



# AN ANALYSIS OF PROBLEMS RELATED TO SYMPTOMATIC THROMBOSIS CAUSED BY A CENTRAL VENOUS CATHETER HAS BEEN OBTAINED FROM A RETROSPECTIVE COHORT STUDY IN CRITICAL CARE UNIT INPATIENTS

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## ABSTRACT

A central venous catheter (CVC) is routinely used in critically ill patients for its ability to monitor vital signs, deliver drugs, and administer renal replacement therapy. CRVT is a condition caused by these catheters. We evaluated the rate of symptomatic CRVTs in ICU patients receiving CVCs along with disease-related risk factors that may contribute to symptomatic CRVT. From January 2015 to December 2019, 1643 consecutive patients who had CVC surgeries in the ICU were retrospectively examined. Sonography and clinical examination revealed many CRVT symptoms. From the electronic medical record system, the variables were retrieved and sorted into two groups based on the presence of symptomatic CRVT. We identified disease-related risk variables of CRVT using the logistic univariate and multivariate regression methods. Twenty-nine symptomatic CRVT events were recorded among the 2114 catheters. In 1000 catheter days, 9.5% of catheters experienced CRVT. The following factors have been identified as significant risk factors within the ICU for symptomatic CRVT: trauma, major surgery, heart failure, respiratory failure, and severe acute pancreatitis. In a multivariate analysis of the data, major surgery (OR 2.457; CI [1.641–3.679],  $P = .000$ ), CRVT in the ICU (OR 2.087; CI [1.401–3.111],  $P = .000$ ), and heart failure (OR 2.087; CI [1.401–3.111],  $P = .000$ ) were all significant independent risk factors. This model was statistically significant with a C-statistic of 0.61 (95 percent confidence interval [0.57-0.65],  $P = 0.000$ ). It was estimated that 9.5 catheter days per 1000 were symptomatic in the ICU group. There is a link between trauma, major surgery, and heart failure and symptoms of CRVT because all three are risk factors for the disease.

**Keywords:** - Thrombosis of the veins caused by catheters; symptoms; thromboembolism; dangerous state.

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## INTRODUCTION

In medical facilities, venous thromboembolism (VTE), a condition that occurs in hospitalized patients, is receiving increased attention due to increased mortality and morbidity rates [1,2]. Multiple studies have shown (CVC) that central vein catheters are one of the leading causes of hospital-acquired thrombosis. Catheter-related venous thrombosis (CRVT) is a type of VTE commonly found in hospitals [3]. The simplicity of CVCs makes

them an increasingly common method of administering intravenous drugs, providing renal replacement therapy, monitoring vital signs, and other practices in clinic, as well as increasing the risks of CRVTs [4-6]. The ICU in patients with acute diseases were more likely to receive CVCs. CVC-related thrombosis has been studied extensively in ICU patients, and factors such as the

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diameter of the venous catheter, lumen count, intubation point, transfusion [7], parenteral nutrition, sedation, and others are linked to this condition. Intensive care units (ICU) are usually reserved for critically ill or seriously injured patients [8]. No research has been conducted on the relationship between CVC-related thrombosis and serious conditions in patients in intensive care units. This study examined disease-related risk factors in patients with CRVT in the ICU who were symptomatic [9].

## Patients and procedures

### Ethics statement

The Ganzhou People's Hospital Medical Ethics Committee approved the retrospective cohort study, and we followed the guidelines carefully. The patient's relatives signed informed consent documents.

### Result Description:

This research was done at a 3200-bed university-affiliated hospital located in a regional medical center over five years. Using electronic medical record retrieval, we examined disease-related risk variables for symptomatic CRVT in critically ill in patients who were hospitalized in the ICU from January 2015 to December 2017. CVCs must be implanted in deep veins of patients aged at least 18 after spending three days in the intensive care unit. Inclusion criteria were the presence of significant thrombus in the CVC prior to admission to the ICU or an intubation period of less than three days.

As part of the research, we collected information about gender, age, hypertension, drinking and smoking, diabetes, history of malignancies, chronic obstructive pulmonary diseases, BMI, and APACHE II (acute physiology and chronic health evaluation II). We also gathered factors associated with hospitalization, including length of stay in the ICU, time spent intubated, time spent indwelling in a CVC, anticoagulant therapy, and contraindications to anticoagulant therapy. ICU admissions resulting from primary diseases were documented with the 9th Revision of the International Classification of Diseases.

### See section

Patients were admitted to the ICU due to their chief complaint, which defined the primary disease. Using the patient diagnostic information provided in the medical records, the members of the research group decided the main diseases were those that were difficult to identify. Patients who have suffered injuries to the head, chest, abdomen, and/or limbs are admitted to the ICU, regardless of whether they have other minor or severe diseases accompanying them. The body's respiration, circulation, and other organ functions may be disrupted by a major surgery that lasts more than two hours and requires life support.

Many trials could be conducted using catheterizations performed on one patient. Qualified practitioners may utilize ultrasound or nonultrasound guidance to perform intravenous catheterization depending on therapeutic needs. Internal jugular vein, subclavian vein, and femoral vein were among the injection sites.

As defined by the American Heart Association, symptomatic CRVT comprises thrombosis at the CVC insertion site. The catheter insertion site or the area where venous blood flows experience redness, swelling, and discomfort. Physicians conduct ultrasound exams in order to determine whether or not there is a catheter-related thrombosis when they discover thrombus symptoms. An attending radiologist interpreted the venous duplex ultrasonography, which was performed by certified technologists. According to the relationship between thrombus volume and vascular lumen, thromboses are classified as complete, mural, or absent.

### Analyzing the data

On the basis of CRVT symptoms, two groups of catheters were selected. Two independent samples are compared using t tests for two means and standard deviations of continuous data from the two groups. A Mann-Whitney test (interquartile range) is performed when nonparametric data are presented as a median. To compare percentages of categorical data, we used the two-test or Fisher exact test. 1000 CVC days were used to calculate the CRVT rate. Symptomatic CRVT is measured by Kaplan-Meier curves. The disease risk factors were analysed using both multivariate and univariate logistic regression models. In order to identify independent predictors of CRVT symptomatology by a multivariate regression model, variables with a P.1 on a univariate basis were included. These odds ratios (ORs) and 95% confidence intervals (CIs) are presented. The c-statistic is used when assessing a model's ability to predict. A significance level of 0.05 was applied to all two-sided tests. SPSS software was utilized. This is a version 24.0 of the IBM Armonk, NY; software.

## Outcomes

### Patient characteristics at the start

4904 patients were admitted to the ICU in the period between January 2015 and December 2019, including 329 patients under 18 years old, 2099 patients who spent fewer than three days in the ICU, 31 patients suffering from CVC thrombosis before arrival, 802 patients without CVC, and 1643 patients with CVC. Patients with up to three catheters were 1187, 380, and 76, respectively. The total number of catheterizations was 2196. There were 82 catheters excluded from the study due to their intubation time of less than three days. Consequently, 2114 catheters are available on the market.

CVCs with CRVT symptoms totaled 209 in total. ICU patients had an overall incidence rate of 9.5 per 1000 catheter days, with an overall total of 21,972 CVC days. Thrombotic events occurred in 75 percent of patients within 17 days of having catheters inserted. Two groups of 2114 CVCs were determined based on whether or not they exhibited symptomatic CRVT. A significant

difference was found between the two groups in age ( $P = .00$ ), BMI ( $P = .00$ ), APACHE II score ( $P = .001$ ), length of ICU stay ( $P = .000$ ), time to intubate ( $P = .000$ ), time to place central lines ( $P = .000$ ), anticoagulation therapy ( $P = .034$ ), and anticoagulant contraindications ( $P = .005$ ). A summary of the patients' clinical characteristics can be found in Table 11.

**Table 1:** outlines the study population's characteristics.

Types of variables	used (n = 2114 Computer Vision Censuses)	A total of 1905 CVCs did not have symptomatic CRVTs	209 CVCs had symptomatic CRVTs	statistically significant
in males (%)	1382 (67.3)	1288 (67.2)	146 (68.5)	.504*
(Median, Interquartile Range), Year	1950-1974	634(51–74)	67 (53–79)	.000†
Weight in kg/m2 within the range (IQR)	18-24	23-28-23-6	(20.8.12-14.9)	.000†
The median of the APEX II score (IQR)	25 (21–31)	25 23 28 26 24 28	28 (23–32)	.001†
Conditions				
Number (%) of Hypertension	807 (41%)	672 (40%)	85 (59.6)	.169*
Number of diabetics (%)	464 (219)	220 (22)	44 (21.1)	.753*
Percentage of malignant tumors	205 (9.5)	1845(9.4)	21 (11.3)	.868*
Number of cases of chronic obstructive pulmonary disease (%)	4945(33.5)	444 (34.4)	51 (24.8)	.853*
Pre-existing conditions				
Alcohol consumption (%)	421 (20.4)	385 (21.8)	37 (25.3)	.247*
Percentage of smokers	706 (34.4)	656 (34.8)	61 (29.56)	.124*
Hospital stay in intensive care unit, median (IQR), day	7 (5–28)	8 (5–28)	16 (7–38)	.000†
Difficulty in intubating endotracheally, median (IQR),	6 (4–25)	6 (4–15)	10 (5–33.5)	.000†
Time spent in the hospital (IQR), CVC indwelling	11 (9–23)	10 (5–15)	15 (22–31)	.000†
No. (%) of anticoagulant contraindications	631 (28.4)	551 (38.5)	78 (48.9)	.008*
Treatment with anticoagulants, No. (%)	723 (44.8)	664 (47.8)	68 (38.4)	.045*

In addition to BMI, COPD and CVC data, the health score will also be calculated using the chronic health assessment II.

#### In other words, the t-test for independent samples. Factors Predicting SCRVT

The most common primary diagnoses in patients admitted to an intensive care unit (n = 386 [18.3%]) are

sepsis, heart failure, major surgery, trauma, hypovolemic shock, renal failure, cerebrovascular disease, severe acute pancreatitis, hepatic failure, and intestinal obstruction. In each disease group, symptoms of CRVT were seen in 7

percent, 7.8%, 13.9 percent, 16.1%, 14.0 percent, 10.6%, 5.9%, 11.8 percent, 4.4 percent, 13.3 percent, and 15.0 percent of patients. Among the univariate risk factors for symptomatic CRVT in the ICU, trauma, major surgery, heart failure, respiratory failure, and severe acute pancreatitis were all associated with disease (Table 2). The multivariate analysis was then applied to these five variables. In consequence, a risk model

incorporating all five diseases was developed. Symptomatic CRVT in the ICU was associated with trauma (OR = 2.046; 95 percent confidence interval (1.325-3160),  $P = .001$ ), major surgery (OR = 2.457; 95 percent confidence interval [1.641-3777],  $P = .002$ ), and heart failure (OR = 2.087; 95 percent confidence interval [1.401-3.111],  $P = .002$ ) (Table 3).

**Table 2:** CRVT risk factors were analyzed univariately in 1905 patients (n=1905 CVCs).

The variables included	a CRVT with no symptoms (n = 1905) and CRVT with no risk factors (n = 1905).	209 showed symptoms (n = 1905).	OR	95 percent confidence interval	Probability
number of respiratory failures (%)	1878 (358)	13 (14 )	0.668	(0.442-4.002)	.065
No. of Sepsis (%)	364.5 (8.1)	29 (14.8)	0.738	=0.536-4.98	.138
Number of heart attacks (%)	290 (26.3)	22 (5.8)	2.96	1.141–2.399	.018
No. of major surgeries (%)	214 (22.3)	41 (18.7)	1.939	1.332–2.583	.012
Number of traumas (%)	215 (12.4)	35 (15.8)	1.592	1.071–2.446	.032
Number of hypovolemia (%)	128 (7.8)	15 (8.3)	1.093	0.621–1.997	.771
Number of renal failures (%)	95 (5.1)	6 (3.8)	0.668	0.241–1.392	.181
Number of Cerebrovascular Diseases (%)	83 (4.4)	11 (6.4)	1.327	0.647–2.349	.521
No. of cases of severe acute pancreatitis (%)	87 (5.4)	4 (3.8)	0.514	0.150–1.247	.098
Number of liver failures (%)	30 (2.1)	6 (2.8)	1.627	0.592–3.472	.445
Percentage of obstruction in the gastrointestinal tract	38 (2.7)	6 (2.8)	1.737	0.675–3.832	.388

Cathode-related venous thrombosis is referred to as OR and confidence intervals as CI.

**Table 3:** Analysis of multivariate logistic regression to identify factors related to symptomatic CRVT in oncology patients.

Factors implicated	include	95% CI	P value
(c-statistic 0.61; 95% confidence interval 0.57-66.5)			
Atraumatic events	2.057	1.436–3.241	<b>.012</b>
Operations mayores	2.358	(16.611-3.799)	<b>.000</b>
Dysrhythmia	2.087	0.401 3.11 311	<b>.000</b>
Failure to breathe	0.924	0.583-0.4281	.472
pancreatitis severe	0.492	0.207–1.458	.412

crvt symptoms in the icu are related to bolded risk factors. confidence intervals and origins ring in equal size.

## Discussion

A model based on the ICU primary disease risk model (c-statistic = 0.610) indicated that there were 9.5 symptomatic CRVT per 1000 catheter days among the ICU population [10]. An independent disease-related risk factor of symptomatic CRVT was trauma, followed by major surgery and heart failure.

In ICU patients, the chance of contracting VTE is higher; nonetheless, different medical facilities report different rates of hospital-acquired VTE. According to one study, duplex sonography [12] detected 59 CRVTs in 28% of ICU patients that had a CVC inserted or removed within 7 days of the placement. performed a retrospective analysis of vein thrombosis in medical ICU patients and found patients with suspected limb thrombosis that needed to be examined using ultrasound [13]. 16 percent of patients developed thrombosis, and 55.26 percent of patients required catheters. Further research was not conducted on symptomatic CRVT, however. A study investigated peripheral CVCs implanted in cancer patients that caused symptoms of thrombosis and found that there was a 6.7 percent incidence of symptoms of CRVT [14]. On average, there were 9.5 symptomatic cases of CRVT per 1000 catheterizations in the ICU group. Perhaps due to the population and the study methodology, the gap was so large. Participants in this study mostly had surgical conditions [15]. Severe accidents pose a greater risk for VTE.

The VTE risk for those with major injuries was greater than 50% in the absence of pharmacological treatment. The coagulation system is upset when functional protein C, antithrombin, and acute fibrinolysis levels are reduced, which disrupts the delicate balance of coagulation immediately after an injury [16]. In patients with severe recurrent trauma, endothelial and tissue injury, arterial stasis, and hypercoagulability together represent an important risk factor for early VTE. Among 153 patients with severe trauma at an ICU of a university level one trauma center, A study reported a prevalence of VTE of 30.7 percent [17]. This group of patients had a significantly increased risk of CVC (OR 4.39, 95 percent CI. We found that most wounds in our population were multiple injuries like serious head, neck, chest, and abdomen traumas [18]. In our study, 16.1% of patients with CRVT had symptoms, which seemed to be not very high. The study did not include thromboembolic disorders unrelated to CVC in its VTE.

Patients are brought to the ICU for life support after major surgery since their respiratory, circulatory, and other organ systems may become unstable [19]. In this hospital, abdominal surgery, cardiac surgery, open brain surgery, and multiple injury repair are the most commonly performed procedures. A venous thrombosis can form as a result of long operation periods, significant blood loss, blood transfusions, and general anaesthesia

use. The incidence of VTE after major surgery ranges from 3.6 percent to 21.3 percent according to clinical researchers in the fields of general surgery, orthopedics, thoracic surgery, urology, tumour surgery, and neurosurgery. A major surgical procedure poses a risk factor for VTE, and prophylactic measures should be implemented [20]. There are 255 patients who have been hospitalized after major surgery in the current study, 41 (13.9%) of whom had SCRVT. An independent risk factor for CRVT symptoms was major surgery.

The study showed that 16.2% (47/290) of patients admitted to the ICU for heart failure had a symptomatic CRVT [21]. ICU inpatients with heart failure comprise a significant percentage of inpatients in ICUs. Based on an analysis of heart failure patients from 2000 to 2013, a study reported increasing rates of heart failure caused by VTE [22]. In a study of inpatients with peripherally implanted CVCs, A researcher identified heart failure as a significant risk factor for thrombosis (OR, 2.52; 95 percent CI, 1.01–6.63) [23]. Cardioembolism, deep venous thrombosis, and pulmonary embolism are all complications of VTE, which is linked to heart failure and a prothrombotic condition. During the course of 22 years, a cohort of 13,728 patients showed 2696 cases of heart failure (20 percent), as well as 729 VTEs [24]. Researchers found a similar correlation between heart failure and an increased VTE risk (OR 4.39, 95 percent confidence interval [2.58–3.80]) that was independent of other VTE risk factors (OR 4.39, 95 percent confidence interval [2.58–3.80]) [25].

This study suggests that extended endotracheal intubations and prolonged CVC intubations may also increase the likelihood of CRVT in ICU patients. In this study population [26], anticoagulation therapy was insufficient due to anticoagulant contraindications. There was a statistically significant difference between the two groups in their anticoagulation treatment ( $P = .005$ ), indicating that symptomatic CRVT is more common. If anticoagulation is not contraindicated, patients should take anticoagulant medications if they are at risk for thrombosis, especially after major surgery or trauma. Prophylaxis for mechanical thrombosis should then be employed [27]. Likewise, according to this study, there were significant differences between these two groups in terms of age, BMI, APACHE II score, length of stay in the ICU, and other factors, in agreement with previous studies.

There are some weaknesses in our investigation. The first patients and one center that took part in the study were few. Due to this study's retrospective design and the diverse demographics of the population studied, information bias could have been introduced. In addition, only those CRVTs causing symptoms were examined in this study. Considering that non-symptomatic CRVT was



not accounted for in the study, the incidence of CRVT may have been underestimated.

## CONCLUSIONS

9.5 out of 1000 catheter days in the ICU group were associated with symptomatic CRVT. A variety of

diseases-related risk factors have been linked to symptoms of CRVT, including trauma, major surgery, and heart failure. ICU patients with these three disorders in particular should be administered thromboprophylaxis and/or mechanical prophylaxis to prevent symptomatic CRVT. See Supplemental Digital Content.

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