

Incidence and Risk Factors of Peripherally Inserted Central Catheter-related Complications in Patients with Different Disease Types

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Abstract: Background: Cancer patients or critical patients need reliable vascular access to meet the requirements of transporting therapeutic drugs or nutrients. Peripherally inserted central catheters (PICCs) are widely used in these patients, however, the incidence of PICC-related complications is high and the data on specific diseases are not yet clear. Methods: We collected geographic characteristics and insertion information of patients with lung cancer, breast cancer, digestive tract tumor and ICU status who underwent PICC during May 2017 to June 2018. Univariate and multivariate analysis were used to estimate the risk factors of PICC-related complications. Results: 634 lung cancer, 979 breast cancer, 1453 digestive tract cancer, and 374 ICU status patients were enrolled in the study with 351 (10.2%) developed complications. There was no difference in the distribution of complications among different disease types ($P>0.05$). Drinking (OR 2.15, 95% CI 1.05-3.69, $P=0.012$) and prior surgery (OR 1.97, 95% CI 1.05-3.69, $P=0.035$) were risk factors of breast cancer patients. Prior surgery (OR 2.51, 95% CI 1.54-4.09, $P<0.001$) and site of PICC (OR 1.56, 95% CI 1.10-2.23, $P=0.014$) were the influenced factors of digestive tract tumor patients. Complications of ICU status patients were influenced by smoke (OR 5.83, 95% CI 1.30-26.14, $P=0.021$) and prior surgery (OR 3.43, 95% CI 1.44-8.13, $P=0.005$). Conclusion: The targeted and reasonable prevention and nursing care should be focused on by medical staff.

Keywords: Peripherally Inserted Central Catheters, Disease Type, Complications, Risk Factors

1. Introduction

PICC has been widely used in cancer and critically ill patients for some advantages such as convenient insertion,

short procedure time, reliable efficacy and fewer complications compared to central venous catheter [1, 2]. Despite the above advantages, PICC-related complications were still at an increased risk [3-5]. The evidence on prevent measures to PICC-related complications is urgently-needed.

Although previous studies have reported risk factors for complications, no consensus has been reached so far. According to the World Health Organization (WHO), Lung, colorectal, stomach and liver cancer are the most common types of cancer in men, while breast, colorectal and lung cancer are the most common among women [6]. In this study, we selected three common cancers (lung cancer, breast cancer and digestive tract tumor) and ICU status patients to explore their PICC-related complications and risk factors aiming to formulate targeted and reasonable prevention and nursing care for patients with specific disease types.

2. Materials and Methods

2.1. Design

This study was performed as a retrospective study at multicenter. All PICCs were 4F, silicone catheters and were placed by the professional nurse team according to instructions. The PICCs used in this study were a subset of Cathicoid™ PICCs produced by Branden Medical Scientific, Inc. From May 2017 to June 2018, patients with lung cancer, breast cancer, digestive tract tumor and ICU status who underwent PICC placement were eligible for inclusion in this study. We collected data on demographic characteristics, insertion situation and complication information during insertion and follow-up period. All data was provided by professional nurses teams who were responsible for catheterization and follow-up of patients included in the study.

2.2. PICC Placement Technique

All PICCs insertion followed care and maintenance protocols formulated by each center. Standard aseptic precaution including hand hygiene, barrier precautions and chlorhexidine skin antisepsis was performed during insertion.

Portable ultrasonography was used to evaluate insertion vein before insertion and catheter tip location was confirmed by chest radiography. Catheters were routinely flushed by nurses. The primary study endpoints were incidence of PICC-related complications. All patients were followed-up until they met criteria for a PICC-related complication or PICC removal.

2.3. Statistical Analysis

Categorical variables were reported as frequency (percent) and continuous variables as means (\pm standard deviation [SD]). Baseline comparisons of different disease types were performed using the chi-square test or Fisher's exact test for categorical variables. One-way ANOVA was used to compare difference for continuous variables. Comparisons of complications in different diseases used Cochran-Mantel-Haenszel (CMH) test. Univariate and multivariate analysis were used to explore risk factors of complications in different disease types. Enter method was used for logistic regression models. $\alpha=0.05$ was used for the significance to enter the model, and $\alpha=0.10$ was used for significance level to delete from the model. A two-sided P value of less than 0.05 was considered to indicate statistical significance. All analyses were performed with the SPSS software (version 24.0, SPSS Inc., IBM, NY, USA).

3. Results

Totally 634 lung cancer, 979 breast cancer, 1453 digestive tract cancer, and 374 ICU status patients were enrolled in the study with 351 (10.2%) developed complications. No significant difference was observed in most basic characteristics ($P>0.05$) expect for gender ($P=0.014$) and vein of PICC ($P<0.001$). The specific results of other basic variables were showed in table 1.

Table 1. Baseline characteristics of patients.

Characteristics	Lung cancer N=634	Breast cancer N=979	Digestive tract tumor N=1453	ICU status N=374	P value
Age*, year	55.3 \pm 12.5	54.8 \pm 12.8	54.3 \pm 12.6	53.8 \pm 12.6	0.187
Gender, Male	28 (45.4)	40 (41.4)	69 (47.8)	15 (42.5)	0.014
Weight*, kg	59.7 \pm 12.2	61.1 \pm 19.8	61.2 \pm 13.9	60.6 \pm 16.2	0.197
Marriage, married	50 (79.7)	78 (80.5)	117 (80.9)	31 (82.9)	0.649
Smoke	6 (10.4)	9 (9.3)	12 (8.6)	2 (6.4)	0.174
Drinking	5 (7.9)	8 (8.2)	10 (7.2)	2 (6.4)	0.670
Coronary heart disease ^Δ	1 (1.6)	1 (1.1)	3 (2.1)	(1.6)	0.359
Diabetic	15 (2.4)	1 (1.8)	2 (1.9)	1 (2.7)	0.716
Liver cirrhosis ^Δ	(0.9)	4 (0.4)	1 (1.2)	(0.5)	0.215
Prior surgery	5 (9.1)	7 (7.5)	12 (8.5)	3 (8.6)	0.651
Site of PICC ^Δ insertion ^Δ					0.062
Right arm	30 (48.1)	50 (51.5)	78 (54.0)	18 (49.7)	
Left arm	32 (51.7)	47 (48.5)	66 (46.0)	18 (50.3)	
Vein of PICC ^Δ insertion ^Δ					<0.001
Basilic vein	55 (86.9)	85 (87.5)	123 (85.1)	32 (86.9)	
Brachial vein	3 (5.7)	6 (6.3)	11 (7.6)	2 (7.5)	
Median vein	3 (5.4)	3 (4.0)	7 (5.3)	1 (3.7)	
Cephalic vein	1 (1.9)	2 (2.1)	2 (2.0)	(1.9)	
Other veins	(0.2)	(0.0)	(0.1)	(0.0)	
Inserting Length*, mm	41.3 \pm 4.2	41.0 \pm 4.2	41.2 \pm 4.2	40.9 \pm 4.6	0.501

*: t test; ^Δ: Fisher exact test

There was no difference in the incidence of complications among different disease types ($P>0.05$). The incidence of complications were 9.3%, 10.8%, 9.6% and 12.6% for lung

cancer, breast cancer, digestive tract tumor, and ICU status patients. OR and 95% CI were showed in table 2.

Table 2. Complications of patients with different disease types.

Disease types	Patients with complications (N=351, 10.2)	Patients without complications (N=3089, 89.8)	OR	95%CI	P value
Lung cancer	5 (9.3)	57 (90.7)	0.88	0.66-1.19	0.409
Breast cancer	10 (10.8)	87 (89.2)	1.10	0.86-1.40	0.446
Digestive tract tumor	13 (9.6)	131 (90.4)	0.89	0.71-1.11	0.291
ICU status	4 (12.6)	32 (87.4)	1.30	0.94-1.81	0.112

No risk factor was found for complications of lung cancer patients. In univariate analysis, drinking and prior surgery were related to complications of breast cancer patients, smoke, drinking, prior surgery and site of PICC were related to complications of digestive tract tumor patients, smoke, drinking, diabetic, and prior surgery were related to complications of ICU status patients. In multivariate analysis, drinking (OR 2.15, 95 CI% 1.05-3.69, $P=0.012$) and prior

surgery (OR 1.97, 95% CI 1.05-3.69, $P=0.035$) were risk factors of breast cancer patients. Prior surgery (OR 2.51, 95% CI 1.54-4.09, $P<0.001$) and site of PICC (OR 1.56, 95% CI 1.10-2.23, $P=0.014$) were the influenced factors of digestive tract tumor patients. Complications of ICU status patients were influenced by smoke (OR 5.83, 95% CI 1.30-26.14, $P=0.021$) and prior surgery (OR 3.43, 95% CI 1.44-8.13, $P=0.005$).

Table 3. Univariable and multivariable analysis for risk factors of complications.

	Univariable analysis		Multivariable analysis		
	χ^2	P value	OR	95% CI	P value
Breast cancer					
Drinking	9.80	0.002	2.15	1.18-3.9	0.012
Prior surgery	7.72	0.005	1.97	1.05-3.69	0.035
Digestive tract tumor					
Smoke	6.54	0.011	1.56	0.69-3.54	0.287
Drinking	5.74	0.017	1.11	0.46-2.68	0.819
Prior surgery	20.73	<0.001	2.51	1.54-4.09	<0.001
Site of PICC	7.21	0.007	1.56	1.10-2.23	0.014
ICU status					
Smoke ^Δ	-	0.001	5.83	1.30-26.14	0.021
Drinking ^Δ	-	0.020	0.67	0.13-3.44	0.633
Diabetic ^Δ	-	0.026	3.59	0.84-15.32	0.084
Prior surgery ^Δ	-	0.001	3.43	1.44-8.13	0.005

^Δ: Fisher exact test

4. Discussion

In this study, we explored the incidence and risk factors of PICC-related complications in different disease types. The main findings were as follows: 1) The total incidence of complications in lung cancer, breast cancer, digestive tract tumor and ICU status patients was 10.2%; 2) The incidence of complications were similar among the above four disease types; 3) Drinking and prior surgery were the most common risk factors for PICC-related complications.

Previous studies have reported the incidence of PICC-related complications in cancer patients patients [3, 7-9]. Bertoglio S. et al reported a 24.7% incidence of PICC-related complications [3]. Yap YS. et al showed a 15.9% rate of the overall complication⁹. But their research subjects were all patients with different types of tumors and did not explore the incidence of complications of a specific disease. Lung cancer, breast cancer and digestive tract tumor were common among cancer patients and accounted for a large proportion of catheter patients. To study the incidence and risk factors of complications in these patients can provide reference for nursing staff to take targeted nursing measures. In our study,

the PICC-related complications incidence of lung cancer, breast cancer, digestive tract tumor and ICU status were 9.3%, 10.8%, 9.6% and 12.6% respectively and significantly lower than some reports [10-12]. The lower incidence may be related to the material of PICC and the operation of medical staff. Although the incidence of complications in patients with different disease types was different, there was no statistical significance.

For lung cancer patients, we did not find risk factors of PICC-related complications. Prior surgery was the risk factor of PICC-related complication for breast cancer, digestive tract tumor and ICU status patients. For cancer patients and ICU patients, they may have received surgery just before catheterization, which has a certain impact on their physiological and psychological conditions. So their anti-infection and other abilities will decline which creat conditions for the occurrence of complications. For breast cancer patients, drinking was risk factor of PICC-related complications. Alcohol may affect the health of blood vessel [13, 14] and the performance of catheters [15]. Left arm insertion affected the incidence of PICC-related complications in digestive tract tumor patients. Compared

with the right arm, the left arm usually has less exercise and its vascular performance may be inferior to that of the right arm, so it is more likely to have complications. Smoke ICU patients were more likely to occur complication. It may due to their poor lung function and vascular status caused by smoking.

The greatest significance of this study is to make the medical staff focus on the key care of different diseases. Despite the fact that we've done research that no one else has done on the incidence and risk factors of specific diseases, there are several limitations of this study. Firstly, we have not made any further exploration for each specific complication. Secondly, the factors influencing the incidence of complications are not comprehensive. These limitation is worthwhile for us to overcome and do further research.

5. Conclusion

The incidence of PICC-related complications was 10.2% in lung cancer, breast cancer, digestive tract cancer, and ICU status patients and the incidence of complications were 9.3%, 10.8%, 9.6% and 12.6% respectively. Prior surgery was the risk factor of PICC-related complication. To reduce complications, we also should pay attention to drinking breast cancer patients, Left arm insertion digestive tract tumor patients and smoke ICU patients except patients with prior surgery. For other patients we did not focus on in this study may take targeted and reasonable nursing measures with reference to these conclusions.

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