Int J Clin Exp Med 2020;13(9):6810-6816
www.ijcem.com /ISSN:1940-5901/IJCEM0113753

Original Article

Analysis of predictive value of caprini evaluation model and autar scale on PICC-related venous thrombosis of lymphoma patients

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Received May 4, 2020; Accepted June 23, 2020; Epub September 15, 2020; Published September 30, 2020

Abstract: Objective: This paper discussed and analyzed the predictive value of Caprini evaluation model and Autar scale on PICC-related venous thrombosis (VTE) of lymphoma patients. Methods: A total of 55 lymphoma patients diagnosed with PICC-related VTE via color Doppler ultrasound from January 2014 to December 2019 were recruited as the case group. According to the ratio of the case group to the control group of 1:3, 165 lymphoma patients who received PICC catheterization with no PICC-related thrombosis were selected during the same period as the control group, on the basis of same gender and type of lymphoma, as well as similar age. Clinical data of the two groups were collected and scored by Caprini valuation model and Autar scale respectively. The two models of risk evaluation were compared for the differential predictive effect on PICC-related venous thrombosis in lymphoma patients. Results: The scores of both Caprini evaluation model and Autar scale in the case group were significantly higher than those of the control group ($P<0.05$); It was found that the area under the ROC curve of the Caprini evaluation model was significantly larger than that of the Autar scale ($P<0.05$); The sensitivity and specificity of the risk evaluation model were 0.818 and 0.721 respectively, and were 0.636 and 0.558 respectively of the Autar scale, indicating the statistically significant difference [X^2 (sensitivity)=5.06, P=0.024; X^2 (specificity)=6.09, P=0.014]. Conclusion: Both Caprini evaluation model and Autar scale have certain predictive abilities on PICC-related venous thrombosis of lymphoma patients, of which the predictive evaluation effect of Caprini evaluation model is superior to that of the Autar scale.

Keywords: Risk evaluation, lymphoma, PICC-related venous thrombosis

Introduction

The peripherally inserted central catheter (PICC) provides a safe and durative venous pathway of long-term transfusion for patient, which avoids the damage to blood vessels caused by repeated puncture [1, 2]. PICC has been widely used in clinical practice due to its advantages of simple and safe operation, long retention time of catheter, and relatively less complications, especially for patients with lymphoma who requires long-term chemotherapy. It can effectively avoid the pain of repeated puncture, and phlebitis or tissue necrosis caused by stimulation of chemotherapy drugs [3, 4]. However, with the widespread application of PICC, we should not ignore the possible complications in PICC indwelling duration, such as blockage, misplacement, fracture and detachment of catheter, infection of puncture site, as well as the venous thrombosis. Studies have shown that the incidence of PICC-related venous thrombosis with typical symptoms was about 1-15.7%, while the figure was as high as 33-75% of which there were no typical symptoms [5, 6]. Once PICC-related venous thrombosis is formed, it will not only cause accidental extubation, resulting in treatment interruption and aggravation of patients' treatment burden, but may also lead to pulmonary embolism, which seriously affects the life safety of patients [7]. Therefore, it is of great importance to evaluate the risk of PICC-related venous thrombosis in lymphoma patients [8]. Unfortunately, there are few hospitals in China that conduct the evaluation for PICC-related venous thrombosis, and most of

which that have not conducted evaluation are due to the lack of effective tools [9]. The Caprini evaluation model and the Autar scale are evaluation tools that are widely reported abroad [10, 11]. The purpose of this study is to provide a reference basis for the selection of risk evaluation tools applied to PICC-related venous thrombosis of lymphoma patients. The study results are reported as follows.

Materials and methods

General materials

A total of 55 lymphoma patients diagnosed with PICC-related venous thrombosis via color Doppler ultrasound from January 2014 to December 2019 were recruited as the case group. According to the ratio of the case group to the control group of 1:3, 165 lymphoma patients who received PICC catheterization with no PICC-related venous thrombosis were selected during the same period as the control group, on the basis of same gender and type of lymphoma, as well as similar age. This study was approved by the ethics committee of our hospital.

The inclusive and exclusive criteria

The inclusive criteria of the case group: (1) All patients included in the study were histopathologically diagnosed with lymphoma; (2) The placement of PICC catheters was operated by qualified nurses in our hospital, and the position of the catheter was determined through chest radiograph; (3) The age of the patients was ≥ 18 years old; (4) All patients involved had complete clinical data and signed the informed consents; (5) The symptom of PICC-related venous thrombosis was diagnosed by color Doppler ultrasound. The exclusive criteria: Non-lymphoma patients with PICC.

The inclusive criteria of the control group: the inclusive criteria of (1)-(4) were the same as those of the case group; (5) Patients diagnosed by color Doppler ultrasound without PICC-related venous thrombosis. The exclusive criteria were the same as the case group.

Methods

Investigation tools: (1) General Information Questionnaire: The questionnaire was designed by the researchers, which covered the age, gender, body mass index (BIM), combined chronic diseases, surgical history in the past 3 months, utilization of anti-coagulation, edema in lower extremities, history of thrombosis, and related hematological indicators of the patients. (2) The latest revised version of the Caprini evaluation model in 2009 was adopted, which included 40 risk factors that may lead to thrombosis, such as age, BIM, past medical history and surgical history, and special examinations for females. Assigned 1 to 5 points to different risk factor items, and divided the patients into 4 levels according to the total score, among which 0~-1 point was classified as low risk, 2 points as medium risk, 3-4 points as high risk, and ≥5 points as extremely high risk. (3) The revised Autar thrombus risk assessment scale in 2003 was adopted, which included 43 items in 7 dimensions on age, BIM, surgical operation, risk of trauma, mobility, existing high-risk diseases and special risks. Assigned 1 to 7 points to different risk factor items, and divided the patients into 3 levels according to the total score, among which 7 to 10 points were classified as low risk, 11 to 14 points as medium risk and ≥15 points as high risk. The corresponding preventive measures were recommended based on the patient's scores of each risk evaluation models.

Data collection

After training, two researchers were appointed to collect and sort out the clinical data of the two groups of patients by face-to-face inquiry of patients and searching of the information system of the hospital. Subsequently, the risk of PICC-related venous thrombosis was scored by the Caprini evaluation model and the Autar scale respectively. Data entry was performed by two persons.

Index observation

This study primarily observed the differences in the prediction of both Caprini evaluation model and the Autar scale for PICC-related venous thrombosis in lymphoma patients, and then observed the differences of each group's scores by the two methods.

Statistical methods

Statistical analysis and processing of the obtained data were adopted by SPSS19.0 statistical software. The measurement data con-

Table 1. Comparison of the general materials of the two groups of patients

Item	Case group (n=55)	Control group (n=165)	X^2/t/U	*P*
Gender (Male/Female, case)	31/24	93/72	0.0000	1.0000
Age ($\bar{x}$ ± s, age)	58.74 ± 9.25	59.26 ± 7.79	0.4085	0.6833
Hodgkin lymphoma/Non-Hodgkin lymphoma (Case)	8/47	24/141	0.0000	1.0000
Complicated diabetes (Yes/No, case)	11/44	29/136	0.0125	0.9110
Complicated hypertension (Yes/No, case)	20/25	79/86	0.1674	0.6824
History of surgery within 3 months (Yes/No, case)	16/39	56/109	0.4404	0.5069
Use of anticoagulant (Yes/No, case)	4/51	16/149	0.2933	0.5881
Lower limb edema (Yes/No, case)	10/45	4/161	14.6463	0.0001
History of thrombus (Yes/No, case)	8/47	3/162	11.5152	0.0007
White blood cell count ($\bar{x}$ ± s, 10^9/L)	7.68 ± 4.25	7.26 ± 4.12	0.6496	0.5166
Blood platelet count ($\bar{x}$ ± s, 10^9/L)	225.94 ± 89.68	228.37 ± 91.15	0.1719	0.8637
Packed cell volume ($\bar{x}$ ± s, %)	34.92 ± 4.86	38.72 ± 4.73	5.1246	0.0000
D-Dimer [M (P_{25}, P_{75}) mg/L]	0.52 (0.13, 1.14)	0.11 (0.11, 0.12)	5.0437	0.0000

forming to normal distribution were expressed as mean ± standard deviation ($\bar{x}$ ± sd), and the results were tested by Student's t test; The measurement data that did not conform to the normal distribution were represented by the median M (P_{25}, P_{75}) and the results were tested by the Mann-Whitney U test; The categorical data were expressed in percentage, and the results were tested with pairing 3D chi-square; SPSS was used to draw receiver operating characteristic curve (ROC) and calculate the area under the acute curve (AUC), and MedCalc software was used to compare the areas under the ROC curve of different risk evaluation models, *P*<0.05 indicated that the difference was statistically significant.

Results

Comparison of the general materials of the two groups of patients

In this study, a total of 220 patients with lymphoma met the inclusive criteria, including 32 cases of Hodgkin's lymphoma and 188 cases of non-Hodgkin's lymphoma. There were no statistical significances in gender, age, tumor type, combined chronic disease, surgical history in the past 3 months, utilization of anti-coagulation, leukocyte count, and platelet count in the two groups (*P*>0.05). However, in the comparison of edema in lower extremities, history of thrombosis, hematocrit (HCT), D-dimer, etc., the figures of patients in the case group were significantly higher than those in the control group (P<0.05). See **Table 1**.

Comparison of different risk evaluation models on the prediction of lymphoma PICC-related venous thrombosis and screening rate of high-risk patients

The scores of Caprini risk evaluation model and the Autar scale of case-group patients were significantly higher than those in control-group patients, and the difference was statistically significant (*P*<0.05). The screening rate of the Caprini risk evaluation model for high-risk patients in the case group was 83.64%, which was significantly higher than that of high-risk patients in the same group by the Autar scale (25.45%), and the difference was statistically significant (*P*<0.05). See **Table 2**, **Figures 1** and **2** for details.

Analysis of ROC curve of PICC-related venous thrombosis of lymphoma patients with differential risk evaluation models

The area under curve (AUC) of the Caprini evaluation model was significantly larger than that of the Autar scale (*P*<0.05) with the optimum cut-off values of 4 points and 11 points respectively. The sensitivity of the Caprini evaluation model was 0.818, and the specificity was 0.721; while the Autar scale had a sensitivity of 0.636 and specificity of 0.558, which has statistical significance of the difference [X^2 (sensi-

Table 2. Comparison of different risk evaluation models on the prediction of lymphoma PICC-related venous thrombosis and screening rate of high-risk patients

Item	Case group (n=55)	Control group (n=165)	t/X^2	*P*
Scoring by the Caprini risk assessment model ($\bar{x}$ ± s, score)	4.92 ± 2.38	3.06 ± 1.15	7.7143	0.0000
Percent of high-risk patients [Case (%)]	46 (83.64)	84 (50.91)	18.2769	0.0000
Scoring by the Autar scale ($\bar{x}$ ± s, score)	11.68 ± 3.82	9.46 ± 3.25	4.1935	0.0000
Percent of high-risk patients [Case (%)]	14 (25.45)	19 (11.52)	6.2864	0.0122

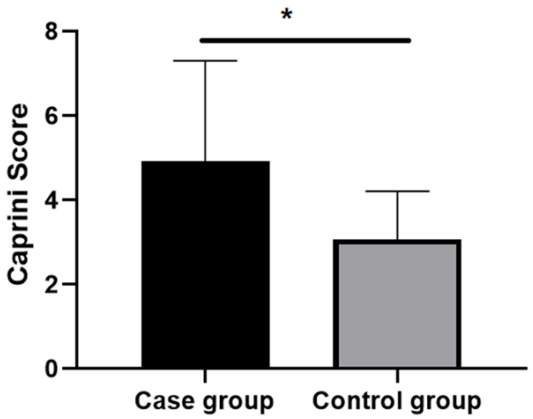

Figure 1. Comparison of the Caprini scores between the two groups. (Note: the area under the ROC curve of Caprini evaluation model and Autar scale were 0.768 and 0.634 respectively).

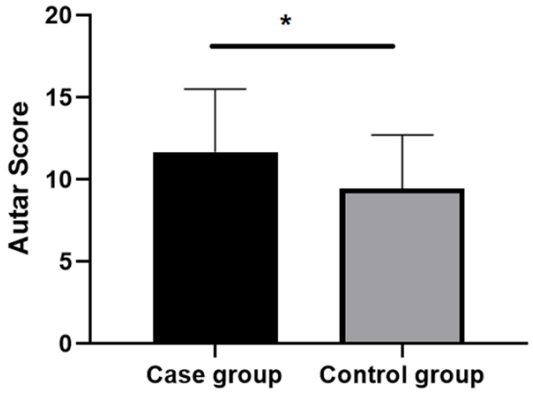

Figure 2. Two groups of Autar scores compared with the control group, **P<0.05.*

tivity)=5.06, *P*=0.024; X^2 (specificity)=6.09, *P*=0.014]. ROC curve is shown in **Figure 3**, and specific values are shown in **Tables 3** and **4**.

Discussion

The Caprini evaluation model, which was developed by American surgeon Caprini and his research team, is a kind of individualized VTE

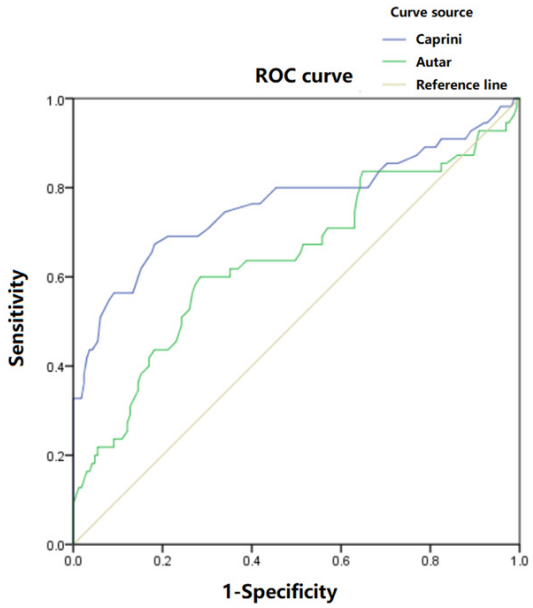

Figure 3. ROC curve of different risk evaluation models. (Note: The ROC curve area of Caprini evaluation model was 0.768, and was 0.634 of the Autar scale).

assessment model that based on the characteristics of surgical patients. In recent years, there are large-scaled retrospective studies in China and abroad have confirmed the effectiveness and feasibility of the model in screening high-risk patients with VTE. The Caprini evaluation model is widely used to assess the risk of venous thromboembolism in hospitalized patients, including severe pulmonary disease, acute myocardial infarction, septicemia, history of venous thrombosis and tumor. A great number of retrospective studies conducted both within China and abroad have confirmed that the model has an excellent predictive value on the risk of venous thromboembolism for the hospitalized patients [12-14]. In the *Chinese Experts' Guide on Prevention and Treatment of Tumor-related VTE* (2015 edition) [15], Caprini evaluation model was recommended as the risk evaluation tool of venous thromboem-

Table 3. Analysis of ROC curve of PICC-related venous thrombosis of lymphoma patients with differential risk evaluation models

Risk Evaluation Table	AUC	SE	95% CI	Z	P
The Caprini evaluation model	0.768	0.053	0.657~0.871	14.9488	0.0000
The Autar scale	0.634	0.059	0.513~0.759		

bolism for patients diagnosed with tumor. At present, Autar scale has been widely used in the risk evaluation of venous thromboembolism in hospitalized patients, especially the patients with orthopedic operation [16-18]. In respect to the screening of high risk of PICC-related venous thrombus in patients with lymphoma, the proportion of Caprini evaluation model for high-risk patients in the case group was 83.64%, which was significantly higher than that in the case group by the Autar scale (25.45%) according to the research studies. The results, which were consistent with Zhou Yating et al. [19], indicated that the Caprini evaluation model had higher sensitivity in screening high-risk patients, and it can reduce the rate of missed diagnosis of high-risk patients.

This study compared the area under the ROC curve of different risk evaluation models and found that concerning the prediction of PICC-related venous thrombosis in patients with lymphoma, the predictive value of the Caprini evaluation model is superior to that of the Autar scale, which was consistent with most research results [20, 21]. The reason may be that Caprini covers more comprehensive range of risk factors and has the term "central venous catheterization" which focuses on the characteristics of tumor patients. While for Autar scale, which was originated and developed in orthopedics, its items were more focused on the characteristics of patients after orthopedic surgery such as the mobility and bedridden condition, and they were thus more suitable for the prediction of venous thrombosis risk in orthopedic patients [22, 23]. Sensitivity and specificity determine if the evaluation model of thrombus risk can correctly distinguish the risk of PICC-related venous thrombosis in lymphoma patients. In this study, both the sensitivity and specificity of the Caprini risk assessment model were higher than those of the Autar scale, indicating that compared with the Autar scale, the Caprini risk evaluation model could improve the diagnosis rate of PICC-related venous thrombosis in lymphoma patients, reduce the rate of misdiagnosis and missed diagnosis in high-risk patients, and have a stronger ability to predict and eliminate the development of PICC-related thrombosis in lymphoma patients. Some scholars scored 216 patients with PICC catheterization by using Caprini evaluation model [24] and found that the sensitivity of the model was 77.14%, which was lower than the result of this study, while the specificity was 86.21%, which was higher than the result of this study. The reason of this result may be related to the different research objects.

In conclusion, both the Caprini evaluation model and the Autar scale have a certain ability to predict PICC-related venous thrombosis of lymphoma patients. The screening rate for high-risk patients by the Caprini evaluation model was significantly higher than that of the Autar scale, and the sensitivity and specificity of the prediction by the Caprini evaluation model were slightly higher than those of the Autar scale. According to the evaluation results, targeted preventive measures can be taken for lymphoma patients to provide strong guarantee for the prevention and treatment of PICC-related venous thrombosis. However, there were certain limitations and shortcomings in this study. On the one hand, the study subjects were chosen from one single center, and there may be certain commonalities among the cases in some respects. On the other hand, the small sample size of this study may have a certain impact on the statistical results. Therefore, it is important in future studies that the in-depth study of multiple centers and large samples to be carried out to support the results of this study.

Disclosure of conflict of interest

None.

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Table 4. Comparison of sensitivity and specificity prediction of different risk evaluation models on PICC-related venous thrombosis in lymphoma patients

3D chi-square test	Data↘		+ (Real positive people) The Caprini evaluation model			- (Real negative people) The Caprini evaluation model		
			+ (positive)	- (Negative)	Total	+ (positive)	- (Negative)	Total
	The Autar scale	+ (positive)	32	3	35	4	69	73
		- (negative)	13	7	20	42	50	92
		Total	45	10	55	46	119	165

Group	Sensitivity	Specificity	Misdiagnosis rate α	Rate of missed diagnosis β	Youden index J	Percent of consistency	Positive likelihood ratio	Negative likelihood ratio
The Caprini evaluation model	0.818	0.721	0.279	0.182	0.539	75%	2.9319	0.2524
The Autar scale	0.636	0.558	0.442	0.364	0.194	58%	1.4389	0.6523
X^2, P	5.06, 0.024	6.09, 0.014	-	-	-	-	-	-

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