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Original Article

Evaluation of the effectiveness of iodophor disinfection intervention against catheter-related bloodstream infections in the operating room

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Abstract: Purpose: The goal of this study was to evaluate the effect of iodophor disinfection intervention on central line-associated catheterization infection (CLABSI) of central venous catheters in operating rooms. Method: A total of 315 patients with indwelling central venous catheter after undergoing an operation were selected as subjects for retrospective analysis. Among them, 160 patients were given iodophor disinfectant (intervention group), while another 155 patients did not receive disinfection intervention (control group). Data of the two groups were compared, including skin redness and pain at the puncture site, catheter indwelling time, incidence of CLABSI, bacterial culture at the puncture site, and the number of colonies. Results: The catheter indwelling time in the intervention group was 9.14±0.82 days, which was significantly higher than that in the control group (6.07±1.15 days) ($P < 0.001$). The infection rate of the intervention group was 5.63%, which was significantly lower than that of the control group by 17.42% ($P=0.001$). The number of colonies at the puncture site in the intervention group after disinfection (T2) and 24 hours after intubation (T3) was significantly lower than that in the control group ($P < 0.001$). In both groups, the number of colonies at T2 decreased compared with T1 ($P < 0.050$), while the number of colonies at T3 increased again compared with T2 ($P < 0.050$). The excellent rate of puncture of the intervention group was also significantly better than that in the control group ($P=0.001$). Conclusion: Treatment with iodophor can effectively reduce the occurrence of CLABSI after insertion of indwelling catheter in the operating room and has a long-term sterilization ability, which can improve the healing effect in patients to some extent.

Keywords: Lodophor disinfection, CLABSI, infection, catheter indwelling

Introduction

Central venous catheterization is a common procedure performed in critically ill patients. A central venous catheter can be used to monitor the blood flow of patients and assist in the injection of drugs. It is necessary for hemodialysis treatment and for safe delivery of parenteral nutrition [1]. For patients with large open trauma surgery, dialysis pathway loss and vascular disease restriction pathways are common after surgery, and the most effective and feasible means to maintain patency of vascular access is insertion of an indwelling central venous catheter [2, 3]. According to the statistics reported by Ha et al. [4], more than 90% of patients who had surgery underwent insertion of indwelling central venous cannula.

CLABSI is a condition of bacteremia or fungal disease in patients after catheter removal. It is a bloodstream infection associated with insertion of intravenous catheters [5]. Several studies [6, 7] have reported that compared with 10 years ago, the number of new CLABSI patients in 2016 is five times higher. According to Woodward et al. [8], the predicted mortality rate of CLABSI patients could be as high as 38%. At present, various clinics are working on finding other methods to reduce the severe effects of CLABSI. The key point of this work is preventing the occurrence of CLABSI [9]. The methods used to prevent the occurrence of CLABSI remained controversial. Since the hospital has applied iodophor disinfection in the operating room since 2016, it has achieved relatively good results.

Through retrospective analysis, this study aims to explore the intervention effect of iodophor disinfection on CLABSI and provide reference

and guidance for the future clinical prevention of CLABSI.

Methods and materials

General information

A total of 315 patients with an indwelling central venous catheter after operation in our hospital from May 5 to December 2017 were selected as subjects for retrospective analysis. Among them, 160 patients who were admitted in our hospital were given iodophor disinfectant during the treatment period, which was regarded as the intervention group and another 155 patients admitted in our hospital did not receive disinfection intervention during the treatment period and were regarded as the control group.

Inclusion and exclusion criteria

All cancer patients, patients whose cancer was diagnosed by biopsy performed in our hospital, patients whose follow-up treatment in our hospital was judged as suitable for surgery by our senior clinician. Patients whose surgery was completed in our hospital, patients who had a successful surgery, patients whose indwelling central venous catheter was inserted postoperatively for blood purification treatment, patients who had a catheter indwelling time of >48 h, patients who were willing to cooperate with the medical staff in our hospital, patients who had complete case data, and patients aged 30-60 years were included in the study. In contrast, patients who were surgically tolerant, patients who underwent radiotherapy and chemotherapy before surgery, patients with infectious diseases, patients with surgical failure, patients with vascular diseases, patients with multiple tumor diseases, patients with mental illness, patients with a family history of genetic diseases, patients who were on long-term bedrest, patients with physical disabilities, and patients who were transferred to the hospital were excluded from the study. This study was approved by the ethics committee of our hospital.

Treatment method

Patients in the intervention group were treated with iodophor disinfectant (5,000 mg/L, purchased from Qingdao Hainuo Medical Products Co., Ltd.) after the central venous catheter was placed to disinfect the blood purification center catheter and the skin around the puncture site. The disinfected area was approximately 15 cm, and the iodophor was applied three times. After the iodophor had dried, the cotton ball soaked with iodophor was applied to the puncture site to cover the transparent thin film. The control group used a conventional disinfection program, and after drying it, it was air-dried.

Observation index

Patients in both groups had redness and pain in the puncture site, which were categorized as follows: no redness and tenderness were judged as excellent, redness and tenderness that gradually disappeared were judged as effective, and redness and tenderness that did not improve or were severe were judged as ineffective. The overall excellent rate was computed as follows: excellent rate = (determined as excellent + determined as a valid patient)/total number × 100%. The catheter indwelling time was measured in both groups. A CLABSI diagnosis was made based on the 2015 CLABSI criteria [10]: presence of local infections, blood infections, suspected blood infections, and co-infections with multiple infections. Total infection rate was computed as follows: total infection rate = number of infections/total number × 100%. Furthermore, the number of bacterial culture colonies at the puncture site before the patient's central venous cannulation (T1), after disinfection (T2), and 24 hours after intubation (T3) was measured and the skin around the puncture site was sampled. The bacterial culture was also used to record the number of skin colonies at the puncture site. Treatment adherence was categorized into complete compliance (treated completely according to the doctor's advice and fully compliance with medical staffs), incomplete compliance (excessive or insufficient dose, increase or decrease in the number of administration, etc.), and non-compliance (resist treatment completely, question doctor's advice) and was computed as follows: treatment adherence = complete compliance with patients/total number × 100%.

Statistical method

Data were analyzed and processed using SPSS version 22.0 statistical software (Shanghai Yuchuang Network Technology Co., Ltd.), in which the count data such as patient age, gender, and CLABSI incidence rate were expressed as frequency (percentage). Chi-square test was

Table 1. Comparison of clinical data between the two groups of patients [n (%)]

	Intervention group (n=160)	Control group (n=155)	t/X^2	P
Age	51.24±9.24	49.87±11.43	1.172	0.242
Disease course (week)	3.64±1.82	3.96±2.04	1.470	0.143
Body weight (KG)	75.36±12.84	76.72±11.91	0.974	0.331
Body weight (KG)	75.36±12.84	76.72±11.91	0.974	0.331
Gender			0.840	0.359
Male	104 (65.00)	93 (60.00)		
Female	56 (35.00)	62 (40.00)		
Tumor type			1.350	0.853
Lung cancer	37 (23.13)	34 (21.94)		
Stomach cancer	40 (25.00)	35 (22.58)		
Cervical cancer	33 (20.63)	29 (18.71)		
Breast cancer	27 (16.88)	28 (18.06)		
Esophageal cancer	23 (14.38)	29 (18.71)		
Pathological stage			0.498	0.480
I~II	68 (42.50)	72 (46.45)		
III~IV	92 (57.50)	83 (53.55)		
Smoking			0.191	0.662
Yes	89 (55.63)	90 (58.06)		
No	71 (44.38)	65 (41.94)		
Drinking			0.106	0.745
Yes	105 (65.63)	99 (63.87)		
No	55 (34.38)	56 (36.13)		
Operation time (min)	164.82±34.38	70.54±38.27	1.396	0.164

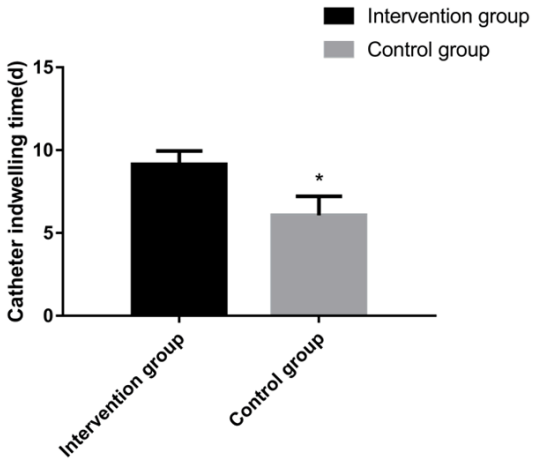

Figure 1. Catheter indwelling time in both groups. The catheter indwelling time in the intervention group was significantly longer than that in the control group; *represents the catheter indwelling time in the intervention group, P < 0.001.

used for comparison between groups. Measurement data such as time that redness and tenderness disappeared, catheter indwelling time, number of colonies, etc. are expressed as mean ± standard deviation, and t-test was used for comparison between groups. P < 0.05 indicated statistical significance.

Results

Comparison of clinical data

The age, gender, course of disease, tumor type, pathological stage, time of surgery, and smoking and drinking habits were compared between the two groups. No significant difference was found between the two groups (P>0.05), which proved that the two groups were comparable (**Table 1**).

Comparison of catheter indwelling time

The catheter indwelling time in the intervention group was 9.14±0.82 days, which was significantly higher than that in the control group (6.07±1.15) d (P < 0.001) (**Figure 1**).

Comparison of CLABSI infection rate

The infection rate of the intervention group was 5.63%, which was significantly lower than that of the control group by 17.42% (P=0.001). Blood infection was predominant in the intervention group, accounting for 2.50% (4 cases). In the control group, local infection was dominant, accounting for 7.10% (11 cases) (**Table 2**).

Comparison of the number of colonies at the puncture site

There was no significant difference in the number of colonies at the puncture site between the two groups at T1 (P=0.198). At T2, the number of colonies at the puncture site (0.24±0.84 cfu/cm^2) was significantly lower than that of the control group (12.53±2.84 cfu/cm^2) (P < 0.001). At T3, the number of colonies at the puncture site (4.32±1.48 cfu/cm^2) was significantly lower than that of the control group (30.76±4.86 cfu/cm^2) (P < 0.001). In both groups, the number of colonies at T2 decreased

Table 2. Comparison of infections between two groups of patients [n (%)]

	Intervention group (n=160)	Control group (n=155)	X^2	P
Local infection	3 (1.88)	11 (7.10)		
Blood infection	4 (2.50)	8 (5.16)		
Suspicious blood infection	1 (0.63)	3 (1.94)		
Concomitant infection	1 (0.63)	5 (3.23)		
Infection rate (%)	5.63	17.42	10.821	0.001

Table 3. Comparison of colony counts between two groups

	Intervention group (n=160)	Control group (n=155)	t	P
T1 (cfu/cm^2)	34.58±4.07	35.14±3.62	1.289	0.198
T2 (cfu/cm^2)	0.24±0.84*	12.53±2.84*	69.491	< 0.001
T3 (cfu/cm^2)	4.32±1.48$^{*,\#}$	30.76±4.86$^{*,\#}$	65.743	< 0.001

Note: *represents comparing with the number of colonies at T1 in the same group, P < 0.050; $^\#$represents comparing with the number of colonies at T2 in the same group, P < 0.050.

Table 4. Comparison of puncture sites between the two groups of patients [n (%)]

	Intervention group (n=160)	Control group (n=155)	X^2	P
Excellent	84 (52.50)	42 (27.10)		
Effective	65 (40.63)	83 (53.55)		
Invalid	11 (6.88)	30 (19.35)		
Valid rate (%)	93.13	80.65	10.832	0.001

Table 5. Comparison of treatment compliance between two groups of patients [n (%)]

	Intervention group (n=160)	Control group (n=155)	X^2	P
Full compliance	139 (86.88)	101 (65.16)		
Incomplete compliance	19 (11.88)	36 (23.23)		
Non-compliance	2 (1.25)	18 (11.61)		
Treatment compliance rate (%)	86.88	65.16	14.221	0.002

compared with T1 (P < 0.001), while the number of colonies at T3 increased again compared with T2 (P < 0.001) (**Table 3**).

Comparison of puncture sites

The excellent rate of puncture of the intervention group was 93.13%, which was significantly better than that of the control group (80.65%) (P < 0.001). In the intervention group, the proportion of patients who were rated as excellent was 52.50% (84 cases). In the control group, the proportion of patients who were considered as most effective was 53.55% (83 cases) (**Table 4**).

Comparison of treatment adherence

Treatment adherence of the intervention group was 86.88%, which was significantly higher than that of the compliance rate of the control group (65.16%) (P= 0.002). In the intervention group, only 1.25% (2) of patients were unable to comply with the treatment; in the control group, 11.61% (18) of patients were unable to follow the treatment (**Table 5**).

Discussion

Central venous catheterization is more suitable for patients with peripheral vascular conditions than those who need long-term infusion. It can not only effectively improve the treatment efficiency, but also significantly reduce the risks of CLABSI. Pain is usually caused by repeated puncture [11, 12]. Because the central venous catheter is used to puncture a relatively large blood vessel, it can significantly increase the patient's infusion rate and shorten the treatment time during infusion [13]. The high application value of central venous catheter in critically ill patients has led to the widespread use in clinical practice both at home and abroad, and the resulting infection has become an increasingly serious problem in the clinic. A number of studies [14, 15] have shown that the bacteria around the puncture site, decline in the patient's immunity, and several digestive system disorders may cause CLABSI. The most common disinfectant in clinical practice is iodophor, which not only

has strong bactericidal ability, but also has no side effects when given in normal dosage, which is suitable for extensive skin disinfection [16]. In this study, the incidence of CLABSI in patients with central venous catheterization was effectively reduced through disinfection with iodophor, suggesting that iodophor disinfection has a high application value for the prevention and treatment of CLABSI.

The results of this experiment suggests that iodophor intervention can effectively reduce the incidence of CLABSI. The iodophor solution is repeatedly applied on the patients' skin to achieve the sterilization effect [17]. The antibacterial spectrum of iodophor is broad. While the most common bacterial infection among patients with indwelling catheters during hospitalization is caused by bacillus species [18], iodophor disinfection is the best choice for preventing the occurrence of infection associated with indwelling catheters.

In this study, after disinfecting the patients' skin three times, the cotton ball soaked with iodophor solution was applied to the puncture site and a long-lasting sterilization effect was achieved. Patients in the intervention group exhibited a lower risk of developing complications of infection. The patient's puncture site was significantly improved, and their treatment compliance was greatly increased, suggesting that iodophor disinfection can also improve the healing effect in patients.

This study had some limitations. For example, the participants were relatively single, and all of them had a tumor. The number of patients within the selected age group and the condition selection were limited. Hence, additional research is required to further evaluate the participants of this study and continue improving our experiments in the future to achieve the best results.

In conclusion, treatment with iodophor can effectively reduce the occurrence of CLABSI after insertion of indwelling catheter in the operating room and has long-term sterilization ability, which can improve healing in patients to some extent.

Disclosure of conflict of interest

None.

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