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The Nurse's Role in Managing PICC-Related Complications: Prevention and Best Practices

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ABSTRACT

Peripherally inserted central catheters (PICCs) have become essential for providing long-term central venous access in critically ill patients. Despite their advantages, PICCs are associated with complications such as infections, venous thrombosis, and mechanical failures. This review aims to provide a comprehensive overview of PICC-

related complications and prevention strategies to guide best practices in critical care settings. Patient factors, including comorbidities and catheter tip position, influence complication rates. Catheter selection, with a preference for smaller diameters and polyurethane materials, can mitigate risks. Strict adherence to sterile techniques, use of 2% chlorhexidine gluconate for skin antisepsis, and compliance with evidence-based guidelines are crucial for infection prevention. Ultrasound guidance during insertion and confirmation of tip placement in the distal superior vena cava can reduce thrombosis and mechanical complications. Innovations like the SecurAcath securement device help prevent catheter migration. The evolving role of PICC nurses necessitates ongoing education and practical training to effectively manage complications. Establishing standardized protocols, promoting multidisciplinary collaboration, and encouraging further research are essential for enhancing PICC care. Future studies should focus on evaluating preventive strategies and clinical outcomes in critically ill populations to advance evidence-based practices, ultimately improving patient outcomes and reducing healthcare costs associated with PICC-related complications.

KEYWORDS: Peripherally Inserted Central Catheters, PICCs, Nurse

1. Introduction

Since their introduction in the 1980s, peripherally inserted central catheters (PICCs) have become widely used to facilitate vascular access. Critically ill patients are at a heightened risk of potentially life-threatening complications, making PICCs an essential tool in their care. PICCs provide central venous access for administering antibiotics and chemotherapeutic agents during prolonged intravenous drug therapy (Baxi et al., 2013). Each year, more than 2.5 million PICCs are placed globally in acute care settings, with approximately 5 million insertions occurring in the United States alone. PICCs have proven to be particularly valuable for critically ill adults and children, offering long-term intravenous access and several advantages, such as ease of insertion, a short procedure time, relatively low complication rates, dependable intravenous (IV) access, and high patient satisfaction (Liem et al., 2012).

Despite these benefits, studies have highlighted an increased risk of PICC-related complications, including venous thrombosis, catheter-related bloodstream infections (CRBSIs), and mechanical failures such as PICC migration, fracture, and obstruction (Barrier et al., 2012; Chopra et al., 2012). Among these complications, infections are frequently reported as the most prevalent and severe, with incidence rates ranging from 16.4% to 28.8%. Similarly, PICC-related thrombosis is a significant concern, particularly among critically ill patients, where it is identified as the second most common complication. One study found that the prevalence of PICC-associated venous thrombosis in critically ill individuals ranges between 13% and 91%. Furthermore, oncology patients experience an overall increase in complication rates, varying from 35% to 65%. Mechanical complications related to PICCs have also been reported, with incidence rates ranging from 0% to 48%.

The persistence of PICC-related complications remains a pressing issue. Numerous studies have investigated measures to mitigate these risks. To minimize

complications, PICC teams must tailor interventions to individual patients. Standard precautions, such as adhering to sterile techniques, thoroughly disinfecting the puncture site, handwashing before catheter handling, and reducing unnecessary catheter manipulations, can help prevent catheter-related bloodstream infections. A retrospective study also highlighted the importance of confirming the PICC tip position in the distal third of the superior vena cava (SVC) using post-procedure chest X-rays or ultrasound (US)-guided placement. This approach significantly reduces the incidence of upper extremity deep vein thrombosis (UEDVT), with rates reported to decline from 4.8% to 2.9% (Fallouh et al., 2015).

Reviewing current scientific evidence regarding PICC complications and prevention strategies is crucial to equipping nurses and caregivers with the knowledge necessary to implement best practices. This, in turn, enhances patient satisfaction and quality of life throughout treatment. However, despite the available research, scientific evidence on general measures to prevent PICC complications remains limited. Therefore, this study aims to address these knowledge gaps by providing a comprehensive review of the literature on PICC-related complications and the associated prevention strategies, ultimately contributing to improved patient outcomes, reduced healthcare costs, and lower rates of PICC-associated complications.

Current PICC Application Situation

At present, PICC insertion is performed using aseptic techniques by a specialized team comprising trained nurses and physicians, typically in a dedicated sterile ward (Liu et al., 2015). The catheter length is measured from the insertion site to the midpoint of the sternum or the xiphoid process, depending on the targeted vein. The procedure involves blind cannulation or insertion without ultrasound (US) guidance, with subsequent confirmation of the catheter tip position through radiographic imaging (Ozkiraz et al., 2013). However, portable US is increasingly utilized before PICC placement to identify suitable veins for insertion, while chest radiography is conducted to confirm the catheter tip's placement in the distal third of the superior vena cava (SVC) (Stokowski et al., 2009).

The catheter insertion site is secured using a suture-free technique, which has been shown to significantly reduce dislodgment and unplanned removal compared to tape securement. The site is then dressed in chlorhexidine-impregnated transparent films. Additionally, the catheter is flushed with 10 ml of normal saline (NS) immediately after placement, after each use, and once a week when not in use. However, the practice of using NS for flushing and locking is not universally adopted. For instance, Chinese PICC nurses traditionally prefer heparin saline (HS) for routine catheter flushing and locking in daily nursing care (R. Wang et al., 2015).

PICC size selection depends on the vein diameter, with 4F catheters commonly used, while 5F catheters are reserved for patients requiring total parenteral nutrition (TPN). For hospitalized patients, dressings should be changed every seven days or as needed if drainage, bleeding, or moisture is observed. Polyurethane PICCs are increasingly favored due to their high flexibility, robust wall strength, compatibility with small catheter sizes, and ability to accommodate high flow rates with minimal rupture risk.

Currently, polyurethane PICCs dominate the market, constituting 70% of all PICCs manufactured in the United States, with projections suggesting an increase to 95% by 2017, rendering silicone catheters nearly obsolete (Seckold et al., 2015).

PICC Procedure Pathway

Establishing standardized procedures for PICC insertion is critical to ensuring best nursing practices and promoting patient safety and well-being. The following steps outline the fundamental practices to guide the development of specific protocols, policies, and procedures:

1. The purpose of the procedure must be explained to the patient and their family members before initiating the process.

2. The procedure and equipment arrangement should be performed by a team of trained personnel, which may include a specialized nurse, anesthesiologist, and interventional radiologist, depending on hospital policy. The procedure may occur bedside, in an operating room, or a sterile area (Fairhall, 2008).

3. The skin at the insertion site must be prepared with chlorhexidine solution, and the surrounding area should be covered with sterile drapes to minimize infection risk. Hand hygiene, sterile gloves, masks, and gowns are mandatory for care providers.

4. A tourniquet should be placed just below the shoulder, and sterile gel applied to the site of expected cannulation. Suitable veins for venipuncture should be identified using US guidance to improve success rates.

5. Lidocaine 1% should be injected intradermally under sterile conditions. A thin needle must then be systematically inserted into the vein using US guidance, and the needle insertion site should be enlarged with a scalpel blade to facilitate guide-wire introduction. Blood return confirmation requires loosening the tourniquet before the needle is removed, after which the PICC line is inserted over the guidewire to the SVC.

6. The guidewire must be withdrawn, and an injection cap attached to the catheter hub.

7. Blood return should be checked, and the catheter flushed with NS. The catheter tip’s position in the distal third of the SVC must be verified using chest radiography.

8. The catheter insertion site should be secured using a suture-free technique and dressed in chlorhexidine-impregnated transparent films.

Post-operative care is essential to maintaining PICC patency and preventing complications. Adherence to hand hygiene and aseptic techniques is crucial during dressing changes, administration of intravenous medications, and the replacement of soiled dressings at regular intervals (Amerasekera et al., 2009).

Finally, proper documentation and communication are vital for monitoring patient conditions, progress, and ensuring coordinated care. This helps reduce the risk of PICC-associated complications and supports effective patient management.

5. Complications

5.1. Factors Associated with Complications

5.1.1. Patient Status

Critically ill, bedridden patients for more than 72 hours often exhibit elevated D-dimer levels and comorbidities, which are primary contributors to PICC-related venous thrombosis. Research has demonstrated that patients whose PICC tips are positioned outside the superior vena cava (SVC) are at an increased risk of venous thrombosis. Additionally, patients receiving erythropoietin-stimulating agents or specific chemotherapeutic infusions, such as fluorouracil and capecitabine, are at higher risk of developing PICC-associated deep vein thrombosis (DVT). Immunocompromised patients are also predisposed to catheter-related infections. Following successful placement, factors such as abnormal movements, elevated intracranial pressure, severe nausea, vomiting, hiccups, and constipation can cause catheter tip malpositioning. Barrier et al. observed that patients with PICC durations of fewer than 14 days who received more than four doses of antimicrobials daily had higher rates of complications (Barrier et al., 2012).

5.1.2. Vein Selection

The insertion of a catheter into smaller veins in the upper extremity results in decreased blood flow compared to central veins, which is a plausible explanation for the increased incidence of PICC-related thrombosis. Although catheter placement in the azygous vein is uncommon, it is considered an alternative in patients with severe venous occlusion. However, this vein is particularly susceptible to complications. Placement in small vessels (6–8 mm in diameter) increases the risk of thrombus formation, vessel stenosis, aperture, and extravasation. Consequently, inserting the PICC line in areas other than the arm (e.g., chest, groin, or neck) is associated with a heightened risk of infection, as the arm is located further from the mouth and nose, where fewer organisms are present (Evans et al., 2007; Fairhall, 2008).

5.1.3. Catheter Choice

The material of the PICC line influences infection risk. Silicone catheters have a higher likelihood of infection and microorganism colonization compared to polyurethane catheters. A single-lumen polyurethane catheter with a small diameter offers advantages, while larger catheters are associated with increased risks of venous thrombosis and occlusion, though randomized studies have yet to confirm this association. The use of PICCs with a diameter of ≥5F is linked to increased upper extremity DVT (UEDVT) rates. Double-lumen PICCs also show higher complication rates (30.8/1000 catheter days) compared to single-lumen PICCs (17.2/1000 catheter days) of smaller gauge sizes.

Liem et al. identified a strong correlation between PICC diameter and thrombosis incidence, reporting a thrombosis rate of 1% with 4F PICCs, 6.6% with 5F PICCs, and 9.8% with 6F PICCs, while 3F PICCs were not associated with thrombosis. Similarly, larger catheters increase thrombosis risk, whereas smaller catheters can cause mechanical issues, though no randomized studies have confirmed these

assumptions. Failure to flush the catheter regularly may lead to blockage, as blood clots can accumulate on the catheter wall. Small-lumen diameters also carry a higher risk of blockage. Slow insertion is recommended to allow the catheter to pass into the vena cava without incident, as rapid threading can increase the risk of malposition (Liu et al., 2015).

5.2. Caregiver Factor

Inadequate knowledge and improper practices among healthcare personnel regarding PICC insertion and care can lead to complications. Failure to adhere to aseptic techniques during catheter placement and routine maintenance, along with insufficient education and skills for infection assessment and poor hand hygiene during patient care, are major contributors to catheter-related infections (Yap et al., 2006).

5.3. Major Complications

Major complications refer to severe issues that often necessitate early removal of the PICC line. These include infections or sepsis, thrombosis, and mechanical failure (Yap et al., 2006).

5.3.1. Infective Complications

A retrospective study evaluating bedside PICC insertion in the ICU over one year reported a central line-associated bloodstream infection (CLABSI) rate of 2.92%, while Bertoglio et al. reported a catheter-related infection rate of 2.1% (0.95% per 1000 catheter days) (Bertoglio et al., 2016). Similarly, Yap et al. observed a complication rate of 5.7% (0.73% per 1000 catheter days) (Yap et al., 2006). Fairhall reported a PICC-associated infection rate of 4.3% (0.49 per 1000 catheter days), compared to a higher rate of 25.3% (11.1 per 1000 catheter days) in another study. Levy et al. reviewed 279 PICC insertions in a pediatric tertiary care hospital and identified an infection rate of 4.4 per 1000 catheter days. These findings underscore the need for strategies to minimize PICC-associated complications.

5.3.2. Thrombosis Formation

Multiple studies have highlighted the increased risk of PICC-related thrombosis in critically ill patients (Brewer, 2012). A retrospective cohort study by Nolan et al. conducted in the Mayo Rochester ICU between 2012 and 2013 estimated catheter-related DVT rates of 4% and 1% (4.6 and 3.1 per 1000 catheter days). Chopra's meta-analysis found a PICC-associated thrombosis incidence of 13%–91% in critically ill patients. A prospective study by Walshe et al. reported a thrombosis complication rate of 32.8% (10.9/1000 catheter days) in 351 cancer patients.

Bertoglio et al. identified an 11.7% catheter-related thrombosis complication rate (0.30% per 1000 catheter days), while Yap et al. observed a 4.5% thrombosis rate (0.58% per 1000 catheter days). Fairhall reported a thrombosis complication rate of 2.4% (0.28 per 1000 catheter days), compared to a lower DVT rate of 0.7% (0.30 per 1000 catheter days) in another study. Inserting the smallest PICC diameter that meets the patient’s needs and confirming the catheter tip’s position in the lower third of the SVC via post-insertion X-ray are essential in minimizing thrombosis risk.

5.3.3. Mechanical Failure

While mechanical complications are rarely life-threatening, they can disrupt treatment and necessitate PICC replacement or removal. Inner lumen occlusions are particularly common, occurring at rates of up to 10.6/1000 catheter days. Bertoglio et al. reported a 4% catheter-related occlusion rate (0.41% per 1000 catheter days), while Yap et al. observed a 3.4% obstruction rate. Fairhall documented a 4.2% PICC migration rate (1.69 per 1000 catheter days), compared to a catheter damage rate of 32.8% (14.4 per 1000 catheter days) in another study (Haider et al., 2009).

Catheter malposition can lead to severe complications, including thrombosis. Critically ill patients, who frequently experience coughing and vomiting, are particularly susceptible. Malposition should be confirmed via chest X-ray, as catheter tip placement outside the distal SVC can cause thrombosis and phlebitis, while placement in the distal right atrium or right ventricle may result in cardiac arrhythmias. Proper positioning is essential to prevent catheter migration or dislodgement, which occurs in 5%–31% of cases.

Overall, infection, thrombosis, and mechanical failure are the most common complications associated with PICCs in critically ill patients. Studies such as those by Bertoglio, Yap et al., Fairhall, and Haider highlight the varying prevalence of these complications, with infections being the most frequent, followed by thrombosis and mechanical issues. Table 1 summarizes the comparison of PICC complication rates across these studies.

5.4. Minor Complications

Minor complications associated with PICC lines are those that can be resolved with secondary treatments and do not necessitate the removal of the catheter. These complications may include phlebitis in the catheterized vein, pain or bruising at the insertion site, skin reactions to the dressing, sluggish blood withdrawal, or resistance during flushing of the catheter (Pittiruti & Cotogni, 2014). Such issues generally do not require hospitalization exceeding 24 hours or re-hospitalization apart from clinical evaluations (Periard et al., 2008). Skin reactions to dressings are relatively common but typically respond well to minor interventions. Once the dressing is replaced, the reaction often subsides within a few days.

Phlebitis, or inflammation of the vein's intima, is marked by symptoms such as pain, redness, and swelling at the catheter site. It usually occurs within the initial 24 hours of catheter placement and often improves with the application of warm compresses. Resistance during flushing or sluggish blood withdrawal may result from fibrin sheath formation around the catheter or a fibrin tail at its distal end. This issue can typically be addressed through the instillation of urokinase (Potet et al., 2015). Thus, minor PICC line complications can frequently be managed through conservative methods or minor treatments, without requiring early catheter removal.

6. Preventive Measures for Complications

6.1. Infection Prevention

Infection is among the most serious and common complications associated with PICC lines, posing life-threatening risks if not promptly addressed. Preventive

strategies should emphasize strict sterile techniques and disinfection of the puncture site. Frequent disturbance of the dressing increases the likelihood of infection by interfering with the integrity of the Central Venous Access Device (CVAD) insertion site. Transparent dressings are preferred as they can remain intact for up to seven days, maintaining their integrity while facilitating observation for damage, moisture, contamination, or bleeding at the insertion site, thereby enabling timely detection of infections.

Research has demonstrated that adherence to the Central Line Bundle (CLB) guidelines significantly reduces catheter-related infections (CRIs). A study reported a reduction in CRIs from 10.0 per 1,000 catheter days to 2.2 per 1,000 catheter days following the implementation of CLB interventions. Similarly, colonization infections decreased from 6.9 per 1,000 catheter days to 2.2 per 1,000 catheter days (W. Wang et al., 2015). The CLB guidelines include essential components such as hand hygiene, dressing management, proper sealing of catheter tubes, and daily assessments by nurses.

Hand hygiene can be maintained through disinfection, adherence to the seven-step handwashing technique, and maximal barrier precautions, including the use of masks, gloves, gowns, and sterile drapes during catheter insertion or handling. Dressing changes should be performed the day after catheter insertion and subsequently on a weekly basis. Nurses should conduct daily assessments of the catheter and dressing for signs of redness, swelling, or inflammation and evaluate whether catheter removal is clinically indicated (Bonizzoli et al., 2011; Marschall et al., 2008).

Education and training for healthcare personnel involved in catheter insertion and maintenance are critical components of infection prevention. This includes the use of maximum sterile barrier precautions during catheter placement and 2% chlorhexidine for skin antisepsis. Evidence suggests that a 2% chlorhexidine-based alcohol solution is more effective for skin decontamination than povidone-iodine, making it the preferred agent for cleaning injection hubs and connectors (Ho & Litton, 2006).

A randomized controlled trial comparing three antiseptic solutions—10% povidone-iodine, 70% alcohol, and 2% chlorhexidine gluconate—found that the use of 2% chlorhexidine gluconate was associated with the lowest rate of catheter-related infections at 2.3 per 1,000 catheter days, compared to 7.1% for povidone-iodine and 9.3% for alcohol. This highlights the effectiveness of 2% chlorhexidine in reducing infection risks.

The skin serves as a natural barrier against microorganisms, but this barrier is compromised during PICC insertion, creating an entry point for pathogens. Consequently, a critical infection prevention strategy involves thorough skin disinfection prior to catheter insertion and appropriate care afterward. Furthermore, normal saline (NS) offers several advantages over heparin solution (HS) in preventing infusion-related infections. The use of NS eliminates the need for manual preparation of HS by nurses, reducing the risk of contamination and bloodstream infections (BSIs). Therefore, NS is considered an essential component in controlling infusion-related infections.

6.2. Prevention of Venous Thrombosis

The risk of PICC-associated deep vein thrombosis (DVT) can be mitigated through enhanced staff education and training focusing on proper insertion, monitoring, and reporting protocols. The selection of smaller-diameter PICCs is crucial, taking into account factors such as cost-effectiveness, safety, resistance to increasing fluid volumes, durability, and low complication rates. Inadequate flushing of the catheter often leads to blood accumulation along the conduit walls, resulting in catheter occlusion. Smaller lumen diameters are associated with higher blockage rates. Therefore, PICC nurses must utilize the gentle flush push-pause technique tailored to various catheter types and sizes. A retrospective study revealed that the incidence of symptomatic catheter-related DVTs was 1% with 4F catheters but increased to 9.8% when 6F catheters were employed. This highlights that 4F catheters significantly reduce catheter-related DVT rates (Brewer, 2012).

Similarly, another retrospective study demonstrated that confirming the PICC tip's placement in the distal third of the superior vena cava (SVC) using either post-procedural chest X-ray or ultrasound (US) guidance lowered the incidence of PICC-related upper extremity DVT (UEDVT) from 4.8% to 2.9%. US-guided PICC placement is associated with a lower thrombosis rate compared to traditional methods relying on anatomical landmarks and palpation, reducing thrombosis rates from 9.8% to 1.9%. Additionally, low-dose heparin is frequently administered as a prophylactic measure to maintain catheter patency and prevent venous thrombosis (R. Wang et al., 2015). However, certain studies indicate that low-dose warfarin does not significantly reduce symptomatic or asymptomatic DVT (RR 0.6, 95% CI 0.3–1.3) (Akl et al., 2008) and confirm that heparin saline (HS) and normal saline (NS) flushes exhibit comparable rates of lumen occlusion. Consequently, existing guidelines do not recommend pharmacologic prophylaxis for catheter thrombosis prevention. Further research is needed to evaluate the effectiveness of flushing solutions and strategies for preventing PICC-related DVT.

6.3. Prevention of Mechanical Failure

Mechanical complications of PICCs include catheter migration, occlusion due to mechanical obstruction, damage, rupture, and breakage. Catheter migration imposes clinical and financial burdens. To address this, Michael Rosenberg, an interventional radiologist in the United States, developed the SecurAcath device, a subcutaneous securement system designed to prevent catheter migration. The application of this device has been shown to be practical and effective in minimizing migration. US-guided PICC placement not only improves the success rate of achieving optimal tip placement in the distal third of the SVC but also reduces incidences of mechanical phlebitis, thrombosis, and trauma resulting from failed insertion attempts.

In terms of material, silicon (Groshong™) catheters are prone to inward blood reflux, leading to clot formation and potential snapping or fracturing, compared to polyurethane (Arrow™) catheters. Polyurethane catheters, which exhibit superior flexibility, wall strength, and high flow tolerance, are less likely to rupture or occlude and are therefore recommended. Another cause of catheter rupture is excessive intraluminal pressure, often caused by using syringes smaller than 10 cc

during flushing. To mitigate this, syringes of 10 cc or larger are advised, as they help prevent catheter rupture and associated damage.

6.4. Prevention of Minor Complications

Minor complications such as phlebitis, pain, bruising at the site, skin reactions to dressings, sluggish blood withdrawal, or resistance during flushing generally do not necessitate hospitalization exceeding 24 hours or re-hospitalization except for clinical evaluation. These issues are common but can be managed effectively with minor interventions. Pain at the insertion site is often linked to phlebitis and insertion difficulty. Applying heat to the affected vein improves blood flow, reducing the incidence of mechanical phlebitis. The use of the smallest PICC suitable for the patient's treatment needs also lowers the risk of phlebitis. Adequate hydration prior to insertion (500–1000 ml IV fluids) further minimizes insertion trauma and phlebitis in critically ill patients.

Polyurethane PICCs are less likely to cause blood reflux, enabling the instillation of urokinase to prevent occlusion and ensure smooth blood withdrawal. Skilled nurses play a pivotal role in preventing skin reactions by redressing patients and maintaining a dry insertion site. Comprehensive education and training for nurses on PICC care and management are critical for reducing these minor complications and improving patient outcomes.

The role of PICC nurses has evolved, requiring advanced education, technical skills, and familiarity with new technologies. Enhancing nursing capabilities through continuous training and improved insertion techniques not only reduces complication rates but also saves costs associated with PICC reinsertion and thrombolytic agent use. Suboptimal practices, such as improper documentation, inadequate flushing protocols, and poor dressing practices, highlight the need for ongoing education among caregivers. In-service education programs are recommended to ensure consistent knowledge updates and improved patient care outcomes. A study evaluating a combined theoretical and practical training course demonstrated significant improvement in staff performance and confidence in PICC-related skills.

7. Future Directions

The management of intravenous devices, including PICCs, requires expertise from trained nurses, physicians, and interventional radiologists. A high level of education and adherence to institutional protocols is essential for identifying and addressing PICC-related complications effectively. Evidence highlights the need for enhanced education, skills, credentials, and training among healthcare providers to ensure patient safety and mitigate risks.

To achieve optimal outcomes, the quality of nursing care and PICC management must be prioritized, emphasizing continuity of records, future research, and enhancements in clinical practice. Developing specific prevention strategies and standardized protocols for PICC units is critical. Future scientific advancements will rely heavily on improving knowledge of best practices for PICC care to reduce patient morbidity, lower healthcare costs, and prevent complications.

Trained staff and the application of evidence-based practices are essential for minimizing risks associated with PICCs. Our study included a comprehensive review

of recent research on PICCs in critically ill patients, which may guide healthcare professionals in selecting appropriate devices, procedures, and preventive measures. Despite the systematic approach, age-specific distinctions were not considered.

PICCs represent a safe and effective option for intermediate to long-term central venous access in critically ill patients. Understanding evidence-based guidelines, recognizing complications early, and adhering to care bundles are pivotal in minimizing risks. Education, training, and a multidisciplinary approach to PICC care are crucial for preventing complications. However, there is a need for more prospective trials that evaluate complications, prevention strategies, and clinical outcomes in critically ill populations.

2. Conclusion

Peripherally inserted central catheters (PICCs) play a vital role in the care of critically ill patients by providing reliable and long-term central venous access. Despite their numerous advantages, PICCs are associated with various complications, including infections, venous thrombosis, and mechanical failures. This review highlights the need for comprehensive strategies to mitigate these risks through evidence-based practices, including adherence to sterile techniques, proper catheter selection, regular monitoring, and targeted educational programs for healthcare providers.

Infection prevention remains a cornerstone of PICC management, emphasizing the use of advanced antiseptic techniques, such as 2% chlorhexidine gluconate, and adherence to protocols like the Central Line Bundle guidelines. Similarly, venous thrombosis can be reduced by using smaller-diameter catheters, confirming tip placement via ultrasound, and employing effective flushing techniques. Mechanical complications, including catheter migration and occlusion, can be minimized through innovations like the SecurAcath device and by using durable materials like polyurethane for catheter construction.

The evolving role of PICC nurses underscores the necessity for continuous education and practical training to equip them with the skills to address complications proactively. Establishing standardized protocols, fostering multidisciplinary collaboration, and encouraging further research are essential to enhancing PICC care and preventing complications.

Future endeavors should prioritize well-designed studies to assess preventive strategies and clinical outcomes in critically ill populations, as existing data are limited. By advancing knowledge and practices surrounding PICCs, healthcare providers can ensure safer, more effective care, ultimately improving patient outcomes and reducing healthcare costs.

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