Pediatric Ward, Medical Ward, Surgical Ward, and Obstetrics/Gynecology. Purposive sampling was used to select participants with relevant clinical experience and direct involvement in intravenous access procedures. A total of 100 healthcare providers from the staff of KFHR were recruited, distributed as follows: 15 from the NICU, 25 from the Adult and Pediatric ICUs, 15 from the Pediatric Ward, 20 from the Medical Ward, 20 from the Surgical Ward, and 5 from the Obstetrics/Gynecology Department.

Eligibility Criteria

Participants will be eligible for inclusion if they are healthcare providers employed in clinical departments, directly involved in intravenous access procedures as part of their routine patient care responsibilities, and willing to provide informed consent to participate in the study. Healthcare providers who are not involved in direct patient care, those unable to provide informed consent, and administrative staff without clinical responsibilities will be excluded from the study.

Data Collection Instrument

A structured questionnaire was developed internally based on a comprehensive literature review and an assessment of the institutional context. The instrument was piloted and subsequently refined. It comprised four sections: (1) demographic characteristics, including gender, age, profession, clinical unit, and years of experience; (2) PICC knowledge assessment,

covering indications, contraindications, insertion techniques, and maintenance protocols; (3) clinical practice evaluation, assessing current PICC procedures and infection control practices. The questionnaire underwent content validation by clinical experts and pilot testing with 10 healthcare providers to ensure clarity and comprehensiveness. Data were collected electronically to facilitate efficiency while maintaining participant anonymity.

Data Management and Analysis

Data were collected electronically and exported to STATA version 18 for analysis. Before analysis, data cleaning included range checks, logic validations, and duplicate identification.

Descriptive statistics were performed for all variables, with categorical variables summarized using frequencies and percentages. Results are presented in tables to display the distributions clearly.

Table 1: Demographic characteristics

Variable	n=100	Percentage
Gender		
Male	39	39%
Female	61	61%
Age group		
25-30 years	14	14%
31-41 years	47	47%
41-50 years	34	34%
51 and above	5	5%
Professional		
Nurse	91	91%
Midwife	4	4%
Medical doctor	5	5%
Unit		
Pediatric	21	21%
NICU	14	14%
Critical care	23	23%
Medical	23	23%
Surgical	10	10%
Other	9	9%
Experience (years)		
<1	4	4%
1-5	27	27%
6-10	22	22%
> 10	47	47%

Ethical Considerations

The study received approval from the King Faisal Hospital Rwanda Institutional Review Board (Ref. KFH/2024/ 208/IRB). All participants provided informed consent electronically before completing the questionnaire. Participation was voluntary, and participants could withdraw at any time without consequences. Data were de-identified to ensure confidentiality, with access restricted to the research team.

RESULTS

The study included 100 healthcare providers, with females comprising 61% of participants. The largest age group was 31-41 years (47%), followed by 41-50 years (34%). Nurses represented the majority of participants (91%), while physicians comprised only 5% of the sample. Nearly half of participants (47%) had more than 10 years of clinical experience, with 22% having 6-10 years and 27% having 1-5 years of experience (Table 1).

Only 3% of participants reported having formal PICC procedure certification, indicating a critical training gap across all clinical departments.

While 73% of participants correctly identified PICCs as appropriate for long-term intravenous therapy, notable knowledge gaps were observed in several key areas. Only 54% correctly understood anatomical placement, including insertion sites and tip positioning, while 46% demonstrated inadequate knowledge. Misconceptions regarding contraindications were common, with 41% incorrectly identifying tattoos as a contraindication. Most participants (81%) correctly recognized the need for post-insertion chest X-ray verification, whereas only 59% understood that PICCs can remain in place for weeks to months. Clinical applications were better understood, with 88% correctly identifying appropriate uses such as chemotherapy, antibiotics, and total parenteral nutrition.

Hand hygiene awareness was excellent, with 97% of participants recognizing its importance in infection prevention. However, notable gaps in infection control knowledge were observed. Over half of participants (53%) incorrectly believed that aseptic technique was required only during PICC procedure. Awareness of personal protective equipment was higher, with 87% correctly identifying the need for sterile gloves, gowns, and

Table 2: Knowledge of PICC Line Management Among Participants (N = 100)

Variable	n	Percentage
PICC line certificate		
Yes	3	3%
No	97	97%
PICC line is a form of intravenous access that can be used for a prolonged period of time for administration of substances that should not be done peripherally		
Yes	73	73%
No	14	14%
Don't know	13	13%
PICC lines are used as intermediate-term venous catheters, which can be inserted in deep arm veins (cephalic, brachial, or basilic) with the tip positioned at the junction of the right atrium and superior vena cava		
Yes	54	54%
No	22	22%
Don't know	24	24%
Environmental sanitation influences the risk of PICC line infection		
Yes	79	79%
No	14	14%
Don't know	7	7%
Hand hygiene before PICC line insertion prevents infections		
Yes	97	97%
No	1	1%
Don't know	2	2%
Maintaining aseptic technique only during PICC line insertion helps to prevent infection		
Yes	53	53%
No	44	44%
Don't know	3	3%
Wearing sterile gloves, gown, and mask during PICC line insertion is advisable		
Yes	87	87%
No	4	4%
Don't know	9	9%
PICC line should be flushed only with Normal Saline and after use		
Yes	77	77%
No	16	16%
Don't know	7	7%
The portable ultrasound probe system is not necessary before PICC placement as the most appropriate vein is well localized		
True	30	30%
False	70	70%
During patient assessment, when would you decide to remove the PICC before the expected removal date?		
When it is patent	4	4%
Rough edges	26	26%
When there is a sign of contamination	91	91%
When it is increasing in length	33	33%
If the catheter appears infected, do all except which one of the following?		
Swab discharge and send for culture and sensitivity	14	14%
Send catheter tip for culture and sensitivity	17	17%
Notify the IVR (Interactive Voice Response)	15	15%
Leave the site open to air to assist drainage	54	54%

masks. Concerningly, 54% reported they would inappropriately leave infected sites exposed to air. Understanding of PICC maintenance protocols was mixed. Most participants (77%) correctly identified the normal saline flushing requirements. Knowledge regarding minimum syringe volumes for flushing varied, with 39% selecting 2 mL, 29% selecting 5 mL, and 24% selecting 10 mL. Conversely, 91% correctly recognized signs of contamination as indications for PICC removal.

DISCUSSION

This study assessed the knowledge and practices of healthcare providers regarding PICC procedures at KFHR. Although participants demonstrated good overall awareness of PICC indications, clinical applications, and the importance of hand hygiene, gaps were observed in critical aspects of PICC care, including anatomical placement, contraindications, maintenance protocols, and infection control practices.

The finding that only 3% of healthcare providers possessed formal PICC certification highlights a gap in structured training and credentialing within the hospital. This deficit is particularly concerning given that 91% of participants were nurses, who often serve as the primary providers responsible for PICC procedures and maintenance in established programs [16,17]. International standards recommend that exclusively certified practitioners who have completed comprehensive training, including didactic instruction, supervised clinical practice, and competency validation, perform PICC procedures.

The absence of formal training likely underlies the knowledge gaps observed across multiple domains. Evidence from developed healthcare systems indicates that structured PICC education programs significantly enhance provider knowledge, reduce complication rates, and improve patient outcomes [18,19]. Implementing mandatory certification requirements represents a critical first step toward the establishment and integration of PICC procedures at KFHR.

While 73% of participants correctly recognized the role of PICCs in long-term therapy, substantial knowledge gaps in technical aspects underscore the critical need for targeted training. Notably, 46% of participants lacked understanding of proper anatomical placement, a concerning deficit given that incorrect tip positioning increases the risk of complications such as cardiac arrhythmias, vessel perforation, and thrombosis [7,20]. Additionally, 41% of participants erroneously identified tattoos as a contraindication to PICC insertion, reflecting outdated beliefs that could unnecessarily limit access for eligible patients. Current evidence indicates that tattoos do not increase PICC-related complications when proper insertion techniques are applied [4,21].

Implementing peripherally inserted central catheters (PICCs) is essential in settings where conventional peripheral intravenous (IV) access is frequently challenging. Difficult peripheral access can lead to multiple failed attempts, increased patient discomfort, delays in treatment, and higher risks of complications such as infiltration, phlebitis, and infection [22,23]. Studies have reported that repeated unsuccessful peripheral line placements contribute to treatment interruptions and can compromise patient outcomes, particularly in critically ill patients and neonates. By providing a more reliable and durable vascular access option, PICCs can reduce the frequency of failed insertions, minimize procedural complications, and improve continuity of care [2,24]. Integrating PICC procedures into routine practice at King Faisal Hospital Rwanda could therefore enhance both patient safety and clinical efficiency, while reducing the burden on healthcare providers who frequently encounter challenges with conventional peripheral lines.

Leading healthcare organizations recommend that PICC programs include dedicated insertion teams, standardized protocols, regular competency assessments, and continuous quality improvement initiatives [25,26]. The absence of these components at KFHR points to the need for integrating established practice standards.

Studies from similar healthcare settings in sub-Saharan Africa have identified comparable challenges, including inadequate training, resource limitations, and absence of standardized protocols [27,28]. However, successful PICC program implementation in resource-constrained environments demonstrates that these barriers can be overcome through targeted interventions and institutional commitment [29].

Developing a comprehensive PICC program at KFHR will require a multifaceted approach that addresses training, equipment, protocols, and quality assurance. A structured training curriculum should be established, covering anatomy, insertion

techniques, maintenance procedures, and the management of complications. Competency-based certification, with regular reassessment, will ensure that staff maintain the necessary skills over time. Evidence-based protocols for PICC procedure, maintenance, and removal should be standardized across the facility. Essential equipment, including ultrasound guidance systems, insertion kits, and maintenance supplies, must be procured to support safe and effective practice. Finally, a robust quality improvement framework should be implemented, incorporating outcome monitoring and continuous improvement processes to enhance patient safety and program effectiveness.

Several limitations should be considered when interpreting these findings. The single-center design limits generalizability to other Rwandan healthcare facilities. The purposive sampling approach may have introduced selection bias, although efforts were made to include representatives from all relevant clinical areas. The cross-sectional design provides a snapshot of current knowledge and practices but cannot establish temporal relationships or assess changes over time.

Additionally, the questionnaire-based assessment of knowledge may not fully reflect actual clinical competency, as practical skills assessment was not performed. Future studies should incorporate simulation-based evaluations and direct observation of clinical practices to provide more comprehensive competency assessments [30].

CONCLUSION

This study has provided the baseline data and highlighted the importance of enhancing knowledge and standardizing clinical practices related to the PICC procedure at KFHR. Establishing a structured PICC program provides an opportunity to strengthen vascular access services, improve patient safety, and ensure consistent care for individuals requiring long-term or complex intravenous therapies. With appropriate systems in place, KFHR can serve as a model for best practice in advanced vascular access both nationally and across the region.

Based on this baseline assessment, a comprehensive approach is required. Training and certification programs should be developed to build and maintain staff competency, incorporating simulation-based learning, supervised practice, and periodic refreshers. Standard operating procedures must be introduced to guide aseptic technique, infection prevention, safe flushing practices, and timely catheter removal, supported by targeted education on appropriate use and decision-making. Adequate provision of portable ultrasound machines and dedicated PICC kits will enable safe and efficient procedures, while establishing vascular access support teams and clear escalation pathways will ensure timely interventions in complex cases. Regular audits, outcome monitoring, and structured feedback loops will reinforce quality assurance and drive continuous improvement in practice.

This study provides a foundation for future research initiatives, highlighting several priority areas. Multi-center studies could expand the scope to other Rwandan hospitals to establish national benchmarks and guide policy. Intervention studies should evaluate the effectiveness of training programs and their impact on clinical outcomes. Cost-effectiveness analyses are needed to assess the costs and benefits associated with implementing a PICC program. Patient outcome studies should focus on long-term follow-up, including infection rates, complications, and overall treatment success. Finally, implementation science research can help identify barriers and facilitators to the adoption of the program, guiding strategies for sustainable integration into clinical practice.

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