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Original Article

Risk factors for catheter-related infections in neck tumor patients undergoing chemotherapy through peripherally inserted central catheters

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Abstract: Objective: To investigate the risk factors for catheter-related infections (CRI) in patients undergoing chemotherapy through tunneled peripherally inserted central catheters (PICCs) following neck tumor lymph node dissection. To provide evidence for clinical intervention strategies. Methods: A retrospective review was conducted on the medical records from 495 patients who underwent tunneled PICC placement for chemotherapy after neck tumor lymph node dissection. Patients were divided into a CRI group (n=55) and a non-CRI group (n=440). The incidence of CRI, infection type, and pathogen distribution were statistically analyzed. Multivariate logistic regression was employed to identify independent risk factors. A logistic regression-based predictive model was established and its performance was evaluated. Results: Among the 495 patients, the incidence of CRI was 11.11% (55/495), with exit-site infections being the predominant type (25 cases, 45.45%). A total of 11 pathogenic strains were isolated. Multivariate logistic regression analysis revealed that PICC indwelling duration >30 days, catheter displacement, concomitant diabetes mellitus, and white blood cell count $\leq 3.0\times10^9$/L were independent risk factors for CRI (all $P<0.05$). The area under the curve (AUC) for the logistic regression model for predicting CRI efficacy was 0.896 [95% CI, 0.845, 0.947], with a sensitivity of 91.0% and a specificity of 79.0%. Calibration curves demonstrated good agreement with the ideal predictions. Conclusions: Patients undergoing chemotherapy through tunneled PICC after neck tumor lymph node dissection exhibit a relatively high incidence of CRI. Clinicians should implement targeted interventions for patients with prolonged catheterization, catheter displacement, diabetes mellitus, and leukopenia to reduce the incidence of CRI and improve patient outcome.

Keywords: Tumor, chemotherapy, peripherally inserted central catheter, catheter-related infection, risk factors

Introduction

Neck tumors such as laryngeal carcinoma, thyroid carcinoma, and nasopharyngeal carcinoma are common malignant tumors of the head and neck region. Epidemiologic investigations indicate that approximately 4.45% of malignant tumors in China are neck cancers, with an annual incidence of about 146,000 new cases and 81,000 related deaths, ranking among the top ten cancers nationwide in terms of morbidity and mortality [1, 2]. Surgical resection combined with adjuvant chemotherapy remains the primary treatment regimen [3]. However, up to 70%-80% of patients are diagnosed at locally advanced or late stages, missing the optimal window for radical treatment. The overall 5-year survival rate of patients with advanced or recurrent disease drops sharply to 20%-30%, and the 5-year survival rate of metastatic cases is even lower than 10% [4].

Constrained by the intricate cervical anatomy and rich vital blood vessels and nerves, advanced tumors readily invade adjacent tissues and metastasize to cervical lymph nodes, resulting in irreversible impairments in swallowing, breathing, speech, and facial appearance. For these neck tumor patients, chemotherapy serves as a core therapeutic approach [5]. Due to the prolonged chemotherapy and the strong irritant properties of drugs such as cisplatin and paclitaxel, repeated peripheral venous punctures not only cause vascular damage and

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phlebitis but may also lead to local tissue necrosis through drug extravasation, severely compromising treatment tolerance and quality of life [6].

Given the presence of surgical incisions and radiation fields in the cervical region, the use of totally implantable venous access ports and central venous catheters is largely restricted in patients with neck tumors. Accordingly, peripherally inserted central catheters (PICCs) have become the most commonly used venous access for patients, effectively mitigating these challenges. Tunneled PICCs, which establish a subcutaneous tunnel for more secure catheter fixation and reduce bacterial entry pathways at the skin surface, are associated with lower catheter-related infection (CRI) rates than conventional PICCs. This makes them the preferred venous access for patients undergoing postoperative chemotherapy for neck tumors [7]. Nevertheless, patients with neck tumors experience compromised local immune barriers due to postoperative lymph node dissection, alongside chemotherapy-induced leukopenia and systemic immunosuppression. Additional comorbidities such as diabetes further increase the risk of CRI in patients with tunneled PICCs [8]. Pinelli et al. [9] reported that the incidence of PICC-associated CRI in cancer patients ranges from approximately 5.0% to 15.0%. Once CRI occurs, it may not only necessitate chemotherapy interruption but also lead to severe complications such as sepsis, prolong hospital stays, increased medical costs, and even pose a threat to life [10].

Current domestic and international studies have focused predominantly on risk factors for CRI associated with conventional PICCs in general cancer patients [11, 12], with limited studies addressing tunneled PICCs following neck tumor lymph node dissection. Therefore, this retrospective analysis evaluated the clinical data of 495 patients who underwent chemotherapy through indwelling tunneled PICCs following neck tumor lymph node dissection. The results of this study aim to identify independent risk factors for CRI occurrence, thereby providing evidence-based guidance for optimizing catheter placement techniques, improving postoperative maintenance, and reducing infection risks.

Patients and methods

General data

A retrospective review of clinical records was conducted for 495 patients who underwent neck lymph node dissection for cervical tumors at the Department of Oncology of our hospital between January 2017 and December 2024. All patients underwent PICC placement and initiated chemotherapy within 1-2 weeks postoperatively. According to the occurrence of CRI, patients were divided into a CRI group (n=55) and a non-CRI group (n=440). This study was approved by the Ethics Committee of The First Affiliated Hospital of Jinan University (Approval No.: 2016-138).

Inclusion criteria: (1) Pathologically confirmed malignant neck tumors treated with neck lymph node dissection; (2) Patients are receiving tunneled PICC; (3) Postoperative PICC placement followed by completion of at least one cycle of chemotherapy following catheter insertion; (4) Chemotherapy regimens containing platinum-based agents with standardized dosages; (5) PICC catheter indwelling duration ≥14 days; and (6) Complete clinical records.

Exclusion criteria: (1) Pre-existing systemic infection (e.g., pneumonia, urinary tract infection) or the presence of skin lesions, erythema, or exudation at the puncture site prior to catheter placement; (2) Coexisting coagulation disorders (prothrombin time >16 seconds or activated partial thromboplastin time >45 seconds) or severe bleeding tendency; (3) Allergy to PICC catheter materials (e.g., silicone, polyurethane); (4) Premature discontinuation of treatment or loss to follow-up during chemotherapy due to tumor progression, multiple organ failure, or other causes; (5) Concurrent immunodeficiency disorders or malignancies in other sites.

CRI diagnostic criteria were as follows [13]: (1) Clinical diagnosis: ① Redness, swelling, pain, or exudation (purulent or non-purulent) at the puncture site or along the subcutaneous tunnel; ② Unexplained fever (temperature >38.0°C) and chills, with other infection sources excluded; (2) Microbiological diagnosis: ① Catheter tip culture (a 5-cm catheter tip segment obtained after catheter withdrawal) showing ≥15 colony-forming unit (CFU); ② Isolation of the same pathogen from both peripheral

blood and catheter blood cultures, with catheter blood colony counts exceeding peripheral blood counts by at least five folds.

Procedures of PICC placement

Preoperative preparation: (1) Patient Assessment: Ultrasound examination was performed to evaluate upper limb and thoracic wall veins (brachial, axillary, subclavian, femoral veins) for diameter (≥3 mm) and blood flow velocity, excluding venous thrombosis. Complete blood count, coagulation function, and fasting blood glucose were tested to ensure the absence of contraindications. Healing of the cervical surgical incision was assessed, and only patients with Grade A healing were eligible. (2) Equipment Preparation: PICC kit (4 Fr/5 Fr, Bard Medical, USA), high-frequency ultrasound scanner, sterile puncture set, 2% lidocaine, saline solution, heparinized saline (10 U/mL), sterile transparent dressing, guidewire, dilator, and related materials were prepared. (3) Environmental Preparation: Procedures were conducted in a sterile operating room. Ultraviolet sterilization was performed for 30 minutes, with an airborne bacterial count ≤500 CFU/m^3. Personnel wore sterile surgical gowns, gloves, masks, and caps, adhering strictly to aseptic technique.

Procedure: (1) Site Selection: The right cephalic vein (5-8 cm above the elbow crease) was preferentially selected, followed by the subclavian vein. If upper limb veins were unsuitable, the femoral vein was considered, avoiding the perineal region [14]. (2) Local anesthesia: 2% lidocaine was subcutaneously infiltrated at the puncture site, avoiding intravascular injection. (3) Puncture and Catheter Placement: Under ultrasound guidance, the target vein was punctured at a 30°-45° angle. Upon visualization of venous return, a guidewire (approximately 40-50 cm in length) was advanced, and the puncture needle withdrawn. The subcutaneous tissue was dilated with a dilator, which was then removed. The PICC catheter was advanced to the predetermined length (50-60 cm). (4) Positioning and Fixation: The guidewire was withdrawn, and the catheter lumen was flushed with saline to confirm unobstructed venous return. Chest X-ray was obtained to verify that the catheter tip was located at the junction of the lower third of the superior vena cava and the right atrial infundibulum. Excess catheter length was trimmed, a heparinized cap attached, and the puncture site secured with a sterile transparent dressing. The placement date and exposed length were recorded.

Postoperative maintenance: (1) Flushing and sealing: Pulse flushing with 10 mL saline was performed before and after each infusion. Following chemotherapy, the catheter was sealed with 5 mL heparinized saline (10 U/mL) under positive pressure. (2) Dressing frequency: The first dressing change was performed 24 hours post-placement, followed by weekly changes. Dressings were replaced immediately if damp, loose, or contaminated. (3) Observation and documentation: The puncture site was assessed daily for erythema, oedema, exudate, or pain. The exposed catheter length was recorded, and vigilance was maintained for catheter displacement or dislodgement.

Observed indicators

(1) Incidence of CRI: The infection rate and infection type, including exit-site infection, tunnel infection, and catheter-related bloodstream infection (CRBSI), were recorded. (2) Pathogen Distribution: Exudate specimens from puncture sites, catheter tips, and blood samples obtained from infected patients were collected for pathogen culture. Then, the pathogen types and composition ratios were statistically analyzed. (3) Identification of Risk Factors: Univariate and multivariate logistics regression analysis were performed to identify factors associated with CRI. Factors such as age, sex, number of punctures per session (≤2 or >2), PICC indwelling duration (≤30 days or >30 days), catheter displacement, concomitant diabetes, white blood cell count (≤3.0×10^9/L or >3.0×10^9/L), chemotherapy cycles (<8 cycles or≥8 cycles), dressing change frequency (≤7 days or >7 days), immune function and insertion site (cephalic vein, subclavian vein or femoral vein) were included.

Statistical methods

Statistical analyses were performed using SPSS version 28.0. Continuous variables were presented as mean ± standard deviation (SD) and compared using the independent samples t-test. Categorical variables were expressed as rates (%) and compared using the chi-square test. Variables with $P<0.05$ in the univariate analysis were incorporated into a multivariate logistic regression model to identify indepen-

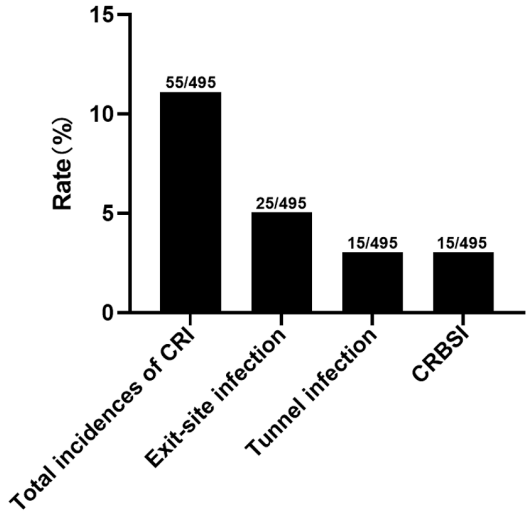

Figure 1. The distribution of infection types and incidences for catheter-related infection. Note: CRI: Catheter-related infection; CRBSI: Catheter-related blood stream infection.

dent risk factors. Then, variables identified as significant by the multifactorial analysis were subsequently incorporated into a joint logistic regression prediction model. The predictive efficacy of this model was evaluated using receiver operating characteristic (ROC) curve analysis. A two-sided *P*<0.05 was considered significant.

Results

General information

Among 495 patients, 55 cases developed catheter-related infections, representing an incidence rate of 11.11%. Regarding the type of infection, an exit site infection was defined as redness, swelling, and purulent discharge at the puncture site. Tunnel infection was considered as pain and induration in the catheter tunnel area. Catheter-related bloodstream infection (CRBSI) was defined as having high fever, chills and positive blood culture. As shown in **Figure 1**, there were 25 cases (45.45%) with the exit site infection, 15 cases (27.27%) with the tunnel infection and 15 cases (27.27%) with CRBSI.

Distribution of pathogenic bacteria in CRI patients

As shown in **Figure 2**, eleven pathogenic strains were isolated from 55 CRI patients, comprising

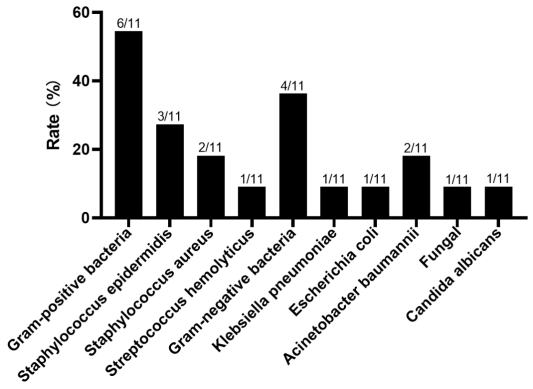

Figure 2. Distribution of pathogenic bacteria in CRI patients. Note: CRI: Catheter-related infection.

six Gram-positive bacteria (54.55%), predominantly *Staphylococcus epidermidis* (three strains, 27.27%) and *Staphylococcus aureus* (two strains, 18.18%), four Gram-negative bacteria (36.36%) including one *Klebsiella pneumoniae* (9.09%), one Escherichia coli (9.09%) and two *Acinetobacter baumannii* (18.18%), and one fungal (*Candida albicans*) (9.09%).

Univariate analysis of CRI patients undergoing tumor tunnel PICC catheterization chemotherapy

There were no significant differences between the two groups in the term of age or gender (all P>0.05). The CRI group exhibited higher proportions of patients requiring >2 punctures per session, PICC indwelling duration >30 days, catheter displacement, concomitant diabetes, white blood cell count $\leq 3.0\times10^9$/L, ≥8 chemotherapy cycles, dressing changes >7 days apart, immunodeficiency, and femoral vein catheter placement compared to the non-CRI group, and significant differences were found between two groups, as shown in **Table 1**.

Multivariate analysis for CRI patients undergoing tumor tunnel PICC catheterization chemotherapy

Variables with P<0.01 by univariate analysis were included in multivariate logistic regression analysis. It was indicated that PICC indwelling duration >30 days, catheter displacement, concomitant diabetes mellitus and white blood cell count $\leq 3.0\times10^9$/L were all independent risk factors for CRI occurrence (all P<0.05), as shown in **Tables 2** and **3**.

Table 1. Univariate analysis of CRI patients undergoing tumor tunnel PICC catheterization chemotherapy

Factor		CRI group (n=55)	Non-CRI group (n=440)	χ^2/t value	*P* value
Age (years)		45.23±4.54	45.12±4.65	0.074	0.941
Hypertension		9 (16.36)	54 (12.27)	0.737	0.391
Hyperlipidemia		7 (12.73)	39 (8.86)	0.866	0.352
Chemotherapy cycles		8.2±1.5	7.9±1.3	1.593	0.112
Gender	Male	30 (54.55)	268 (60.91)	0.826	0.363
	Female	25 (45.45)	172 (39.10)		
Number of Single puncture (Times)	≤2	30 (54.55)	300 (68.18)	4.091	0.043
	>2	25 (45.45)	140 (31.82)		
Indwelling time of PICC (d)	≤30	15 (27.27)	209 (47.50)	8.074	0.005
	>30	40 (72.73)	231 (52.50)		
Movement of the tube	No	15 (27.27)	221 (50.23)	10.330	0.001
	Yes	40 (72.73)	219 (49.77)		
Complicated with diabetes mellitus	No	25 (45.45)	400 (90.91)	83.190	<0.001
	Yes	30 (54.55)	40 (9.09)		
White blood cell count ($\times10^9$/L)	≤3	35 (63.64)	190 (43.18)	8.250	0.004
	>3	20 (36.36)	250 (56.82)		
Chemotherapy treatment course (Times)	<8	25 (45.45)	268 (60.91)	4.834	0.028
	≥8	30 (54.55)	172 (39.09)		
Frequency of dressing change (d)	≤7	25 (45.45)	267 (60.68)	4.686	0.030
	>7	30 (54.55)	173 (39.32)		
Immunologic function	Normal	20 (36.36)	232 (52.73)	5.238	0.022
	Low	35 (63.64)	208 (47.27)		
Catheter position	Basilic vein	15 (27.27)	180 (40.91)	7.553	0.023
	Subclavian vein	15 (27.27)	137 (31.14)		
	Femoral vein	25 (45.45)	123 (27.95)		

Note: PICC: Peripherally inserted central catheters; CRI: Catheter-related infections.

Table 2. Assignment of independent variables

Independent variable	Assignment
Indwelling time of PICC	≤30 d: 0, >30 d: 1
Catheter displacement	No: 0, Yes: 1
Complicated with diabetes mellitus	No: 0, Yes: 1
White blood cell count	>3.0×10^9/L: 0, ≤3.0×10^9/L: 1

Note: PICC: Peripherally inserted central catheters.

Development and evaluation of the binary logistic regression model

Based on the results of the multivariate logistic regression analysis in **Table 3** and utilizing the regression coefficients, the following factors were combined: indwelling time of PICC (>30 d), catheter displacement, complicated with diabetes mellitus and white blood cell count. Let X1 = indwelling time of PICC (>30 d), X2 = catheter displacement, X3 = complicated with diabetes mellitus, X4 = white blood cell count. The variable Y represented the new value of the combined prediction model for X1, X2, X3, X4. This yields the combined predictive regression model: Y=1.603*X1+1.510*X2+1.398*X3+1.325*X4. This model assessed the relative impact of each factor on the incidence of catheter-related infections in patients. The area under the curve (AUC) for predicting CRI efficacy was 0.896 [0.845, 0.947], with an optimal cut-off value of 7.194, yielding a sensitivity of 91.0% and a specificity of 79.0%. This indicated the model possessed good predictive

Table 3. Risk factors affecting CRI incidence in patients undergoing tumor tunnel PICC catheterization chemotherapy

Risk factor	β	SE	Wald	*P*	OR	95% CI
Indwelling time of PICC (>30 d)	1.603	0.576	7.782	0.007	4.982	1.563-15.821
Catheter displacement	1.510	0.589	6.584	0.011	4.523	1.412-14.485
Complicated with diabetes mellitus	1.398	0.567	6.052	0.018	4.051	1.284-12.733
White blood cell count (≤3.0×10^9/L)	1.325	0.579	5.296	0.024	3.762	1.193-11.812

Note: PICC: Peripherally inserted central catheters; CRI: Catheter-related infections; SE: Standard error; OR: Odds ratio; CI: Confidence interval.

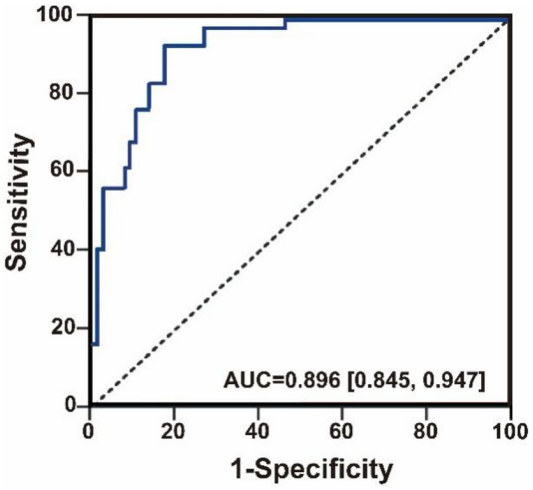

Figure 3. ROC curve for logistic regression model prediction of CRI. Note: CRI: Catheter-related infection; AUC: Area under the curve; ROC: Receiver operating characteristic.

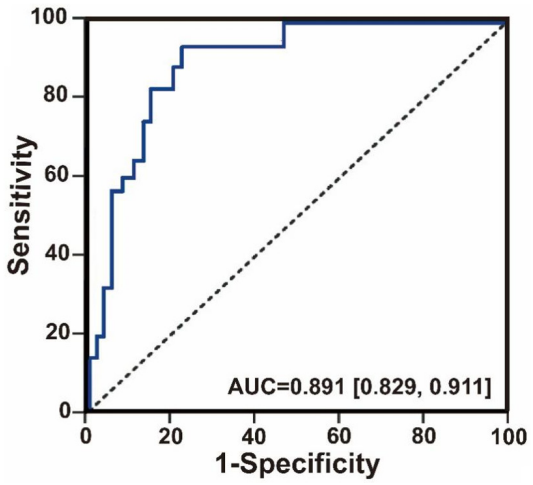

Figure 4. ROC curve for evaluating the efficacy of the model predicting CRI in the form of internal validation. Note: CRI: Catheter-related infection; AUC: Area under the curve; ROC: Receiver operating characteristic.

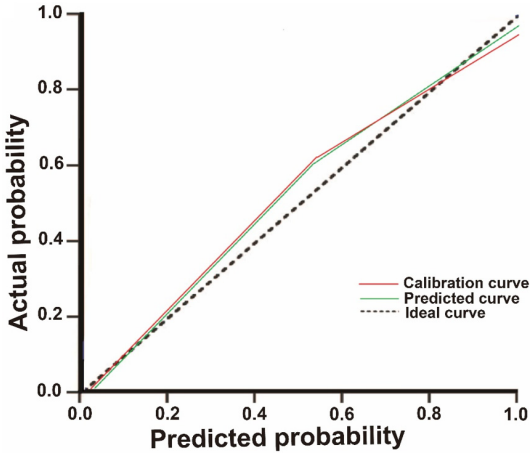

Figure 5. Calibration curve for the incidence of CRI incidence in patients undergoing tumor tunnel PICC catheterization chemotherapy. Note: CRI: Catheter-related infection.

efficacy for CRI, as seen in **Figure 3**. Within the internal validation cohort, the AUC of the ROC curve was 0.891 [0.829, 0.911], as shown in **Figure 4**. Calibration analysis results showed that the calibration curve was close to the ideal curve, as shown in **Figure 5**.

Additionally, 100 patients with tumor tunnel PICC catheterization chemotherapy were selected (10 patients with CRI and 90 without CRI) from February 2022 to May 2024 as an external validation cohort. The external validation cohort was derived from the same center over a different time period. Identical inclusion and exclusion criteria were applied for sample screening in the external validation cohorts. Baseline demographics, clinical characteristics, and key predictor variables were compared between cohorts to ensure consistency; no significant differences were observed (all P>0.05), confirming cohort comparability. Evaluation

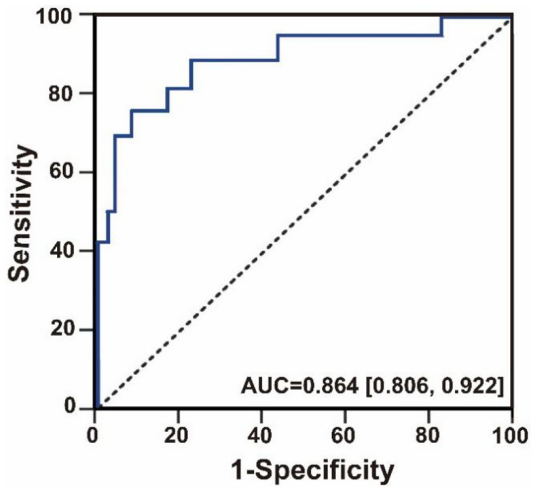

Figure 6. ROC curve for assessing the efficacy of the model predicting CRI in the form of external validation. Note: CRI: Catheter-related infection. AUC: Area under the curve; ROC: Receiver operating characteristic.

using the ROC curve yielded an AUC of 0.864 [0.806, 0.922], as shown in **Figure 6**.

Discussion

Tunneled PICC placement for chemotherapy in patients following neck tumor lymph node dissection is a widely adopted strategy for establishing long-term, stable venous access. However, the risk of developing CRI in this population should not be overlooked [15-17]. Patients who have undergone neck lymph node dissection represent a high-risk cohort due to surgical trauma and chemotherapy-induced immunosuppression. Neck lymph node dissection disrupts the local skin barrier and lymphatic drainage, resulting in delayed tissue healing and providing potential entry points for infection at the PICC insertion site and along the subcutaneous tunnel [18, 19]. Chemotherapy-induced granulocytopenia further compromises systemic immune defenses [20, 21]. Furthermore, as a foreign body, the catheter surface is prone to biofilm formation, creating an ideal breeding ground for bacteria, particularly *Staphylococcus epidermidis* and *Staphylococcus aureus*. CRI may present as localized redness, swelling, and purulent discharge at the puncture site, and in more severe cases, progress to bacteremia, triggering systemic toxic symptoms such as high fever and chills. Such complications not only disrupt chemotherapy schedules but can also be life-threatening [22, 23].

In the present study, among 495 patients, 55 developed CRI, corresponding to an incidence rate of 11.11%, with exit-site infections being the predominant site (25 cases, 45.45%). Eleven pathogenic strains were isolated, including six Gram-positive bacteria (three *Staphylococcus epidermidis* strains), four Gram-negative bacteria, and one fungal strain. Notably, the incidence of CRI in this study exceeded that typically reported in conventional PICC placements for general oncology patients. This was primarily the result of impaired postoperative lymphatic drainage in the neck region, compromised local immune barriers, and the effect of neck functional exercises on catheter stability. Consequently, even with standard procedures, the risk of infection exposure remained elevated. Exit-site infections predominated, likely because the external catheter segment is in direct contact with the skin surface. Postoperative patients exhibited reduced epidermal barrier repair capacity, and factors such as loosely applied dressings or excessive perspiration may facilitate skin-colonizing bacteria to breach compromised barriers, causing localized infection. Tunnel infections and catheter-related bloodstream infections occurred less frequently, reflecting the physical barrier provided by the tunnel structure against bacterial entry along the catheter's outer wall [24]. However, the risk of systemic infection arising from bacterial colonization within the catheter lumen remained.

Gram-positive bacteria accounted for over half of the isolates, predominantly *Staphylococcus epidermidis*. As a normal skin commensal, this bacterium can enter the bloodstream through the catheter if sterile technique is compromised during insertion. Its secreted polysaccharide adhesins cause biofilm formation on the catheter surface, impeding antimicrobial penetration and evading host immune responses, leading to persistent, difficult-to-treat infections [25, 26]. Gram-negative bacteria constituted 36.36% of isolates and were predominantly intestinal origin, possibly reflecting translocation from the gut microbiota or cross-infection during hospitalization. Fungal pathogens were infrequent, likely due to the absence of prolonged broad-spectrum antimicrobial use and the relatively preserved immune function, preventing the establishment of a microenvironment conducive to fungal overgrowth [27, 28].

Univariate analysis revealed that the CRI group exhibited a higher proportion of cases with more than two punctures per session, PICC indwelling duration >30 days, catheter migration, concomitant diabetes, white blood cell count ≤3.0×10^9/L, ≥8 chemotherapy cycles, dressing change intervals >7 days, immunodeficiency, and femoral vein catheterization compared to the non-CRI group. Multivariate logistic regression analysis identified PICC indwelling duration >30 days, catheter migration, concomitant diabetes mellitus, and white blood cell count ≤3.0×10^9/L as independent risk factors for CRI. Repeated punctures (>2 per session) can damage subcutaneous tissue and vascular endothelium, compromising the natural skin defense barrier and creating entry points for bacterial invasion [26, 29, 30]. Extended dressing change intervals (>7 days) permit cumulative bacterial colonization beneath dressings, further increasing infection risk [31, 32]. Among the independent risk factors, prolonged PICC indwelling (>30 days) induces vascular endothelial damage due to continuous catheter irritation, activates the coagulation system to form fibrin sheaths, and provides a substrate for bacterial colonization. Moreover, prolonged catheterization increases dressing change frequency, further weakening the skin barrier [33]. Catheter migration generates friction within the subcutaneous tunnel, damaging local tissue and vascular endothelium, while disrupting the local immune microenvironment. Concurrently, gaps created by the catheter movement allowed skin colonizing bacteria to enter the tunnel [34, 35]. In patients with concomitant diabetes, hyperglycemia suppresses neutrophil phagocytic activity and macrophage function, diminishing anti-infective capacity. Chronic hyperglycemia induced vascular endothelial cell apoptosis, reduces vascular elasticity, and slows blood flow, thereby creating conditions favorable for bacterial colonization and dissemination [36]. A white blood cell count ≤3.0×10^9/L, resulting from chemotherapy-induced bone marrow suppression, leads to insufficient core anti-infective cells, impeding clearance of locally colonizing bacteria and facilitating progression from localized to systemic infection [37].

Based on the multi-factor logistic regression coefficients, a combined clinical prediction model was subsequently established. The model demonstrated an AUC of 0.896, with sensitivity of 91.0% and specificity of 79.0%, indicating robust predictive efficacy for CRI. Internal and external validation further confirmed the model's predictive performance.

Based on these risk factors, the following interventions are proposed: (1) Optimize catheterization procedures: ① Employ ultrasound-guided puncture to enhance single-puncture success rates and minimize vascular injury; ② Perform immediate post-placement X-ray to verify catheter tip position within the lower third of the superior vena cava, promptly adjusting for misplacement to avoid repeated interventions; ③ Prioritize the right femoral vein as the primary puncture site when indicated, given its larger caliber and straighter course, which reduce misplacement risk. (2) Enhanced catheter maintenance: ① Limit indwelling duration to ≤30 days; if extension is necessary, perform vascular ultrasound every 30 days to assess vascular endothelial integrity and catheter condition; ② Use dual fixation methods: tunnel fixation with sterile sutures and exit site fixation with sterile transparent dressings adhering closely to the skin to minimize catheter displacement. ③ Standardize dressing change protocols: disinfect the puncture site and tunnel exit with 2% chlorhexidine alcohol solution, covering an area ≥10 cm in diameter. Document exposed catheter length after each dressing replacement and monitor daily for displacement. (3) Targeted management of underlying conditions and immune status: ① For patients with concomitant diabetes, maintain fasting blood glucose to <8.0 mmol/L preoperatively and monitor daily postoperatively to avoid hyperglycemia; ② For patients with a white blood cell count ≤3.0×10^9/L, implement prophylactic measures such as chlorhexidine mouthwash to prevent microbial translocation and administer prophylactic antimicrobial agents when necessary; ③ Enhance nutritional support for immunocompromised patients, including albumin and amino acid supplementation, to enhance immune function.

Nevertheless, several limitations of this study should be acknowledged. First, the single-center retrospective study design may have introduced selection bias and thereby limited

the generalizability of the findings. Second, although the sample size was relatively large, external validation was conducted in a limited number of patients from the same institution, and multicenter validation is still required. Third, long-term follow-up data were unavailable, and thus the impact of CRI on long-term catheter function, treatment compliance, and patient prognosis could not be fully assessed. Finally, the underlying biological mechanisms linking the identified risk factors to CRI were not investigated. Future prospective, multicenter studies with larger sample sizes and longer follow-up periods are warranted to validate the present findings and further elucidate the mechanisms underlying CRI development in this patient population.

Conclusion

Patients undergoing tunneled PICC chemotherapy following neck tumor lymph node dissection exhibited a relatively high incidence of catheter-related infections. PICC indwelling duration >30 days, catheter migration, concomitant diabetes mellitus, and white blood cell count $\leq 3.0\times10^9$/L were identified as independent risk factors for CRI. Therefore, targeted preventive and management strategies addressing these risk factors should be implemented to reduce the incidence of CRI and improve outcomes.

Disclosure of conflict of interest

None.

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