# ANALYSIS OF EPIDEMIOLOGICAL CHARACTERISTICS OF PATIENTS WITH VENOUS THROMBOSIS IN EMERGENCY DEPARTMENT OF A 3A HOSPITAL IN SHENZHEN DURING COVID-19 EPIDEMIC

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**Abstract:** Objective To explore the impact of COVID-19 on the incidence of thrombosis in Shenzhen, analyze the epidemiological characteristics of thrombotic diseases during the epidemic period, and predict the long-term incidence trend. Methods The data of thrombus patients in the emergency Department of Peking University Shenzhen Hospital from January 2017 to June 2024 were collected. R4.3.1 was used for statistical analysis. Results There were 115 patients with thrombus before the epidemic(January 2017 to December 2019), the male to female ratio was about 0.89:1. During the epidemic period(January 2020-December 2022), 190 patients with thrombosis were diagnosed, with a male/female ratio of 1.23:1. Since the epidemic(January 2023 to June 2024), 67 patients with thrombosis, the ratio of male to female is about 0.91:1. The number of patients in the 31~60 age group was the largest(51.30%,45.79%,44.78%, respectively). The main type of thrombotic disease was venous thrombosis (90.32%). Conclusion The COVID-19 epidemic significantly increased the incidence of thrombotic diseases, but with the popularization of vaccines and epidemic control, the incidence of thrombotic patients gradually recovered to the pre-epidemic level. **Keywords:** Thrombosis; COVID-19; Epidemiological characteristic; Incidence rate

#### **1 INTRODUCTION**

The global emergence of the SARS-CoV-2 virus has brought about a wide range of health challenges beyond the well-known respiratory symptoms. Emerging evidence from various clinical and research settings indicates that SARS-CoV-2 infection may induce significant vascular endothelial injury. The endothelium, which lines the interior surface of blood vessels, plays a crucial role in maintaining vascular homeostasis. When compromised by the virus, it can lead to a cascade of pathological events, including inflammation and the activation of coagulation pathways. Consequently, this increases the risk of thrombotic events, posing a serious threat to patients' health.

Thrombotic disorders, encompassing conditions such as deep vein thrombosis, pulmonary embolism, and arterial thrombosis, represent clinically significant pathologies with substantial morbidity and mortality. These conditions can lead to long-term health complications, reduced quality of life, and increased healthcare costs. Given their severe impact, understanding the epidemiological patterns of thrombotic disorders is crucial for developing effective prevention strategies, especially in the context of the ongoing pandemic.

The COVID-19 pandemic has disrupted many aspects of healthcare delivery and disease incidence. It is essential to investigate whether and how the pandemic has influenced the incidence of thrombotic events. Such an analysis can provide valuable insights into the interplay between viral infections and thrombotic risk, and help inform public health policies and clinical practices moving forward.

This study aims to fill this knowledge gap by analyzing data from thrombosis patients presenting to the Emergency Department of Peking University Shenzhen Hospital. The dataset spans a period from January 2017 to June 2024, covering both the pre-pandemic and pandemic periods. By comparing the incidence rates of thrombotic events before and during the pandemic, we can evaluate the pandemic's impact on thrombotic incidence. Additionally, this study will project long-term trends to anticipate future challenges and guide the allocation of healthcare resources. The findings from this research will contribute to a better understanding of the complex relationship between SARS-CoV-2 infection and thrombotic disorders, ultimately aiding in the development of targeted prevention and treatment strategies.

## 2 MATERIALS AND METHODS

## 2.1 Data Sources

The study cohort comprised consecutively enrolled patients diagnosed with thrombotic disorders at Peking University Shenzhen Hospital Emergency Department from January 2017 through June 2024.

## 2.2 Data Collection

Electronic medical records were systematically reviewed for:

Demographic characteristics (name, sex, age)

Diagnostic timestamps

Thrombosis classification

Inclusion Criteria:

(1) Physician-confirmed thrombotic diagnosis

(2) Venous thrombosis or non-cerebral/non-coronary arterial/microvascular thrombosis

Exclusion Criteria:

Cerebral/coronary thrombosis cases secondary to hypertension, atherosclerosis, or diabetes mellitus

Statistical Analysis

Analyses were performed using R version 4.3.1. Categorical variables were expressed as proportions. Inter-group comparisons (pre-pandemic vs. pandemic vs. post-pandemic) employed  $\chi^2$  tests with Yates' correction and Fisher's exact tests where appropriate. A Bonferroni-adjusted significance threshold of  $\alpha$ =0.025 (two-tailed) was applied for multiple comparisons.

## 2.3 Results

Demographic Characteristics: The index case of pneumonia of unknown etiology was identified on December 8, 2019. The COVID-19 pandemic period in China was defined as January 2020 through December 2022. Accordingly, we categorized thrombotic cases as follows:

Pandemic cohort: All thrombosis patients presenting to the emergency department during January 2020-December 2022 Pre-pandemic cohort: Cases from January 2017-December 2019

Post-pandemic cohort: Cases from January 2023-July 2024

The pre-pandemic cohort comprised 115 thrombosis cases, representing 0.0160% of total emergency department visits during this period. The cohort showed:

Gender distribution: 54 males (46.96%) and 61 females (53.04%) Age distribution peak: 31-60 years age group (51.30% of cases) (Table 1)

During the pandemic period, we identified 190 thrombotic cases (0.0393% of emergency visits), with: Significant male predominance: 105 males (55.26%) vs 85 females (44.74%) Highest proportion in 31-60 age group (45.79%) (Table 1)

The post-pandemic cohort included 67 cases (0.0141% of emergency visits), demonstrating: Gender distribution: 32 males (47.76%) and 35 females (52.24%) Predominance in 31-60 age group (44.78%) (Table 1)

Table 1 Distribution of Demographic Characteristics	es of Thrombosis Patients Visiting the Emergency Department of
Peking University Shenzhen Hos	ospital before, during and after the Pandemic

Before the Pandemic			During the Pande	mic		After the Pandemic			
Demographic	Number	Constituent	Demographic	Number	Constituent	Demographic	Number	Constituent	
Characteristics	of Cases	Ratio (%)	Characteristics	of Cases	Ratio (%)	Characteristics	of Cases	Ratio (%)	
Age Group			Age Group			Age Group			
(years old)			(years old)			(years old)			
< 30	4	3.48	< 30	21	11.05	< 30	7	10.45	
31~60	59	51.30	31~60	87	45.79	31~60	30	44.78	
61~90	43	37.39	61~90	80	42.11	61~90	29	43.28	
>90	9	7.83	>90	2	1.05	>90	1	1.49	
Gender			Gender			Gender			
Male	54	46.96	Male	105	55.26	Male	32	47.76	
Female	61	53.04	Female	85	44.74	Female	35	52.24	

Epidemiological Characteristics of Thrombotic Disorders

The predominant thrombotic subtype was venous thrombosis, accounting for 90.32% of all cases. Comparative analyses demonstrated:

Age-specific distribution: No statistically significant differences in thrombotic subtypes were observed across age groups ( $\chi^2 = 3.0349$ , P = 0.3863).

Sex-specific distribution: Similarly, no significant variations were noted between sexes ( $\chi^2 = 1.9856$ , P = 0.1588). However, stratification by sex revealed:

Venous thrombosis prevalence: 87.96% in males vs. 92.82% in females

Non-cerebral/non-coronary arterial and microvascular thrombosis prevalence: 12.04% in males vs. 7.18% in females (See Table 2 for detailed distributions.)

Table 2 Types of Thrombosis in Patients Visiting the Emergency Department of Peking University Shenzhen Hospital

(11, 76)										
Type of Disease	Age Group < 30	(years old) 31~60	61~90	>90	Gender Male	Female	Total			
Thrombosis of the Venous System	31(96.88)	156(88.64)	139(91.45)	10(83,33)	168(87.96)	168(92.82)	336(90.32)			
Arterial Thrombosis in Other Parts (Excluding Cerebral Arterial Thrombosis and Coronary Arterial Thrombosis) and Microcirculatory Thrombosis	1(3.12)	20(11.36)	13(8.55)	2(16.67)	23(12.04)	13(7.18)	36(9.68)			

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## **3 RESULT**

#### 3.1 Data Analysis

Regarding the change in the number of thrombosis patients over time, by comparing the period before the pandemic with that during the pandemic and using Fisher's exact probability test, the obtained p-value was  $1.372 \times 10^{-15}$  (the p-value was less than 0.025), indicating that the pandemic had a significant impact on thrombotic diseases. When comparing the period before the pandemic with that after the pandemic, the p-value obtained was 0.8054 (the p-value was greater than 0.025), which means that there was no significant difference in the number of thrombosis patients before and after the pandemic. The statistical data from Beishen Hospital shows that the proportion of the number of thrombosis patients in the total number of patients seeking medical treatment during the same period can be used to estimate the incidence of thrombotic diseases.

By comparing the number of patients with venous thrombosis during the pandemic with that before the pandemic and the number of patients with arterial thrombosis in other parts (excluding cerebral arterial thrombosis and coronary arterial thrombosis) and microcirculatory thrombosis, similarly, the p-value obtained was 0.284 (greater than 0.025), indicating that there was no significant difference in the impact of the COVID-19 pandemic on thrombotic diseases of the venous system and its impact on arterial thrombosis in other parts (excluding cerebral arterial thrombosis) and microcirculatory thrombosis in other parts (excluding cerebral arterial thrombosis diseases of the venous system and its impact on arterial thrombosis in other parts (excluding cerebral arterial thrombosis) and microcirculatory thrombosis.

Secondly, the number of thrombosis patients was counted in units of half a year. Bar charts were used to present the trends of the number of thrombosis patients over time, the number of patients with venous thrombosis over time, and the number of patients with arterial thrombosis in other parts (excluding cerebral arterial thrombosis and coronary arterial thrombosis) and microcirculatory thrombosis over time. Line charts were used to present the trend of the proportion of the number of thrombosis patients in the total number of patients seeking medical treatment during the same period over time and the trend of the proportion of venous thrombosis and arterial thrombosis in other parts (excluding cerebral arterial thrombosis and coronary arterial thrombosis) and microcirculatory thrombosis and coronary arterial thrombosis over time.



Figure: The Number of Patients with Venous Thrombosis in the Emergency Department of Beisnen Hospital and the Proportion of the Number of Patients with Venous Thrombosis in the Total Number of Patients Seeking Medical Treatment during the Same Period over Time from the First Half of 2017 to the Second Half of 2024





nd half of 2024, and the proportion of the number of such throm in the total number of patients treated during the same period.

(c)

Figure 1 The Proportion of Thrombosis Patients in the Emergency Department of Beishen Hospital to the Total Number of Thrombosis Patients over Time and the Number of Thrombosis Patients over Time from the First Half of 2017 to the Second Half of 2024

#### 3.2 Comparison of the Incidence Rate of Thrombotic Diseases among the Study Subjects

It was calculated that during the pandemic from January 2020 to December 2022, the proportion of the number of thrombosis patients among the total number of patients seeking medical treatment during the same period was approximately 0.0405%. For the patients seeking medical treatment before the pandemic from January 2017 to December 2019, the proportion of the number of thrombosis patients among the number of patients seeking medical treatment during the same period was 0.0160%.

For the patients seeking medical treatment after the pandemic from January 2023 to June 2024, the proportion of the number of thrombosis patients among the number of patients seeking medical treatment during the same period was approximately 0.0201%. The proportion of the total number of thrombosis patients among the number of patients seeking medical treatment during the same period in the non-pandemic period was approximately 0.0173%. By comparing the proportion of the number of thrombosis patients among the number of patients seeking medical treatment during the same period, the calculated p-value was 0.1653, which was greater than 0.05, indicating that the difference between 0.0160% and 0.0201% was not statistically significant.

When comparing the proportion of the number of thrombosis patients among the number of patients seeking medical treatment during the same period in the pandemic period and the non-pandemic period, the calculated p-value was less than  $2.2 \times 10^{-16}$ , indicating that there was a significant difference in this proportion (p < 0.01). Therefore, in the one-sided test, the proportion of the number of thrombosis patients among the number of patients seeking medical treatment during the same period increased significantly during the pandemic.

#### Conclusion of the Analysis of Image Data Information

Figure 1 shows that during the periods when the novel coronavirus was not prevalent (from January 2017 to January 2020 and from July 2023 to July 2024), the incidence rate of thrombosis patients in the Emergency Department of Peking University Shenzhen Hospital remained basically stable. Since the outbreak of the pandemic, the number of thrombosis patients has gradually increased and reached its peak in the second half of 2022. After 2022, the number of thrombosis patients gradually decreased and returned to the baseline level before the pandemic after the pandemic was brought under control.

## 4 DISCUSSION

Exploration of the reasons for the peak in the number of thrombosis patients shown in Figure 1 (a): Firstly, the COVID-19 pandemic fully erupted and continued to spread from 2021 to 2022. Correspondingly, the number of thrombosis patients increased from the first half of 2021 to the second half of 2022. It is reasonably speculated that the novel coronavirus may have led to an increase in the incidence rate of thrombotic diseases. Secondly, consider the factor of vaccination: Since China launched the COVID-19 vaccination for key groups on December 15, 2020, the growth rate of the number of thrombosis patients began to slow down in the first half of 2022 and gradually decreased in the second half of 2022. By the second half of 2023, the COVID-19 pandemic was basically under control, and the number of thrombosis patients stabilized at the baseline level before the pandemic.

The novel coronavirus has a significant impact on the incidence rate of thrombotic diseases, increasing the incidence rate of such diseases. After the vaccine took effect and the pandemic was brought under control, the incidence rate of patients with thrombotic diseases stabilized at the baseline value again. The impact of the novel coronavirus on thrombotic diseases is mainly manifested in the following aspects.

First, endothelial cell damage: SARS-CoV-2 directly invades endothelial cells, causing damage to vascular endothelium and the release of pro-inflammatory cytokines. Its spike protein can activate the alternative complement pathway [1, 2]. The damage caused by SARS-CoV-2 to vascular endothelial cells can widely trigger inflammatory reactions and abnormal coagulation functions, and may also lead to lesions or even dysfunctions in the lungs, heart, brain, kidneys, lower limb veins, skin and other parts. This is not only an important mechanism for causing damage to multiple organ functions in the human body but also the main reason for the significantly increased risk of venous thromboembolism (VTE) in COVID-19 infected patients [3].

Second, hypercoagulability of the blood: Due to the release of acute inflammatory reaction mediators caused by factors such as intravascular catheters or severe infections, the coagulation and fibrinolysis systems are affected through multiple pathways. There are factors such as a decrease in the levels of protein C and antithrombin-III (AT-III), an increase in the level of plasminogen activator inhibitor-I (PAI-1), an increase in coagulation factor VIII, an increase in fibrinogen, and neutrophil extracellular traps (NETs). Eventually, it leads to the activation of the coagulation cascade reaction and the inhibition of the fibrinolysis system, making the blood in a hypercoagulable state and further promoting the occurrence of VTE [4, 5].

Third, blood stasis: COVID-19 infected patients may experience insufficient fluid volume due to water loss caused by symptoms such as fever, diarrhea, and poor appetite, or blood stasis may occur due to reasons such as bed rest, obesity, shock, and coma, which further creates conditions for the formation of venous thrombosis and the occurrence of VTE [6, 7].

## **5** CONCLUSION

During the COVID-19 pandemic, the number of thrombosis patients increased significantly, and the risks of venous, arterial, and microvascular thrombosis increased significantly [8, 9, 10], which has attracted widespread attention from the global medical community. Through the analysis of the epidemiological characteristics of a total of 372 thrombosis patients in the emergency department of a large tertiary first-class general hospital during the COVID-19 pandemic and the non-pandemic period, as well as the data analysis of the proportion of the number of thrombosis patients among the number of patients seeking medical treatment during the same period before, during, and after the pandemic, it was found that before and after the pandemic, there were more female patients with thrombotic diseases than male patients, with male-to-female ratios of 0.89:1 and 0.91:1 respectively. During the pandemic, there were more male patients with thrombosis than female patients, with a male-to-female ratio of 1.24:1. The largest number of patients with thrombotic diseases was in the age group of 31 to 60 years old (accounting for 51.30%, 45.79%, and 44.78% respectively). The main type of thrombotic disease was venous thrombosis (accounting for 90.32%).

According to the results of this study, there is reason to believe that the novel coronavirus can significantly increase the incidence rate of thrombotic diseases. After the end of the COVID-19 pandemic, the proportion of the number of thrombosis patients among the number of patients seeking medical treatment during the same period tends to be stable. It is speculated that the long-term incidence rate of thrombotic diseases in the population will stabilize around the baseline value[11].

In conclusion, through the investigation and analysis of the population of thrombosis patients seeking medical treatment in the Emergency Department of Peking University Shenzhen Hospital, a preliminary prediction of the long-term incidence rate of the general population in Shenzhen was made. There is reason to believe that the novel coronavirus will not cause an increase in the long-term incidence rate of thrombotic diseases in the population.

## **COMPETING INTERESTS**

The authors have no relevant financial or non-financial interests to disclose.

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