

Review Article

Complications and Risk Factors of Peripherally Inserted Central Catheters: A Review

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Abstract: Peripherally inserted central catheters (PICCs) are widely used in cancer and critical patients for its convenience and performance compared to central venous catheters (CVCs), however, PICCs are still associated with some complications which increase disease burden and health care cost. No agreement about incidence and risk factors of PICC-related complications has reached from previous studies although much work has been done in this area. Lack of targeted prevention may lead to difficulties and stagnation in prevention of PICC-related complications. Our review reviewed current literatures on PICC-related complications and risk factors aiming to provide reference for further PICC research and prevention measures. In this review, we searched PICC related literatures, and listed the incidence and risk factors of PICC-related complications. Different studies reported different data and risk factors, and we have detailed in this review. The total incidence rate of complications ranged from 3% to 61.67%, infection and venous thrombosis are the most two common complications. The risk factors varied from study to study, but it is basically divided into patient related-, operation related- and material related-. For the prevention measures, we considered standardized operation and nursing according to guidance played an important role. In this field, better research and conclusions are needed to guide the work of medical staff.

Keywords: Peripherally Inserted Central Catheters, Complications, Risk Factors

1. Introduction

PICCs are widely used for various indications and their use has steadily grown over the years due to its increased safety for long term use and decreased cost [1] compared to CVCs. Despite those advantages, PICC could develop complications including venous thrombosis [2, 3], catheter related bloodstream infection (CRBSI) [4, 5], pain, bleeding,

and mechanical failure [6, 7]. Various studies have reported PICC-related complications: Jennifer M et al. reported a 11.77% rate of PICC-related complication including 3% catheter-associated thrombosis, 4% mechanical complications, 2% CRBSI, and 1% cellulitis [8]; Junren K showed 17.0% developed PICC-related complications with 4.6% skin allergy, 1.9% upper extremity deep venous thrombosis (UEDVT) and 1.3% CLABSI [6]. The incidence

of PICC-related complications raised concerns on their use and several studies have tried to explore risk factors of PICC-related complications [9-11], but no unanimous conclusion has been reached so far. In this study, we reviewed the literature on PICC-related complications and risk factors to reduce the incidence of complications, disease burden, and health care cost.

2. Incidence and Risk Factors of PICC-related Complications

PICCs are of pivotal importance for critically ill patients and cancer patients for fluids or drugs infusions, parenteral nutrition, and antibiotic therapy. However, concerns on PICC-related complications have never diminished. We reviewed the related studies of PICC complications in two important groups of patients with hematological malignancies and cancer using PICC.

Patients with hematological malignancies have increased risk for serious and life-threatening complications for their low immune function [12]. PICC can meet the need of reliable venous access for these patients. Curto-García N estimated the overall rate of potentially major dangerous complications was 11.36%, with 6.8% CRBSI and 4.5% catheter-related thrombosis [12]. Nicholas S et al reported the incidence of all complications ranged from 32.27% to 61.67% with CLABSI ranging from 4.2 to 5.6%, UEDVT ranged from 3.11 to 10.91%, and complete occlusion ranged from 13.66 to 43.33%. Fracchiolla NS et al conducted a large multicenter study in patients with hematological malignancies, estimating 21% blood stream infections (BSI) and 8% catheter-related thrombosis [13]. Morano SG et al also carried out research in patients with hematological malignancies with 7.7 % CLABSI and 2.6 % catheter-related thrombosis [14]. 18.9% CLABSI was reported in Yoshinori H et al study [15]. Harter C et al reported 7.7% incidence of phlebitis [16]. From the previous studies, the incidence of PICC-related complications was relatively high and the two most common complications were infection and catheter-related thrombosis in patients with hematological malignancies, however, we still could not conclude an accurate incidence range of complications due to the incidence of complications varies considerably with the number reported in each literature (from 3% to 61.67%). Hematopoietic cell transplantation (HCT) status [9], HM [17], type of disease [14], PICC type [9, 17], sex [9], patient safety and hospital resources [17, 18] were proved to be influencing factors. However, not all the literatures has reported the influencing factors, so we can't draw a conclusion.

Another important research subject is cancer patients. Xie J et al studied on patients with advanced cancer. They found the overall complication rate was 53.1%: 15.1% patients exhibited PICC-related infectious complications and of which 3.9% were CLABSI; 11.4% developed PICC-related thrombosis; 9.1% were phlebitis. Comorbidity, body mass index (BMI) and duration of radio-chemotherapy were

associated with PICC-related complications [19]. Bertoglio S reported 25% developed complications with 12% UEDVT and 2% CLABSI [20]. Jones D found 5.5% developed UEDVT and risk factors for UEDVT were more than one attempt for insertion and the use of fluoropyrimidine containing chemotherapy, 5.3% developed thromboembolism and male gender was the risk factor [11]. Rykov MY reported 4.5% catheter-related thrombosis and 0% CLABSI [21]. Campagna S reported 16.9% incidence of complications and inserted at the brachial site, with open systems and gender could influence the occurrence of complications [22]. Besides, there's a lot of research we haven't listed yet. But the general trend is incidence and risk factors reported in different studies differed considerably and were almost different, which may be related to different countries and regions, such as doctor's operation, PICC products, nursing and so on.

In one review, patient status, vein selection, catheter, and caregiver factor (including knowledge and practice of healthcare personnel) were reported to be factors associated with complications [23]. From above studies, we can conclude there are various factors that affect the complications of patients, and the risk factors of different disease types are different. Therefore, we should summarize a set of risk factors for the complications of common intubation patients, so as to focus on the intervention of these patients.

3. Prevention Measures for PICC-related Complications

Infection and venous thrombosis are the most two common complications and can pose a great threat to the life and health of patients. Liem TK et al and Fairhall M et al have reported infection was the most common and severe complication [23]. The incidence rates of infections ranged from 3.9 to 37.9 % [19, 24]. Thrombosis is considered the second major complication [23].

A study showed that the use of a Central Line Bundle (CLB) guideline could decrease the incidence of infections and CRBSIs [4]. PICC team should strictly implement aseptic technology and puncture point disinfection. In insertion process, the following conditions should be established: a treatment center and qualified doctors and nurses, hand hygiene, maximum sterility, skin preparation, and selection of the best puncture site. In maintenance process, hand hygiene, dressing management, filling and sealing the catheter tube, and daily assessments by duty nurses. Besides, education and training of healthcare personnel are also needed in infection prevention.

If the catheter is not washed in time, it will lead to the accumulation of blood attached to the catheter wall, which will lead to the blockage of the catheter. PICC nurses should know how to use different types and specifications of catheters, and use push-stop technique to wash gently [25]. Low-dose heparin is commonly used as a preventive drug to

flush and lock peripheral venous catheters to maintain their effectiveness and prevent venous thrombosis [26]. Meanwhile, PICC tip in the distal third of the superior vena cava (SVC) can effectively alleviate PICC-related UEDVT, so the position should be confirmed by using Xray or ultrasound [27].

Mechanical complications including migration, occlusion, catheter damage, ruptures, and breakages. SecurAcath device, US guidance PICC insertion, silicon catheters, and using 10 cc needles or larger may reduce the incidence of mechanical complications [26, 28]. For this complication, it's also important to choose different materials, but there's no way to say which one is better (polyurethane or silica).

4. Conclusion

The incidence and risk factor of PICC-related complications have been reported by many previous studies. From our review, the total incidence rate of complications ranged from 3% to 61.67%, infection and venous thrombosis are the most two common complications and the risk factors varied from study to study. The key protective measure is implementing education, training and appropriate multidisciplinary approaches to PICC nursing among nurses. Strict nursing of PICC line, targeted and reasonable prevention of PICC-related complications, and good nursing work have important clinical significance in reducing the occurrence of potential complications of PICC. More randomized clinical trials are needed for consistent incidence and complications study.

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