

# Study on the Risk Factors of Central Venous-Related Bloodstream Infection in Outpatients

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**Abstract:** *Objective:* To analyze the risk factors of catheter-related bloodstream infection in outpatients and propose feasible prevention and control measures. *Methods:* The medical records of outpatients with peripherally inserted central catheter (PICC) from January 2020 to December 2021 were selected for retrospective analysis, and the factors that may be related to the occurrence of catheter-related bloodstream infection were analyzed by logistic multivariate analysis. *Results:* The incidence rate of catheter-related bloodstream infection among the enrolled patients was 4.78%. It was found that age, duration of catheterization, catheter site, number of punctures, and diabetes were all risk factors for catheter-associated bloodstream infection, and the differences were statistically significant. *Conclusion:* Age, duration of catheterization, catheterization site, and diabetes are all risk factors for catheter-related bloodstream infection, and medical personnel should fully understand and learn more about these risk factors and actively develop countermeasures to reduce the risk of catheter-related bloodstream infection.

**Keywords:** Outpatient; Central venous catheter; Bloodstream infection

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## 1. Introduction

Central venous catheters (peripheral inserted central venous catheters [PICC]) and catheter-related bloodstream infection refers to a bacterial infection mainly manifested by fever, chills, and leukocytosis when the patient receives antibacterial drug treatment after central venous catheter is inserted through the peripheral vein. Catheter-related bloodstream infection can occur in all patients with central venous catheters, and the elderly, long-term bedridden, and intensive care patients are high-risk groups<sup>[1-3]</sup>. The incidence of catheter-related bloodstream infection increases with the age of patients, and the incidence of catheter-related bloodstream infection is as high as 50% to 100% if the patient is receiving an antibiotic treatment. The purpose of this study is to understand the relationship between the incidence of catheter-related bloodstream infection and related risk factors in outpatients, and to provide a scientific basis for the prevention and control of catheter-related bloodstream infection in outpatients.

## 2. Materials and methods

### 2.1. General information

In this study, the medical records of patients with PICC catheterization from January 2020 to December 2021 were selected for retrospective analysis. The survey subjects were outpatients, including 172 males and 142 females; aged 10–81 years, with an average  $51.23 \pm 15.67$  years old; the catheterization sites were peripheral veins such as the median cubital vein, basilic vein, and cephalic vein. The diagnostic criteria for

catheter-associated bloodstream infection were implemented in accordance with the “PICC Diagnosis and Management Guidelines” formulated by the Infectious Diseases Branch of the Chinese Medical Association, and PICC-associated bloodstream infection was divided into three categories: asymptomatic infection, acute inflammatory fever, and subclinical infection.

Inclusion criteria: (i) patients with clinical symptoms such as fever, chills, and increased leukocytes; (ii) patients whose catheterization sites were cephalic vein, basilic vein, and median cubital vein; (iii) patients who had been receiving antimicrobial therapy for more than 3 months.

Exclusion criteria: (i) patients who had been intubated for more than 3 months; (ii) patients who need to be intubated due to various diseases.

## 2.2. Research methods

Data collection: self-made form that included the patient’s gender, age, admission diagnosis, underlying disease (coronary heart disease, diabetes, hypertension, chronic obstructive pulmonary disease, kidney disease, immune system disease, tumor, etc.), nutritional status, duration of catheterization, site of catheterization, number of punctures, catheter care, antibiotics, hormone use, use of mechanical ventilation, use of total parenteral nutrition (TPN), etiological results, etc.

## 2.3. Statistical processing

The collected data was statistically analyzed using SPSS13.0 software, and  $P < 0.05$  was considered statistically significant.

## 3. Results

### 3.1. General information

A total of 314 patients with PICC catheterization were included in this study, among which 15 cases had catheter-related bloodstream infection, with an incidence rate of 4.78%. Among them, the age of patients with catheter-related bloodstream infection was  $61.2 \pm 14.3$  years old, and the age of patients without catheter-related bloodstream infection was  $55.1 \pm 13.7$  years old, and the age difference was statistically significant ( $P < 0.01$ ). Besides, the difference between the occurrence of catheter-related bloodstream infection was statistically significant based on the site of catheterization ( $P < 0.05$ ). The incidence of infection was also affected by the number of punctures during catheterization (1 case of infection in punctures of not more than 2 times, 5 cases in punctures of 3–5 times, 9 cases in punctures of  $\geq 6$  times), with statistically significant differences ( $P < 0.05$ ). As for duration of catheterization, 4 cases of infection occurred in patients with indwelling catheters for  $\leq 7$  days, and 11 cases for those  $> 7$  days), and the difference was statistically significant ( $P < 0.05$ ). Besides, 5 cases of infection occurred in diabetic patients, which was a incidence rate of 14%, but the incidence rate of non-diabetic patients was 2% (1 case), and the difference was statistically significant ( $P < 0.05$ ). The aforementioned are all risk factors for catheter-related bloodstream infection, and the differences were statistically significant.

### 3.2. Multivariate logistic regression analysis of catheter-related bloodstream infection

The factors of catheter-related bloodstream infection obtained from the univariate analysis was included in the logistic regression analysis. The results showed that the age of the patient, the site of catheterization, the number of punctures during catheterization, the duration of catheterization, and the history of diabetes were all factors related to catheter-related bloodstream infection. There were statistically significant differences in the risk factors of catheter-related bloodstream infection ( $P < 0.05$ ), as shown in **Table 1**.

**Table 1.** Multivariate logistic analysis of catheter-related bloodstream infection

Factor	$\beta$ -value	Wald value	P-value	OR	95% CI
Age	1.774	188.242	0.003	4.671	4.133–5.767
Site of catheterization	1.846	12.325	0.006	2.795	2.152–3.856
Number of punctures	1.558	15.712	0.007	3.644	2.874–4.868
Duration of catheterization	1.331	16.786	0.003	2.183	1.834–2.363
History of diabetes	1.922	11.123	0.004	3.212	2.142–3.574

### 3.3. Etiological results of catheter-related bloodstream infection

Catheter-related bloodstream infection occurred in 15 of the 314 patients, and 16 strains of pathogenic bacteria were isolated. The results showed that G+ cocci accounted for about 56%, which was the biggest proportion, and *Staphylococcus epidermidis* and coagulase-negative staphylococci were more common among them. The distribution of each type of bacteria is shown in **Table 2**.

**Table 2.** Etiological results of catheter-associated bloodstream infection

Pathogenic bacteria	Number of plants (n)	Constituent ratio (%)
G- bacteria	7	2.23
<i>Klebsiella pneumoniae</i>	1	0.32
<i>Escherichia coli</i>	2	0.64
<i>Proteus mirabilis</i>	1	0.32
<i>Enterobacter aerogenes</i>	1	0.32
Other G- bacilli	2	0.64
G+ cocci	9	2.87
<i>Staphylococcus epidermidis</i>	3	0.96
coagulase-negative staphylococci	2	0.64
<i>Staphylococcus aureus</i>	2	0.64
<i>Enterococcus faecium</i>	1	0.32
Other positive cocci	1	0.32

## 4. Discussion

A central venous catheter is an invasive catheterization that provides patients with long-term venous blood therapy support. However, due to the complexity of the operation and the susceptibility to the patient's own conditions, coupled with the problems of irregular catheter maintenance and high risk of infection, catheter-related bloodstream infection can occur due to direct or indirect causes, including catheter-related infections, bloodborne infections, sexually transmitted infections, and nosocomial infections [4-6].

Catheter-related bloodstream infection refers to central venous catheter-related bloodstream infection, which is a global health problem, and the current incidence rate in China is 2–3%. The results of our study showed that the incidence of catheter-associated bloodstream infection among outpatients was 4.78%. This study found that the incidence of catheter-related bloodstream infection in patients was related to age, gender, and duration of catheterization. These results were consistent with some reports, indicating that the pathogenesis of catheter-related bloodstream infection in outpatients is still unclear, and it may be related to the following factors [7-11]: (i) outpatients are a high-risk group and they suffer from long-term anxiety and depression, which will reduce immunity and increase the chances of infection; (ii) outpatients have multiple underlying diseases, such as hypertension, diabetes, etc.; (iii) outpatients are mostly elderly or bedridden; (iv) outpatients often use broad-spectrum antibiotics.

Catheter-associated bloodstream infection is a serious clinical complication that can lead to death. Catheter-associated bloodstream infection is prevalent globally and has become the third leading risk factor for hospital-acquired infection worldwide <sup>[12]</sup>. The incidence rates of catheter-associated bloodstream infection in the United States, the United Kingdom, Canada, and other countries are 18%, 6% and 8%, respectively. It is estimated that approximately 85,000 people die each year from catheter-associated bloodstream infections, including 15,500 in intensive care unit (ICU) patients <sup>[14]</sup>. This study analyzed the risk factors for catheter-associated bloodstream infection through a retrospective study of outpatients. The results of the study showed that the independent risk factors for catheter-related bloodstream infection in outpatients were comorbid underlying diseases, duration of catheterization, and puncture site infection. According to multivariate Logistic regression analysis, underlying diseases, long indwelling catheter time, and puncture site infection were independent risk factors for catheter-related bloodstream infection in outpatients. The results of this study showed that underlying diseases, long durations of catheterization, and puncture site infection were independent risk factors for catheter-related bloodstream infection; among them, underlying diseases, long indwelling catheter time and intravenous catheter-related infection were closely related.

In order to avoid the occurrence of catheter-related bloodstream infection, several factors should be paid attention to in terms of blood draw and duration of catheterization.

- (i) The management of catheter-related bloodstream infections in outpatients should be strengthened to reduce the occurrence of iatrogenic infections. Outpatients should disinfect themselves during PICC catheterization to reduce the occurrence of cross-infection <sup>[15]</sup>.
- (ii) The training of medical staff and the medical staff's awareness of PICC catheter infection prevention and control measures should be improved to reduce the incidence of catheter-related bloodstream infection. In addition, the hand hygiene of medical staff should be strengthened to avoid contact with sources of infection.
- (iii) The maintenance and management of venous catheters should be standardized according to the relevant guidelines, and relevant standard operating procedures and disinfection and isolation systems should be formulated for post-PICC catheterization care. Besides, the occurrence of catheter blockage and detachment should be avoided. (iv) The disinfection and hand hygiene compliance during catheter use should be strengthened. Hospitals should conduct regular training for medical staff to improve their medical staff's awareness towards catheter-related bloodstream infection. Patient management should be improved, so that patients with catheter-related bloodstream infection can be treated in time. Moreover, patients should be evaluated after PICC catheterization, and targeted interventions should be implemented for high-risk patients.
- (iv) Catheter-related bloodstream infections in outpatients should be monitored regularly and relevant management systems and measures should be formulated to reduce the incidence of catheter-related bloodstream infections in outpatients.

## 5. Conclusion

In short, the incidence of catheter-associated bloodstream infection in outpatients is high, and age, gender, catheterization site, catheterization time, duration of antibiotic administration, and catheter type are the important factors that affect the occurrence of catheter-associated bloodstream infection in outpatients. In this study, male, elderly, and critically ill patients were more prone to catheter-associated bloodstream infection, which was consistent with previous studies. In addition, in outpatients, the use of V-VAC suction units and PICC catheters had a higher probability of infection. This study only involved outpatients in this clinic but not all patients, so there may be certain limitations. Therefore, further prospective, multi-center large-sample studies are needed to further clarify its risk factors.

## Disclosure statement

The authors declare no conflict of interest.

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