

## EXPLORING INDIVIDUAL AND ORGANIZATIONAL FACTORS INFLUENCING REGISTERED NURSES IN PREVENTING PERIPHERALLY INSERTED CENTRAL CATHETER RELATED COMPLICATION

Boka Dugassa Tolera\*<sup>1</sup> & Feng Hui<sup>2</sup>

\*<sup>1</sup>BSc in Nursing & MSc. Student in Advanced Nursing Practice, School of Nursing, Addis Ababa University, Addis Ababa, Ethiopia, Xiangya School of Nursing, Central South University, Changsha, China

<sup>2</sup>Associate Professor, Xiangya School of Nursing, Central South University, Changsha, China

### Abstract

#### Keywords:

*Individual, Organizational, Influencing Factor, Peripherally Inserted Central Catheter, Complication, Registered Nurse.*

Peripherally Inserted Central Catheter (PICC) is an essential vascular access device used in clinical practice in the delivery of fluids, medications, blood products, and nutrition. Despite the numerous benefits of PICC, various individual and organizational factors have made it difficult for registered nurses to practice in accordance with standardized nursing guideline developed for PICC insertion and removal. The purpose of this review was to explore factors influencing registered nurse in preventing risks of PICC related complication. The major outcome was generally, reviewed at individual and organizational level. Nurses 'gap in knowledge and skill, poor self – confidence, unfamiliarity with PICC insertion and removal equipment and poor attention to utilization of evidence based clinical guidelines for insertion and removal of PICC were identified as individual factors influencing registered nurses in preventing PICC related complications whereas lack of support from colleague and organizational leaders, lack of adequate resource, lack of continuous training and education were identified as organizational factors influencing registered nurses in preventing PICC risk complication. Throughout, important link between the use of PICC and the risk of PICC related complication were highlighted, Along with a significant individual readiness and organizational support were needed to improve this gap through providing training, creating awareness, and enhancing nurses' abilities in PICC related risk prevention. This can make to further improvement in quality of nursing care for patient with venous access device including PICC device.

### Introduction

Peripherally Inserted Central Catheter (PICC) is a thin and soft flexible tube inserted into the patient's arm that allow for patient to receive medicines and fluids. It is recommended for patients with long term chemotherapy regimens, extended antibiotic therapy, or total parenteral nutrition in all age group [1]. This catheter enters the body through the skin (percutaneous) at a peripheral site, extends to the superior vena cava (a central venous trunk), and stays in place (dwells within the veins) for days or weeks depending on the patients' condition [2, 3]. The Insertion of Peripherally Inserted Central Catheter (PICC) has become a worldwide nursing practice, different from the classical nursing role, offering a high level of skill and independence [4].

Peripherally Inserted Central Catheter (PICC) may have one or two catheter openings. These openings are called "ports" or "lumens." If the PICC has two catheter openings, medication can be given through one opening, for example, while nutrition can be given through the other opening. On another hand, PICC differs from tunneled central venous catheters in that they have a pressure sensitive valve at the internal end which allows fluid to be injected into the catheter and blood to be withdrawn. When not in use the valve remains closed, thus preventing blood from flowing back into the catheter and air entering the venous circulation [5]. Hence, it is suggested that PICC have become an alternative to the traditional central venous catheter [6]

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**Historical back ground of Peripherally Inserted Central Catheter (PICC)**

Historically, It is well documented that Peripherally Inserted Central Catheter (PICC) were introduced into practice in the USA in the 1970s, but only gained popularity in the UK during the 1990s as the important type of venous access device [7, 8]. Since then PICCs were inserted using a breakaway needle and the peel-away method because the catheter was threaded through the opening in the vessel created by the needle. However, in 1989, Goodwin was described the PICC insertion technique which is modified by Seldinger [9]. The modified Seldinger techniques (MST) was a minimally invasive technique in which the practitioner accesses the target vessel with a small bore needle, then dilates to the size required for the catheter.

Traditionally, it was believed that the procedure of PICC insertion is performed by only specially trained physician, usually on an intensive care unit or in the operating theatre [10]. However, currently, due to the advancement in catheter technology and in the knowledge base of professionals in the practice of intravenous therapy, the use of PICC become standard practice for most patients requiring long-term therapy. Consequently, the use of the PICC in the hospital environment is expanding and nursing has a fundamental role in its insertion, maintenance and removal [11]. In 2009, the Infusion Nurses Society (INS) recommended that a qualified RN, who is proficient in infusion therapy and who has been appropriately trained for the procedure, may insert, maintain, and remove intraosseous access devices [12]. Therefore, currently, many trained nurses can provide the PICC service for patient [13]. For example, a study from United Kingdom reported that the nurse-led Peripherally Inserted Central Catheter (PICC) services are becoming common place provided for any age group patient with acute and chronic disease [14, 15].

Similarly, this service is provided by many trained nurses in Asian countries like Korea [2], India [16] and China [17]. However, to the author's knowledge, the level of utilizing and providing Peripherally Inserted Central Venous Catheter (PICC) services among nurses in African countries is not well documented. This may be due to lack of awareness of PICC procedure or lack of resource including a well-trained nurses. Hence, the advantage and disadvantage of these device is not widely known in many African countries.

**Advantages of Peripherally Inserted Central Catheter (PICC)**

A PICC has a numerous advantage: it is essential device used for patients with advanced disease or those undergoing intensive systemic therapy [18]. It allows infusion of solutions with extremes of pH and osmolality, vesicant or irritant drugs and total parenteral nutrition [1, 19, 20]. It is used when technicians need blood samples drawn or transfusions frequently and also when the service providers need an IV site more than once a week. The service can be provided when the patient need IV medications at home. Thus, it is suggested that PICCs are reliable devices for a wide variety of intravenous infusions [2, 21]. It is a well-recognized, safe, cost-effective, and less invasive mode for dependable venous access in both short-term and alternative as compared with multiple peripheral intravenous catheter type [22-24]. Especially, the cost effectiveness of peripherally inserted central catheter (PICC) is associated with a type of service provider: i.e. a dedicated team of clinicians who have responsibility for insertion and removal of peripherally inserted central catheter [25].

Another advantages of peripherally inserted central catheter (PICC) is its introduction at the bedside or at outpatient PICC clinic which can be inserted by qualified nurses [26, 27]. A minimal pain has reported at the time of insertion and removal from its placement [21]. Even the majority of patients would recommended the proactive PICC insertion to other patients as it made the whole process much easier and safe [28, 29]. Because PICC is easily inserted through peripheral veins, such as the basilic or cephalic veins, leaving the tip residing in the superior vena cava- a larger vein above the heart [2, 29]. The insertion is accomplished by cannulating a peripheral vein with a metal or plastic needle and then introducing the small gauge catheter through the needle. However, inappropriate insertion or placement of these lines carries a significant risk for serious complications. It can lead to increased morbidity, suffering, and sometimes, even a fatal outcome [30, 31].

**PICC related Complications**

Despite their advantages, there are a numerous identified potential problems associated with inappropriate PICCs service provided by nurses. For example several study have shown that PICCs have risks of complications like bad

positioning of catheter, venous thrombosis, phlebitis, hemorrhage, arrhythmia, bacteremia, nerve and tendons damage chest pain and occlusion[3, 17, 23, 32-34]. Unexpectedly removal of venous access device is associated with all of these adverse events (catheter-related blood stream infection, deep vein thrombosis, occlusion, pain, infiltration, bleeding, phlebitis, catheter leakage and dislodgement)[35]. Particularly, the risk of inflammation of vein (phlebitis) is one of the most frequently reported complication associated with inappropriate procedures of PICC service by nurses [17, 36-38].

Currently, there are several methods proposed to reduce the risk of phlebitis related with PICC complication. For example Ong, C.K., et al, (2010) suggested that utilization of polyurethane PICCs can reduce the risk of phlebitis related with PICCs service[39]. In addition, Nichols, I. and J.P. Humphrey (2008) suggested that utilization of catheter arterial can reduce the complications rates by using more than one needle[24]. Inserting clinicians and advance-level nurses have a responsibility to reduce the incidence of this complication and improve outcomes following PICC insertion. Not only reducing the complication of phlebitis but also nurses have a responsibility to reduce any complication related with PICC service. It is suggested that advanced-level nurses have a responsibility to reduce the incidence of venous thromboembolism associated with PICC procedure[40]. For example a recent study suggested that utilization of appropriate catheter size to vein ratio can reduce the risk of Venous thromboembolism[41].

Additionally, a recent study conducted by Blotte, C., et al. (2017) compared the complications between Broviacs® and PICCs in children with intestinal failure. The researcher reported that although central venous thrombosis associated with PICCs is fewer than Broviacs®, both of them had almost similar complication rates: including infection, breakage and occlusion[42]. Besides, several patient, provider, and device characteristics appear associated with PICC occlusion. For example according to Smith, S.N., et al. (2017), catheter tip malposition and utilization of double- and triple-lumen PICCs were associated with greater incidences of occlusion[43, 44]. Thus, the occlusion of a PICC and damage to its corresponding vein can develop another complication, including potential failure of future arteriovenous grafts or fistulae in patients with chronic kidney disease, ultimately requiring dialysis [45]. In addition, the occurrence of occlusion has negative impact on the economy of patient. Because it may need additional payment from patient for replacement [46].

In general, although, PICCs are commonly used to provide a reliable infusion route for infusion therapy of all types, they can put patients at many risk for complications. Hence, the use of PICCs in skilled nursing facilities is not without inherent problems. The challenge of nurses in preventing Peripherally Inserted Central Catheters (PICCs) related complication is generally identified at two level. i.e at individual and organizational level.

### **Individual factors influencing registered nurses in preventing PICC related complication**

Despite the expected benefits of Peripherally Inserted Central Catheters (PICC), various individual factors have made it difficult for nurses to provide this practice. Nurse 'gap in knowledge and skill, poor self – confidence, unfamiliarity with PICC insertion and removal equipment and poor attention to utilization of evidence based clinical guidelines for insertion and removal of PICC are some identified individual factors influencing registered nurses in preventing PICC related complications.

#### **Nurses' gap in knowledge, skill and self-confidence**

Although PICC frontline registered nurse are expected to have a developed an expert knowledge base, complex decision- making skills and clinical competencies for expanded practice. Several researchers have reported that nurses have little knowledge of and poor skills in providing Peripherally Inserted Central Catheters (PICC) Service. For example, the pilot study conducted by Chopra, V., et al (2015) was identified the gap in knowledge of and practice of nurse in providing Peripherally Inserted Central Catheters service [44]. Even the insertion of Peripherally Inserted Central Catheters (PICC) was found to be associated with increased stress in nurses [47]. Due to variability in nurses' experiences, practice, opinions, and knowledge related to PICC use, several errors have occurred at any stage of PICC procedure from inserting to removal [1, 32, 48, 49]. Similarly, incorrect or inadequate documentation, lack of flushing orders, and unclean/non intact dressings were observed among nurse[50, 51]. Besides, it was reported that only a few number of nurses had adequate knowledge about initial location of the catheter tip[52].

Additionally, abnormal extubation of PICC was reported as a negative experience and procedures performed by nurses[32]

According to the recommendation of Infusion Nurses Society(INS), a trained nurses are expected to identify all indications and contraindication beforeconducting the procedures of PICCs[53]. Similarly, The Centers for Disease Control and Prevention (CDC) recommended that all clinicians including nurse who have a responsibility to Provide PICC service should be familiar with the indication and contra indication of venous access device. In addition, it was suggested that the IV site should be selected on the basis of intended purpose, planned duration of use, known infectious and noninfectious complications, and experience of the IV access inserter[54]. However, study has shown that nurses lacked the knowledge of indication and contraindication of PICC service[55]. In addition, Renata Rangel Birindiba de Souza, et al (2016) reported the poor knowledge of nurses regarding to the insertion, maintenance and removal of the catheter in newborn infants[56]. On another hand, unfamiliarity with equipment use for PICC is reported as a challenge of nurses in providing PICC service[49]. A lack of knowledge, poor self- confidence and poor skill in providing PICC service can have a negative impact on quality of patient care.

### **Lack of attention to utilization of evidence based clinical guidelines for insertion and removal of PICC**

Translating evidence into practice while implementing, planning and caring for patients is a core competency of nurse practitioners in all health care organization. For example currently, several individual and organizational evidence based guideline are proposed for insertion and removal of PICC [57-62]. This evidence based clinical practice guidelines for insertion and removal of PICC are designed to improve quality of care, reduce variation in practice and ensure evidence based care in delivery of health care service. Especially advanced practice providers have the expertise to guide the process change necessary to bring clinical practice guidelines to the bedside to improve the health, quality and safety of patients.

Althoughutilization of evidence-based clinical guideline had a significant improvement in both nurses' knowledge and skill in flushing central venous access device[63], a gap between utilization of evidence based clinical guideline in providing peripherally inserted central catheter among nurses was frequently reported[1, 26, 64]. On other hand, wide practice variationwas reported with inconsistent adherence to recommendations [65]. Similarly Mingorance, P., et al.,(2014) suggested the elaboration of a clinical guideline for professionals who manipulate the PICC[66]. Because, the insertion techniques, and maintenance processes is not provided in accordance of national PICC insertion guide line [1, 56].

Additionally, Ullman, A.J., D.A. Long, and C.M. Rickard (2014) have reported the gap in knowledge and practice of utilizing evidence-based catheter- related blood stream Infection prevention among pediatric intensive care nursing staff[65]. This indicates that the perception and attention of nurses for using clinical practice guidelines for insertion and removal of PICC is still poor. However, according to Ober, S. and G. Craven (2012), the RN will assume only those duties and responsibilities within RN scope of practice and for which the RN has acquired and maintained necessary knowledge, skills and abilities to competently insert, manage and remove a PICC in accordance with accepted professional standards[61]. However, deviation from using clinical guide line was readily reported during performing any type of procedure, for example during venous blood collection among nurse[67].

The safety of peripherally inserted central catheter can be maximized and complications reduced when nurses strictly use the PICC operating guidelines, detect complications early, and manage problems promptly [61, 68]. Therefore, to ensure patient safety, it is important that nursing practitioners inserting these devices maintain up-to-date knowledge and evidence-based practice guideline. This should ultimately reduce complication and risk, however clinical practice guidelines, which are designed to encourage consistent, efficient applications of scientific evidence in the daily practice of nurses' who have responsibility to provide PICC service are often underutilized. In another word, despite the creation of PICC guidelines at national and international levels, guidelines are underutilized by nurses at the bedside to improve patient care. It is said that lack of attention to utilization of evidence based clinical guide line is a risky for health of patients'[69-71].

### **Organizational factors influencing registered nurses in preventing peripherally inserted central catheter (PICC) related complication.**

Several research literature reveals that there are a numerous organizational factors influencing registered nurses in preventing peripherally inserted central catheter (PICC) related complications: For example. Lack of support from colleague and organizational leaders, lack of adequate resource and lack of continuous training and education are identified as organizational factors influencing registered nurses in peripherally inserted central catheter related complication prevention.

### **Lack of support from Colleague and Organizational Leaders**

Nurses recognize that professional health care must be based on evidence obtained from daily work - both originated by their colleagues and by themselves. However, it is reported that nurses have perceived a lack of support from their colleagues and leaders' of health institution[72]. Lack of strong inter-professional collaboration results inappropriate provision and utilization of peripherally inserted central catheter (PICCs). For example Krein, S.L., et al. (2017) has examined relationship between perceived role and appropriate use of peripherally inserted central catheters among nursing professionals. They reported the reason for inappropriate insertion of PICCs is lack of strong inter-professional collaboration [49]

It is believed that nurses who have a responsibly to provide PICCs across a range of practice settings are a critical link in providing continuity and coordination of care. Dedicated vascular access nursing teams have, historically, been limited to peripheral cannulation with some teams having the ability to insert peripherally inserted central catheters[73]. Similarly, Zargham-Boroujeni, A., et al(2013), discovered the barriers to spread the usage of peripherally inserted central venous catheters in the neonatal intensive care unit as alack of team sprit anddisagreement between nurses and physicians were reported[74].As reported, many time was wasted, and extra cost was paid for PICCs service. Similarly, Harrod, M., et al(2016) deficiencies in communication between hospitals and nurses with respect to device care, date of last dressing change, and PICC removal time[51]. In general lack of support from colleagues and leaders of work organization (work environment) can increase the chance of many complication related with PICC service. Especially, Poor communication between staff nurse and lack of organizational support can increase the risk of Peripherally Inserted Central Catheter related complication.

### **Lack of adequate Resource**

Before selecting a blood vessel for vascular access, the Infusion Nurses Society (INS) recommendsthe necessity of available resources to care for an IV devices[53]. Because the availability of adequate resource is one of the best requirement for provision of advanced procedure. In addition, it has great impact on providing quality of patient care. However, lack of adequate resource is identified as the main challenge of nurses in providing PICCs service [1, 51]. As reported PICCs were not tracked at the organizational level because of the absence of formal list or document on PICC. In addition, infrequent consideration of the device was reported when assigning frontline nurses [51].In fact nurses can face several challenge in provision of patient care. For example, Vorderstrasse, A.A., M.J. Hammer, and J.R. Dungan,(2014) stated that “nurses face increasing challenges and opportunities in communication, support, and advocacy for patients given the availability of advanced testing, care and treatment in personalized and precision medicine”[75]

Additionally, poor access to utilization of up-dated information (current evidence) in providing peripherally inserted central catheter (PICC) is identified as challenge for nurses [1, 44]. Similarly, a study conducted by Piorkowska, M., Z. Al-Raweshidy, and K. Yeong (2013) reported that lack of information sheets in the patient notes is a challenge for nurses in providing peripherally inserted central catheter [76]. Furthermore, a recent study conducted by Harrod, M., et al. (2016) reported a lack of well-organized information resource among nurses as main challenges in preventing peripherally inserted central catheter associated complication[51]. In general, lack of resource was identified as the main organizational factors influencing nurses in providing PICC related service.

### **Lack of Continuous Training and Education**

Currently, it is clear that the role of infusion nurse is constantly changing and becoming more complex as new technologies arise and patient safety and infection prevention mandates improve care. Thus, many vascular access team nurses have faced a several challenge in providing care for patient. For example Meyer, B.M. (2012) stated that “the vascular access team nurses have faced rapidly changing technology, challenging ergonomic issues, and the need for careful scrutiny for infection and quality control” [77]. Hence, it is suggested that training and education of

nursing and medical staff is a crucial factor in reducing the rate of complications in PICC insertion [2]. In addition, education can improve awareness of guidelines amongst staff improving patient outcomes and reducing costs [76]. Because through teaching, the basics of safe intravenous care can be consistently understood and applied, and competency assessed.

Hence, establishing consistent, simple and clear health education on the care and maintenance of intravenous devices is needed to reduce variation in providing PICC service [78]. Based on this, many researchers have suggested the advantages of training clinicians including nurses to improve the standardized practice of central venous cannulation insertion including peripherally inserted catheter [73, 76, 79]. Similarly, Renata Rangel Birindiba de Souza, et al (2016) suggested the necessity of standardized and professional based training for nurses to provide a quality care for infants with peripherally inserted central catheter [56]. Besides, it was suggested that several theoretical-based educational intervention can improve nurses' knowledge, self-efficacy, and skills in reducing PICC related complications [80]. Moreover, Sharpe, E.L., (2014) concluded that provision of education and annual retraining can prevent PICC-related complications [81].

Although continuous professional training and education can reduce the variation in providing venous access device, several study reported that peripherally inserted central catheter (PICC) care was identified as a challenging area for the nursing workforce in both acute care and community services. Especially lack of continues training and education on PICC inserters were identified as a challenge for PICC inserting nursing team to facilitate the integration of care [76, 82]. Moreover, Roslien, J. and L. Alcock (2009) stated that "even though care and troubleshooting of peripherally inserted central catheters are essential practices of all bedside nurses, PICC education has not been encouraged for nurses [83].

Research has shown that there are numerous nursing practice discrepancies in providing venous access device including PICC service. For example, Russell, E., et al (2014) observed several suboptimal outcomes among nurse. Particularly, incidences of local site complications, incorrect or inadequate documentation, lack of flushing orders, and unclean/non intact dressings were observed among nurse who have responsibility to provide PICC service [50]. All of these observed discrepancy among nurses are related with lack of continues training and education. Similarly, Harrod, M., et al. (2016) have reported a gap in training and education as barriers to practicing PICCs service among nurses [51].

It is clear that majority of registered nurses did not trained the insertion and removal of peripherally inserted catheter (PICC). Thus, a large number of registered nurses do not have insertion license. For instance, Belo, M.P., et al (2012) found that nearly 65% of nurses did not have license for insertion of the PICC [52]. Consequently, only a few number of nurses (8.3%) had adequate knowledge about initial location of the catheter tip. Hence, the researchers recommended the necessity of incentives to train nurses to use the PICC [52]. Because, it is recommended that a centrally based service with specifically trained operators can be beneficial by potentially improving patient safety and promoting organizational efficiencies [84]. However, a gap in training among nurses on central venous cannulation were reported in many literatures [73]. Lack of training and education have a negative impact in providing quality health care.

## Conclusion

This review has demonstrated the link between individual and organizational factors influencing registered nurses in preventing PICCs related complications. A quantitative and qualitative studies conducted to identify individual and organizational factors influencing registered nurses in preventing PICCs related complications were included. Although a PICC frontline registered nurses are expected to have a developed an expert knowledge base, complex decision-making skills and clinical competencies in preventing PICCs related complication, there were identified several individual and organizational factors influencing registered nurses in preventing PICC related complication. Nurse gap in knowledge and skill, poor self-confidence, unfamiliarity with PICC insertion and removal equipment and poor attention to utilization of evidence based clinical guidelines for insertion and removal of PICC are identified at individual factors influencing registered nurses in preventing PICC related complications whereas lack of support from colleague and organizational leaders, lack of adequate resource, lack of continuous training and education are identified as organizational factors influencing registered nurses in preventing risk of

PICC related complication. Therefore, it is recommended that individual readiness and organizational support were needed to improve this gap through providing training, creating awareness, and enhancing nurses' abilities in providing PICC related risk prevention.

### Summary

- Peripherally Inserted Central Catheter (PICC) has a pivotal importance in a variety of disease states and in a variety of clinical settings (emergency, intensive care, surgery) and for different purposes (fluids or drugs infusions, parenteral nutrition, antibiotic therapy, hemodynamic monitoring, and procedures of dialysis).
- Although the technological advancement of PICC procedure is vital to offer distinct advantages for safer delivery of nutrition and medications for all age groups, there were identified several risk factors associated with PICC procedures.
- Infusion nurses are expected to have a developed an expert knowledge base, complex decision- making skills and clinical competencies in preventing risk of PICC related complication. However, the role of individual and organizational factors were influenced nurses in providing PICC related complication prevention.
- Creating awareness on appropriate utilization of venous access device for both infusion nurse and organizational manager has a significant outcome on quality of health care service

### Future Issue

- How can all healthcare organization have similar guideline for insertion and removal of PICC?
- Which clinical guide lines is most appropriate for nurses to prevent risks of PICC related complication?
- How do nurses can easily use evidence based clinical practice guidelines?
- What are the influence of individual patient on nurses in preventing risk of PICC related complication?

In what condition PICC service can be provided at Rural or Community health Center?

### Methods

This a preliminary explorative review on individual and organizational factors influencing registered nurses in preventing PICC related complication was highlighted for further development and advancement of Peripherally Inserted Central Catheter (PICC) related services provided by advanced and well trained nurse in skilled nursing facilities.

### Objectives

The general objective of this literature review was to explore the individual and organizational factors influencing a frontline registered nurses in preventing PICC related complication.

The specific objectives of this literature review were to:

1. Review factors related to individual nurses in prevention of PICC related risk complications.
2. Review organizational factors influencing register nurses in preventing PICC related risk complication.

### Search strategy

Literature searching was done by reviewing an article's reference citations by using Endnote and also investigating articles that were noted to have cited the primary and secondary article of interest. During the literature review process, we tried to focus on the global and local influences of individual and organizational factors influencing registered nurses in preventing PICC related risk of complications. Iteratively, a broader literature review was then performed to review the individual and organizational factors influencing registered nurses in preventing PICC related complications

Available literature was searched to place the current study in the context of previous studies in related fields. The review related literature supporting the individual and organizational factor influencing nursing professionals in preventing PICC related risk complications were deeply searched. Electronic sources, journal articles, books and policy documents on individual and organizational factor influencing nurses in PICC related complication were used in the review of these literature.

Searching the library databases that were utilized included Ovid MEDLINE, CINAHL, Scopus, Cochrane library, and Google Scholar. Key words and phrases used to search the literature included: (a) individual (b) organizational (c) Influencing factors (d) Peripherally Inserted Central Catheter (e) Complication (f) Nurses.

### Inclusion and Exclusion Criteria

In this review, the inclusion and inclusion criteria were describe as follows:

- (1) The inclusion criteria were limited to publications in English language
- (2) Studies that explored the individual and organizational factors influencing nurses for prevention of PICC related complication,
- (3) Studies measuring the practice of nurses' readiness for Insertion and removal of Peripherally Inserted Central Catheter i.e., their knowledge, attitudes, beliefs, and skills, including information literacy and other related to Peripherally Inserted Central Catheter (PICC) service,
- (4) Studies related to evaluating the impact of various interventions (including theoretical and practical intervention) designed to promote practicing nurses' readiness for inserting and removal of PICC,
- (5) Studies reporting on both primary and secondary empirical research studies in PICC service among nursing professionals,
- (6) Both quantitative and qualitative studies conducted to identify individual and organizational factors influencing registered nurses in preventing PICCs related complications were included. Whereas the exclusion criteria includes:
  - Studies not focusing on individual and organizational challenges of nurses in preventing PICC related complications ,
  - Studies reporting on PICC relatedquestionnaire development, testing, or validation.
  - Information from unpublished research thesis and dissertations.

### Disclosure of the statement

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

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