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Progress in patient factors of intravascular catheter-associated bloodstream infection

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Abstract
Intravascular Catheter (IVC) is an essential part of medical practice for intravenous infusion therapy, laboratory testing or hemodynamic monitoring in any setting such as inpatient, emergency, outpatient or home. As IVC is widely used in practice, complications of Catheter-Related Infection (CRBSI) have followed. In this paper, the risk factors of CRBSI were reviewed, and the prevention and reduction of CRBSI were prospected.

Keywords: CRBSI, intravascular catheters, bloodstream infections, factors, progression

1. Introduction

Intravascular Catheter (IVC) is an essential part of medical practice for intravenous infusion therapy, laboratory testing, or hemodynamic monitoring in any setting such as inpatient, emergency, outpatient, or home [1-3]. As IVC is widely used in practice, complications of Catheter-Related Infection (CRBSI) have followed. At present, the incidence of CRBSI in foreign countries is about 0.35-1.7 cases /1000 catheter day, and in Asia it is about 6.8 cases /1000 catheter day [4, 5]. The occurrence of CRBSI will prolong the hospitalization time of patients and increase related costs [4]. Therefore, understanding the risk factors of CRBSI and developing corresponding intervention strategies can prevent and reduce its occurrence and development. The risk factors of intravascular CRBSI are summarized as follows.

2. Etiological analysis

It can be seen from numerous reports that gram-positive cocci are the most common pathogens, followed by gram-negative bacilli and fungi [3, 4, 6, 7]. The specific composition is as follows: (1) gram-positive cocci account for about 55-87.5%, mainly from the skin flora of alien patients or the hands of medical staff, among which coagulase negative staphylococcus (CoNS) is the most dominant, and staphylococcus epidermosis is common in CoNS [3, 6-9]. Besides CoNS, Staphylococcus aureus is also a common pathogen [7, 8]. (2) gram-negative bacilli accounted for 11.1-19%, mainly from non-ductal blood-borne infections in other sites, such as nosocomial pneumonia, urinary tract infection or abdominal infection, among which acinetobacter baumannii had several outbreaks in the ICU [9,10]. In recent years, there is a trend of increasing infection rate caused by Gram-negative bacilli and decreasing infection rate caused by Gram-positive cocci in cancer, granulocytopenia, critically ill patients and children patients. The reason is that these patients have low immunity and are prone to be infected with CRBSI from other parts of blood. Prevention guidelines for IVC-associated infections recommend empiric treatment of Gram-positive bacilli for effective prevention and control. Therefore, targeted treatment for CRBSI should be carried out in clinical practice according to patients' specific conditions and local epidemiological situation [11-12]. (3) fungi account for about 1.4-8%, and form mixed biofilms with bacteria that are highly resistant to antibacterial agents and immune system, leading to long-term infection [4, 7]. In addition, as a new hospital pathogen, Corynebacterium striae invasions patients with indwelled IVC and immunosuppressed, bringing great challenges to treatment and prevention [13].

3. Age and sex

As patients get older, their physical abilities gradually decline, and there is a risk of the interruption of aseptic techniques. In addition, the incidence of CRBSI in patients with other chronic diseases is nearly twice as high as that in younger patients [5, 9, 14]. Specifically, the risk of catheter removal increased by 2% for each year of patient age [14]. Studies showed that the mortality rate of CRBSI was 8.8% in patients >65 years old, but only 3.8% in patients <65 years old [5]. In addition to the age of the patient, gender is also an important factor causing CRBSI. Researchers have found that male patients with gastrointestinal surgery are more likely to develop CRBSI than female patients [8]. Marschall *et al*. [15] pointed out that female patients have a lower risk of CRBSI, and the specific causes and mechanisms need to be further studied in the future.

4. Diseases and immunity

Most cancer patients suffer from adverse reactions such as nausea, vomiting, poor appetite, and granulocytopenia due to anticancer treatment, and the continuous invasion and metastasis of cancer cells, resulting in severe malnutrition in 81.5% of cancer patients, followed by decreased immunity [4, 16-17]. At this time, such patients need to receive blood products and complete parenteral nutrition solution, which provides a good culture medium for the pathogenic bacteria migrating from the catheter device to the lumen, and the continuous growth and reproduction of the pathogenic bacteria cause CRBSI [4, 5]. Vashi *et al*. [4] found that the risk of CRBSI infection in patients with severe malnutrition and cancer metastasis was twice that of well-nourished patients without metastasis. CRBSI accounts for 23.6-49% of blood infections in patients with hematological cancer, and 65% of bone marrow transplant patients are complicated with CRBSI [6]. Patients with hematological cancer and bone marrow transplantation have a higher risk of CRBSI infection than other cancer patients because of suppressed immune function and the need for transfusion of a large number of blood products (5.2 cases /1000 catheter days vs 0.02-3.00 cases /1000 catheter days) [6]. In addition, due to the need for complete parenteral nutrition support, the overgrowth of intestinal bacteria in patients with intestinal failure leads to bacterial displacement and increases the risk of CRBSI [18]. CRBSI occurred more frequently when the residual small intestine was <50 cm, or < 50% of the normal intestine, because the patient's resistance was reduced after partial intestinal and lymphatic tissue was removed [18]. When patients suffer from other serious diseases, such as congestive heart failure, abdominal perforation, ventilator-associated pneumonia, renal insufficiency or multiple organ dysfunction, etc., their body immunity is weakened and they are also prone to CRBSI infection [2, 19]. Tao *et al*. [5] performed acute physiology and chronic health Assessment II (APACHE II) scores in ICU patients and found that scores > 20 were independent risk factors for early CRBSI within 14 days of IVC catheterization. At the same time, patients with more than 3 basic diseases, due to the severe decline of immunity, also prone to CRBSI.

Therefore, when catheterization is performed for critically ill patients with low immunity and multiple underlying diseases, techniques such as antimicrobial coated catheter or catheter sealing can effectively prevent the occurrence of CRBSI [6].

5. Recent history of bloodstream infection

In patients with a recent history of bloodstream infection, when the catheter is re-placed, the pathogenic bacteria in the blood re-adhere to the newly inserted catheter through blood circulation, causing the recurrence of CRBSI [2, 5, 19-21]. Daneman *et al*. [21] found that the recurrence rate of CRBSI was significantly higher in patients with internal catheterization after 2 days of infection control than after 3 days of catheterization (6.5% vs 0.3%). Therefore, it is recommended that patients be re-catheterized after 3 days of blood infection control and use antimicrobial coated catheter to prevent recurrence of CRBSI.

6. Medication factors

The nature of the patient's fluid input is one of the factors contributing to CRBSI. Most cancer patients using high-dose chemotherapy drugs or hormone drugs are likely to cause adverse reactions such as malnutrition, bone marrow suppression, leukopenia and so on, resulting in reduced immune function and susceptibility to pathogen invasion [19, 22]. At the same time, fatty milk, amino acids and other parenteral nutritional fluids and blood products needed for patients with malnutrition easily adhere to the inner wall of the catheter due to their high concentration, providing a good environment for the growth and reproduction of pathogenic bacteria, and easily causing CRBSI in patients with weak immunity [19]. In addition, long-term (>90 d) combined use of antibiotics (>3) increases the body's drug resistance, which makes it difficult to prevent and control CRBSI [22]. Patients who use anticoagulants at the same time will have bleeding, hematoma and other adverse reactions at the puncture site, which increases the chance of pathogen invasion and leads to the risk of infection [14]. Durkin *et al*. [14] found that patients using anticoagulants had a 1.64-fold increased risk of catheter complications compared with patients not using anticoagulants. Therefore, the lumen should be cleaned in time after the patient is delivered with thick liquid or blood products, and long-term combined use of antibiotics should be avoided. Observation after the use of anticoagulants should be strengthened.

7. Tracheotomy and mechanical ventilation

Mechanical ventilation for treatment of patients with tracheotomy or tracheal intubation is required, the pathogen easy parasitism in ventilation equipment, easy with airflow into the respiratory tract in patients with respiratory infections, such as ventilator associated pneumonia, then cause blood infection in lung with gas exchange into the blood stream, and then transmitted through blood adhesion to the catheter CRBSI, Invasive ventilation was associated with a higher risk of CRBSI infection than non-invasive ventilation [23]. In addition, when the tracheostomy was placed in the internal jugular vein or subclavian vein, the tracheostomy was close to the puncture site, and tracheal secretions were easy to contaminate the catheter, increasing the risk of catheter infection [2, 19]. Therefore, for patients with mechanical ventilation, medical staff should strengthen the tracheostomy or oral care, reduce the breeding of pathogens; In addition, patients with tracheotomy should avoid catheterization in the internal jugular vein or subclavian vein. If the location is unavoidable, try to keep the fixed application complete, dry and clean to prevent the puncture point and the

surrounding skin from being contaminated.

8. Skin Condition

When patients have skin ulcers or open wounds, microbial contamination migrates to the catheter interface or along the external surface of the catheter and spreads to the catheter, resulting in CRBSI [5, 14]. Therefore, skin wound care should be strengthened for IVC patients with incomplete skin to reduce the occurrence of CRBSI.

9. Conclusion

The occurrence of CRBSI is closely related to the internal factors of patients and external factors such as catheter and medical staff. Some of these risk factors are internal and cannot be changed, but most of the external factors can be prevented and controlled by intervention. Therefore, improving nursing staff's ability to identify and evaluate risk factors and enhancing their awareness of following hospital prevention and control has great benefit value in preventing patients from developing CRBSI and reducing hospital stay and related costs.

10. References

1. Gorski L, Hadaway L, Hagle M, *et al*. Infusion therapy standards of practice. 5 edition. Massachusetts: Infusion Nurses Society. 2016, S42-S44.
2. Chopra V, Ratz D, Kuhn L, *et al*. PICC-associated bloodstream infections: prevalence, patterns, and predictors. Am J Med. 2014; 127(4):319-328.
3. Planes AM, Calleja R, Bernet A, *et al*. Evaluation of the usefulness of a quantitative blood culture in the diagnosis of catheter-related bloodstream infection: Comparative analysis of two periods (2002 and 2012). Enferm Infec Micr Cl. 2016; 34(8):484-489.
4. Vashi PG, Virginkar N, Popiel B, *et al*. Incidence of and factors associated with catheter-related bloodstream infection in patients with advanced solid tumors on home parenteral nutrition managed using a standardized catheter care protocol. Bmc Infect Dis. 2017; 17(1):372-380.
5. Tao F, Jiang R, Chen Y, *et al*. Risk Factors for Early Onset of Catheter-Related Bloodstream Infection in an Intensive Care Unit in China: A Retrospective Study. Med Sci Monitor. 2015; 21:550-556.
6. Zakhour R, Chaftari AM, Raad II. Catheter-related infections in patients with haematological malignancies: novel preventive and therapeutic strategies. Lancet Infect Dis. 2016; 16(11):e241-e250.
7. Guembe M, Pérezgranda MJ, Capdevila JA, *et al*. Nationwide Study on Peripheral Venous Catheter Associated-Bloodstream Infections in Internal Medicine Departments. J Hosp Infect. 2017; 97(3):260-266.
8. Wu S, Ren S, Zhao H, *et al*. Risk factors for central venous catheter-related bloodstream infections after gastrointestinal surgery. Am J Infect Control. 2017; 45(5):549-550.
9. Song SH, Park JS, Kwon HR, *et al*. Human bloodstream infection caused by Staphylococcus pettenkoferi. Journal of Medical Microbiology. 2009; 58(2):2709-272.
10. Ulukilic A, Gundogdu A, Cevahir F, *et al*. An outbreak of bloodstream infection due to extensively resistant acinetobacter baumannii among neonates. Am J Infect Control. 2017; 46(2):154-158.
11. Braun E, Hussein K, Geffen Y, *et al*. Predominance of Gram-negative bacilli among patients with catheter-related bloodstream infections. Clin Microbiol Infect. 2014; 20(10):O627-O629.
12. Centers for Disease Control and Prevention. Guidelines for the prevention of intravascular catheter-related infections. (2017-07)[2018-08-19]. https://www.cdc.gov/infectioncontrol/guidelines/bsi/index.html.
13. Daisuke U, Oishi T, Yamane K, *et al*. Corynebacterium striatum Bacteremia Associated with a Catheter-Related Blood Stream Infection. Case Rep Infect Dis, 2017, 2682149.
14. Durkin MJ, Dukes JL, Reeds DN, *et al*. A Descriptive Study of the Risk Factors Associated with Catheter-Related Bloodstream Infections in the Home Parenteral Nutrition Population. Jpen-Parenter Enter. 2016; 40(7):1006-1013.
15. Marschall J, Mermel LA, Fakih M, *et al*. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. Infect Cont Hosp Ep. 2014; 35(7):753-771.
16. Rahal JJ. Intravascular-catheter-related infections. Lancet; 1998; 351(9117):1739.
17. Russo A, Wood H, Mcmullen K, *et al*. The Appropriateness of Peripheral Inserted Central Catheter (PICC) Use Among Hospitalized Patients. American Journal of Infection Control. 2011; 39(5):E38-E39.
18. Robinson J L, Casey LM, Huynh HQ, *et al*. Prospective cohort study of the outcome of and risk factors for intravascular catheter-related bloodstream infections in children with intestinal failure. Jpen-Parenter Enter. 2014; 38(5):625-630.
19. Pongruangporn M, Ajenjo MC, Russo AJ, *et al*. Patient- and Device-Specific Risk Factors for Peripherally Inserted Central Venous Catheter–Related Bloodstream Infections. Infect Cont Hosp Ep. 2013; 34(2):184-189.
20. Rinke M L, Milstone A M, Chen A R, *et al*. Ambulatory pediatric oncology CLABSIs: Epidemiology and risk factors. Pediatr Blood Cancer. 2013; 60(11):1882-1889.
21. Daneman N,Downing M,Zagorski BM, *et al*. How long should peripherally inserted central catheterization be delayed in the context of recently documented bloodstream infection?. J vascu inter radiol. 2012; 23(1):123-125.
22. Tarpatzi A, Avlamis A, Papaparaskevas J, *et al*. Incidence and risk factors for central vascular catheter-related bloodstream infections in a tertiary care hospital. New Microbiol. 2012; 35(4):429-437.
23. Spelman T, Pilcher DV, Cheng AC, *et al*. Central line-associated bloodstream infections in Australian ICUs: evaluating modifiable and non-modifiable risks in Victorian healthcare facilities. Epidemiol Infect Australian. 2017; 145(14):3047-3055.