

Prevention of hematogenous infection in peripheral venous catheterization with integrated medical assistance in patients undergoing chemotherapy.



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Prevention of hematogenous infection in peripheral venous catheterization with integrated medical assistance in patients undergoing chemotherapy.

OBJECTIVE: *This study is aimed at verifying the effect of specific management modalities aimed at reducing or preventing the incidence of infections in the blood flow in relation to the use of the central venous catheter (CRBSI = catheter-related bloodstream infection) in patients undergoing chemotherapy.*

METHODS: *36 patients (n = 36) with a peripherally inserted venous catheter (PICC) were enrolled in the integrated medical treatment group, while 128 patients with an internal central venous catheter were enrolled in the control group. The patients in the control group underwent routine nursing, while the patients in the treatment group underwent integrated surveillance control infection treatment by doctors and were compared between these two groups for incidence of complications, CRBSI.*

RESULTS: *The incidence of complications of the CRBSI type was significantly lower in the whole treatment group than in the control group and the difference was statistically significant (p < 0.05).*

CONCLUSION: *It is concluded that the implementation of the infection control management modality within the integration of medical care for PICC chemotherapy patients in the Oncology Department can effectively reduce the incidence of infectious complications in the bloodstream, and improve the level of nursing care in peripheral venous catheterization (PICC) with improved patient satisfaction.*

KEY WORDS: Chemotherapy, Individualized management, Infection control management mode under medical care integration/Nursing, Peripherally inserted central catheter (PICC)

Introduction

The peripherally inserted central catheter (PICC) has been extensively used in intravenous chemotherapy¹. As a scientific and effective way of intravenous infusion,

PICC is a medical operation technique for implementing special medications and treatment, which can reduce the pain of multiple punctures and infusions in patients, and alleviate adverse reactions during the drug infusion². However, the incidence of catheter-related bloodstream infection (CRBSI) increases due to long indwelling time, the stimulation of blood vessels by the catheter, low white blood cell (WBC) count after chemotherapy, and the decrease in autoimmunity³. CRBSI refers to bacteremia or fungemia, complicated with fever (T ≥ 38 °C), shivering or hypotensive shock, and other infectious manifestations within 48 hours after intravascular catheter or removal of the intravascular catheter, with no other clear sources of infection except for the intravascular catheter. Laboratory microbial tests have revealed the positive bacteria or fungi from the peripheral venous blood culture, or pathogenic bacteria from the catheter

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segment and peripheral blood culture, with same species and same drug sensitive results, and this may be life-threatening when treatment is not given in time⁴. The incidence of CRBSI in tumor patients with PICC has reached up to 4.73%-8.92%⁵. The occurrence of CRBSI increases medical costs, prolongs the length of stay, increases the burden of patients, and increases mortality⁶.

The infection control management mode under medical integration refers to the doctors and nurses who cooperate with each other, promptly communicate, and jointly formulate and implement infection control measures. This is a modern infection control mode that achieves the overall management of medical staff and patients, emphasizes the prevention of cross-infection between doctors and nurses, patients and patients, patients and family members, and patients and articles in different links. Therefore, this is not only conducive to the improvement of nursing quality and effectiveness, but also fundamentally eliminates medical disputes⁷. In order to reduce the incidence of catheter infection in tumor patients with chemotherapy in the Oncology Department during the PICC and ensure the safety of patients, our department implemented the infection control management mode under medical care integration since January 2018, in order to carry out these intervention measures to prevent catheter infection in patients with chemotherapy in the Oncology Department, and this has achieved satisfactory results. These are reported, as follows.

Methods

CLINICAL MATERIALS

The present study was approved by the Ethics Committee of the center. A total of 136 patients with PICC, who were treated in our department from January to December 2018, were enrolled to the treatment group, while 128 patients with PICC from January to December 2017 were enrolled to the control group. Among these patients, 122 patients were male (46.2%) and 142 patients were female (53.8%), and their age ranged within 18-86 (66.7±24.8) years old. Furthermore, among these patients, 66 patients had breast cancer, 52 patients had colorectal cancer, 39 patients had lung cancer, 38 patients had gastric cancer, 21 patients had pancreatic cancer, 18 patients had liver cancer, 16 patients had ovarian cancer, 12 patients had esophageal cancer, and two patients had malignant lymphosarcoma. Inclusion criteria: (1) patients with a PICC indwelling time of 7-122 days; (2) patients who were ≥18 years old; (3) patients who had no CRBSI before admission; (4) patients with no history of psychiatric or psychological disorders; (5) patients who provided a signed informed consent. Exclusion criteria: (1) patients with psychiatric disorders; (2) patients with deafness or dyslexic; (3) patients without continuous chemotherapy.

STUDY METHODS

The catheters of all patients were 4FR three-way valvular PICCs (Bard, USA), and were connected with BD heparin cap at the end. The dressings were sterile transparent films (3M, USA). The catheterization was performed in the catheter room or ward by qualified venous specialist nurses. PICC maintenance and daily nursing were implemented by qualified primary nurses, who have been trained and passed the examination.

Control group

Patients in the control group received the routine infection control management mode. This included the strict implementation of the aseptic technique, implementation of catheter maintenance according to the PICC nursing routine, regular evaluation of catheterization quality, the conduction of extubation assessment and bacterial culture by evaluating the signs of redness, swelling, or infection of local skin in the early stage, and reasonable arrangement of the infusion sequence to avoid the complications of catheterization.

Treatment Group

The infection control management mode under medical care integration was implemented for patients, and the specific management plan was, as follows: establish an infection control management system under medical care integration in the department, and set-up an infection control team with the head doctor and head nurse as the team leaders. The team members consisted of two infection control doctors and three infection control nurses, and they were responsible for the infection control management systems and procedures of catheterization, the regular training of infection control, and the implementation of quality management of infection control in the whole process. (1) Implementation of catheter maintenance standards: According to the PICC maintenance guidelines of the American Infusion Nurses Society (INS) in the *American Nursing Practice Standards of Infusion Therapy*, all nurses of the department received PICC maintenance training and regular assessment, and were qualified and licensed to take up posts, in order to identify the control items, risk points and strategies related to infection⁸. The infusion therapy team members of the department applied the Checklist for the Prevention of Catheter Infection to regularly evaluate the susceptibility links during the catheter indwelling, standardize the operation process, formulate detailed and reasonable infection control plans, continuously improve the quality of care, monitor the incidence of CRBSI, and ensure the clinical safety and efficacy of tumor patients with PICC⁹. (2) Strict implementation of catheter main-

tenance operation procedures: The hospital infusion therapy nursing team unified the regulations for the PICC catheterization and maintenance procedures, strictly implemented the hand disinfection standard, changed the awareness of hand hygiene, strictly conducted the aseptic operation technique and increased the compliance of hand washing, maintained the manipulation standard, and used the maximum sterile barrier and whole arm disinfection when placing catheters, with a disinfection area of 15×15 cm, correct pulsing flushing, and the positive pressure sealing technology¹⁰. (3) Enhancement of infection control training: The disinfection and isolation system, nosocomial infection control monitoring system, hand hygiene and aseptic technique, blood-borne disease infection control monitoring, waste management and operation process standard were investigated in the department every month according to the plan. The learning and training of infection control and CRBSI prevention measures based on the JCI assessment criteria were regularly organized. The risk points of nosocomial infection that exist in the department were determined, and regular simulation operations, exercises and assessments were carried out for the junior nurses in the department¹¹.

The whole process quality control for the prevention of catheter infection was implemented¹². (1) Before the indwelling catheter: The standard operating procedure and preparation procedure were strictly implemented. The staff who performed the catheterization wore clean work clothes, a round hat and mask, and disinfected both hands with soapy water and hand disinfectant, based on the seven-step disinfection. Before the operation, the Catheterization Room was disinfected by ultraviolet light for one hour. The Waiting Room was set up with an air cleaner. The staff that assisted these patients wore shoe covers or changed slippers, and wear a round hat, assisted in cleaning the pre-selected puncture site with soap liquid and hand sanitizer, and wore a mask. Family members were not allowed to enter. (2) During the indwelling catheter: The aseptic technique and standard operating procedure were strictly implemented, which included wearing disposable sterile operating gowns, and completely covering these patients with large sterile sheets. (3) After the indwelling catheter: The first return visit system within 24 hours and the first dressing change system after 24 hours were strictly followed, in order to understand the working conditions of the catheter, observe the uncomfortable symptoms at the puncture points, such as blood seepage, pain, swelling, skin allergy and palpitation, and guide the patients in the regular application of hot soaks and performing handgrip exercises to prevent complications. The quality control staff of the infusion therapy team of the department performed weekly checks, and carried out continuous quality control on the patient's needs and self-care, and the nursing staff's catheter maintenance, observation and treatment of complications.

OBSERVATION INDICATORS

The diagnosis of CRBSI was carried out in accordance with the Diagnostic Criteria for Nosocomial Infection promulgated by the Ministry of Health⁸. According to the results of the laboratory blood culture, CRBSI was considered according to one of the following conditions: The blood was collected from the PICC and peripheral veins at the same time for the blood culture. The positive time of PICC blood culture was at least two hours earlier than that of the peripheral blood culture. The blood was collected from the PICC and peripheral veins at the same time for quantitative blood culture. The duct colony count-to-peripheral blood colony count ratio was $\geq 5:1$. In one case, the semi-quantitative catheter culture was positive or the quantitative catheter culture was positive, while the peripheral venous blood culture was positive, and this was the same microorganism as the segment of the catheter. CRBSI rate = the number of infection cases / the number of monitoring cases $\times 1,000\%$. Infection rate per thousand catheters daily = the number of catheter infection cases / the number of catheter days $\times 1,000\%$.

STATISTICAL TREATMENT

SPSS 20.0 statistical software was used to carry out the analysis. The measurement data were expressed as mean \pm standard deviation ($\bar{x} \pm SD$). *T*-test or *U*-test were adopted. The enumeration data were expressed by χ^2 . $P < 0.05$ was considered statistically significant.

Results

BASIC INFORMATION OF PATIENTS

As shown in Table 1, the difference in gender, age, catheterization site, catheterization time, bacterial colonization, application materials of the catheter, regular dressing change and frequency, tumor type, WBC count, coagulation mechanism, blood glucose level in patients complicated with type-2 diabetes, cirrhosis, and hormone or immunosuppressant treatment was not statistically significant ($P > 0.05$) between these two groups.

THE INCIDENCE OF COMPLICATIONS SUCH AS CRBSI IN THE TWO GROUPS OF PATIENTS

According to Table II, the incidence of local infection, phlebitis, CRBSI and bacterial culture positive in the control group was 8.5% (11 cases), 3.9% (five cases), 5.5% (seven cases) and 3.9% (five cases), respectively, while those in the treatment group was 3.7% (five cases), 2.2% (three cases), 1.5% (two cases) and 1.5% (two

Table I - Comparison of Basic information between the two groups

Project	Control group (n=128)	Treatment group (n=136)	P	
Gender				
Male	56	60	0.784	
Female	72	76		
Age(year, x±s)	63.2±22.6	66.4±21.3	0.591	
Location				
Cephalic vein	19	16		
Median cubital vein	21	13		
Basilic vein	88	107		
Retention time(d)				
≥14	116	129	0.184	
<14	12	7		
Catheter dressing material				
Aseptic transparent film from 3M	128	136		
Regular dressing change and frequency 7d/w	128	136		
Tumor types			0.569	
Breast cancer	30	36		
Colorectal cancer	24	28		
Lung cancer	18	21		
Gastric cancer	15	23		
Pancreatic cancer	12	9		
Liver cancer	10	8		
Ovarian cancer	10	6		
Esophageal cancer	7	5		
Lymphoma	2			
White blood cell count				0.426
≥2500	110	112		
<2500	18	24		
Clotting mechanism			0.323	
Normal	116	118		
Abnormal	12	18		
Blood glucose levels			0.103	
Normal	106	122		
Abnormal	22	14		
Application of hormone			1.000	
Yes	112	119		
No	16	17		
Immunosuppressant application			0.281	
Yes	36	42		
No	92	94		
Bacterial colonization			0.218	
Yes	5	2		
No	123	134		

cases), respectively. The incidence of these four diseases was significantly lower in the treatment group than in the control group ($p < 0.05$).

Discussion

The difference in the incidence of CRBSI and catheter local infection was very significant ($p < 0.05$) between the

treatment group and control group. This shows that the implementation of the infection control management mode under medical care integration can reduce the risk of CRBSI in patients and nosocomial infection among medical staff, continue the quality improvement and ensure medical safety, and standardize the operating procedure, thereby making infection control more standardized, normalized and internationalized¹³ In accordance with the standards of the monitoring system for

Table II - The incidence of complications such as CRBSI in the two groups of patients [n(%)]

Groups	Local infection	Phlebitis	CRBSI	Bacterial culture positive
Control group (n=128)	11(8.5)	5(3.9)	7(5.5)	5(3.9)
Treatment group (n=136)	5(3.7)	3(2.2)	2(1.5)	2(1.5)
X2	4.83	6.31	4.07	3.06
P	<0.05	<0.05	<0.05	<0.05

infection control and quality control in our hospital, the causes of infection should be timely analyzed, the key factors that lead to infection should be determined, the weak links should be optimized, and a three-level monitoring network with the department supervisor should be formed. In the opinion of the investigators, the infection control management mode under medical care integration should be implemented based on the following two aspects.

STRENGTHENING OF THE TRAINING AND ASSESSMENT OF HAND HYGIENE INFECTION CONTROL MEASURES

Operators should strengthen their hand hygiene during the indwelling and use of PICCs, and guide some important links, such as hand hygiene protection measures, during the period when the patient has a catheter. As the main transmission method of hospital pathogens, the hand plays an important role in nosocomial infection. According to domestic and foreign literature, careful hand washing can reduce the risk of nosocomial infection by 30%^{14,15}. Before and after the catheterization and maintenance, nurses should carry out strict hand disinfection, trainings and assessments, and improve the compliance and cautiousness of hand hygiene. Furthermore, QC nurses should perform a good job in home health education and guidance during the period when patients take the catheter home. These patients should be informed not to use their hands to pull off the sticker, and not to use the fixed positive pressure joint without permission. In case of bathing, sweating, sticker loosening or skin allergy, puncture point redness, swelling, and tingling, the patients should be instructed not handle this on their own, in order to avoid contamination to the sticker and catheter. This should be timely replaced, treated and maintained, in order to avoid causing unnecessary complications, such as infection. When maintaining the catheter, the patient should wear a mask to prevent saliva splashing, which may contaminate the sterilized site. If the patient's skin is allergic and itchy, the original sticker should be replaced in time, and a disinfectant should be applied to prevent itching. Patients should be strictly forbidden to scratch using their hands, in order to prevent pollution and skin damage.

REFINING THE WHOLE PROCESS MONITORING OF PICC MAINTENANCE TO REDUCE THE INCIDENCE OF CATHETER INFECTION

According to a survey, as many as 88% of these patients are worried about catheter care after discharge, and some of them were forced to pull out the catheter due to fear of complications, such as the CRBSI caused by the failure of normal maintenance after taking the catheter home¹⁶. In the present study, the infection control management mode under medical care integration was applied in the whole process of the PICC catheterization. Therefore, the quality management was intensively monitored, the environmental management of the catheter maintenance room was strengthened, and the patients were also required to wear a mask. It was strictly stipulated that full-time medical staff, who have obtained the Qualification Certificate of PICC Specialist Training and Assessment of Chinese Nursing Association, should perform the procedures and maintenance of catheterization, strengthen the room disinfection, hand disinfection and patient's skin cleaning and disinfection, reduce the cross-infection caused by environmental factors, establish the registration system of PICC complications in the department, register the complications of CRBSI, and report to the relevant quality control department. In case of any difficulties, the medical staff should analyze and discuss these during the infusion therapy team meeting in time, formulate solutions, discover problems and improve the catheter nursing work in time, eliminate the hidden dangers of catheter infection and the risk of infection, continuously improve the monitoring measures of nursing quality, strengthen the management and control of medical staff, and maintain the correct use of catheters in the whole process, in order to ensure the medical safety of patients. Nosocomial infection is becoming more and more important to medical workers, especially when CRBSI fails to be properly handled in time. This can increase the hospitalization period and medical expenses, delay the best time for effective treatment, and even has a life-threatening risk¹⁷. In accordance with the quality control plan for the prevention of PICC infection formulated by hospital infusion therapy team, our department implements the whole process control of prevention of catheter infection in patients with PICC, improves the

maintenance links, refines the operation process, standardizes the operator's behaviors, concept and awareness, enhances the education, strengthens the concept of maintenance effectiveness, strengthens the awareness of timely medical report, formulates the regular return visit system, carries out health and knowledge training lectures, and distributes the health education manuals¹⁸. Through the implementation of the infection control management mode under medical care integration, the investigators implement the nosocomial infection control, create a culture atmosphere conducive to the clinical medical safety of patients, reduce the risk of cross infection among patients and hospital employees, continuously improve the quality of hospital infection control, enhance the medical safety quality of tumor patients with PICC and the safety of catheters throughout the course, prevent and eliminate the occurrence of iatrogenic and pathogenic CRBSI, and obtain the good satisfaction of patients and their families to the hospital¹⁹.

Conclusion

In summary, the control measures in the implementation of the infection control management mode under medical care integration can effectively regulate nurse behaviors, significantly reduce the incidence of catheter infection, especially CRBSI and other serious complications, and improve the clinical efficacy of the long-term safe use of PICCs.

Riassunto

Questo studio è finalizzato a verificare l'effetto di specifiche modalità di gestione intese a ridurre o prevenire l'incidenza delle infezioni nel flusso ematico in relazione all'impiego del catetere venoso centrale (CRBSI = catheter-related bloodstream infection) nei pazienti sottoposti a chemioterapia.

Sono stati arruolati nel gruppo di trattamento medico integrato 36 pazienti (n = 36) con un catetere venoso inserito perifericamente (PICC), mentre 128 pazienti con un catetere venoso centrale interno sono stati arruolati nel gruppo di controllo. I pazienti del gruppo di controllo sono stati sottoposti ad un intervento infermieristico di routine, mentre i pazienti nel gruppo di trattamento sono stati sottoposti ad un trattamento di controllo dell'infezione integrato da sorveglianza da parte dei medici ed è stata confrontata tra questi due gruppi l'incidenza di complicanze, CRBSI.

Risultati: l'incidenza di complicanze del tipo CRBSI, è stata significativamente inferiore nel gruppo di trattamento integrato rispetto al gruppo di controllo e la differenza era statisticamente significativa (p <0,05).

Si conclude che l'implementazione della modalità di gestione del controllo delle infezioni nell'ambito dell'in-

tegrazione delle cure mediche per i pazienti chemioterapici con PICC nel Dipartimento di Oncologia può ridurre efficacemente l'incidenza di complicanze infettive nel torrente ematico, e migliorare il livello di assistenza infermieristica nel cateterismo venoso periferico (PICC) con miglioramento della soddisfazione del paziente

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