Postprint: Analysis of the Prevalence and Epidemiological Characteristics of Venous Thromboembolism in Jiaxing City

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Abstract

Venous thromboembolism (VTE) has become the third most common cardiovascular disease following ischemic heart disease and stroke. Since the official launch of the "National Pulmonary Embolism and Deep Vein Thrombosis Prevention and Treatment Capacity Building Project" in 2018, medical personnel's awareness of VTE has increased, and VTE screening rates have also risen significantly. However, VTE-related epidemiological investigations have mostly been limited to single-center studies, and large-scale survey data on VTE prevalence that includes medical institutions of different levels and types remain lacking. Objective To investigate the prevalence and epidemiological characteristics of VTE in Jiaxing City, and to provide evidence for further improving VTE prevention and treatment in this region. Methods A total of 731,755 patients discharged with a VTE diagnosis from all secondary-level and above medical institutions in Jiaxing City in 2021 were included as study subjects. General patient information and Diagnosis-Related Group (DRG) indicators reflecting patient volume and technical difficulty of diagnosis and treatment were collected. Multiple linear regression analysis was used to explore factors influencing the number of VTE patients in hospitals. Results According to inclusion and exclusion criteria, there were 10,758 VTE patients, including 10,429 with deep vein thrombosis (DVT) and 614 with pulmonary thromboembolism (PTE). The median patient age was 71 (62, 79) years. General hospitals had the highest number of VTE patients at 9,732 (90.46%), while psychiatric specialty hospitals had the fewest at 53 (0.49%). Tertiary hospitals had more VTE patients than secondary hospitals [7,929 (73.70%) vs. 2,829 (26.30%)]. The proportion of VTE patients to total discharges was highest in general hospitals (1.85%) and lowest in maternal and child health hospitals (0.10%). The proportion was higher in tertiary than secondary hospitals (1.80% vs. 0.97%). VTE prevalence differed significantly across age groups (2=32383.098,

P<0.001). Pairwise comparisons showed that older age groups had higher VTE prevalence than younger groups (P<0.05). VTE prevalence in males aged 15-44 was significantly higher than in females (P<0.001). Surgical treatment was a risk factor for VTE. Linear regression showed that the number of cases with weight (RW) $ 2 $was a factor influencing VTE patient numbers ($P < 0.001$); $for each additional case with RW$ $2, VTE cases increased by 0.363. Conclusion The prevalence of VTE in Jiaxing City was 199.2 per 100,000 population, with a disease burden reaching or even exceeding that of Western countries. The key at-risk population comprises elderly patients undergoing surgery with comorbidities such as malignant tumors, hip/pelvic/lower limb fractures, heart failure, and respiratory failure. Efforts should be made to further improve VTE prevention and treatment in general hospitals and to enhance participation and attention to standardized VTE prevention and treatment in traditional Chinese medicine hospitals, maternal and child health hospitals, and psychiatric specialty hospitals.

Full Text

Prevalence and Epidemiological Characteristics of Venous Thromboembolism in Jiaxing City

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Abstract

Background: Venous thromboembolism (VTE) has become the third most common cardiovascular disease after ischemic heart disease and stroke. Since the official launch of the National Programme for Prevention and Management of Pulmonary Embolism and Deep Vein Thrombosis in 2018, medical personnel have paid more attention to VTE, and the screening rate of VTE has also increased significantly. However, epidemiological investigations related to VTE remain mostly limited to single-center studies, and large-scale prevalence survey data encompassing medical institutions of different levels and types are still lacking.

Objective: To understand the prevalence and epidemiological characteristics of VTE in Jiaxing and provide a basis for further prevention and treatment of VTE in this region.

Methods: A total of 731,755 discharged patients from all secondary and above medical institutions in Jiaxing City in 2021 were included as study subjects. General patient data and disease diagnosis-related grouping (DRG) indicators reflecting the number of patients admitted and the difficulty of diagnosis and treatment techniques were collected. Multiple linear regression analysis was used to explore influencing factors of the number of VTE patients in hospitals.

Results: According to inclusion and exclusion criteria, a total of 10,758 VTE patients were identified, including 10,429 patients with deep vein thrombosis (DVT) and 614 patients with pulmonary thromboembolism (PTE). The median age of patients was 71 (62, 79) years. General hospitals had the highest number of VTE patients at 9,732 cases (90.46%), while psychiatric hospitals had the lowest at 53 cases (0.49%). Tertiary hospitals had significantly more VTE patients than secondary hospitals [7,929 cases (73.70%) vs. 2,829 cases (26.30%)]. The proportion of VTE patients to total discharged patients was highest in general hospitals at 1.85% and lowest in maternal and child health hospitals at 0.10%. The proportion in tertiary hospitals was higher than in secondary hospitals (1.80% vs. 0.97%). The prevalence of VTE differed significantly across age groups (^{2}=32,383.098, P<0.001). Pairwise comparisons between age groups showed that higher age groups had significantly higher VTE prevalence than lower age groups (P<0.05). The prevalence of VTE in males aged 15-44 years was significantly higher than in females (P<0.001). Surgical treatment was a risk factor for VTE patients. Linear regression analysis showed that the number of cases with weight (RW) $\geq$ 2 was an influencing factor on the number of VTE patients (P<0.001), with each additional case of RW $\geq$ 2 associated with an increase of 0.363 VTE cases.

Conclusion: The prevalence rate of VTE in Jiaxing is 199.2 per 100,000 population, and the disease burden has reached or even exceeded that of Western countries. The main at-risk populations for VTE are elderly patients who have undergone surgical treatment and have comorbidities such as malignant neoplasm, hip/pelvis/lower limb fracture, heart failure, and respiratory failure. The level of VTE prevention and treatment in general hospitals in this region should be further improved, and the participation and attention to standardized VTE prevention and treatment in traditional Chinese medicine hospitals, maternal and child health hospitals, and psychiatric hospitals should be enhanced.

Keywords: Venous thromboembolism; Prevalence rate; Risk factors; Diagnose-related groups; Jiaxing; Retrospective studies

Introduction

Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary thromboembolism (PTE), represents two important clinical manifestations of the same disease at different stages and locations [1]. Currently, VTE has become the third most common cardiovascular disease after ischemic

heart disease and stroke [2]. Due to its insidious onset, atypical symptoms, high fatality and disability rates, VTE has attracted considerable attention from clinicians and hospital administrators in recent years as an important cause of unexpected death among inpatients [3-4].

Studies have shown that the incidence of VTE continues to rise significantly. The incidence in European populations ranges from 104 to 183 per 100,000 person-years, while in North America it is 122 per 100,000 person-years [5]. Asian populations have generally been considered to have relatively lower VTE incidence, with Japan reporting 12.6 per 100,000 and South Korea 13.83 per 100,000 [6-7]. A cross-sectional survey of 90 provincial capital or large/medium-sized tertiary hospitals in China showed that the prevalence of VTE continuously increased from 2007 to 2016, reaching 17.5 per 100,000 [8]. In 2018, the National Programme for Prevention and Management of Pulmonary Embolism and Deep Vein Thrombosis, officially approved by the National Health Commission's Medical Administration and Hospital Administration Bureau, was formally launched. By December 2022, Jiaxing had five general hospitals that had established VTE prevention and treatment systems according to national standards and passed certification, forming a regional VTE prevention and treatment alliance. Consequently, medical personnel have increased their attention to VTE, and VTE screening rates have risen significantly. However, epidemiological investigations related to VTE remain mostly limited to single-center studies, and large-scale prevalence survey data encompassing medical institutions of different levels and types are still lacking [9].

This study conducted a retrospective analysis of the disease burden, epidemiological characteristics, and risk factors of VTE in Jiaxing by analyzing the front pages of medical records and DRG data from all secondary and above medical institutions (33 total) in Jiaxing City in 2021, aiming to provide reference information for further improving local VTE prevention and treatment efforts.

Methods

1.1 Study Data This study utilized data from the front pages of inpatient medical records in the Jiaxing Population Health Information Platform, covering 731,755 discharged patients from all secondary and above medical institutions (33 total) in Jiaxing City in 2021. Inclusion criteria: discharge date between January 1, 2021 and December 31, 2021; VTE cases identified by discharge diagnoses containing DVT or PTE-related diagnoses according to ICD-10 codes. DVT diagnosis corresponded to ICD-10 codes D73.5, I80, I81, I82, I97.8, K55.0, O22.3, O22.9; PTE diagnosis corresponded to ICD-10 codes I26.0, I26.9, O08.2, O88.2. Exclusion criteria: (1) cases not first diagnosed within the study period; (2) cases with removal of inferior vena cava filter as the primary discharge diagnosis. Medical institution DRG data were obtained from the DRG performance evaluation platform of the Jiaxing Municipal Health Commission. A total of 10,758 eligible VTE patients were ultimately included. This study was approved by the Ethics Committee of the First Hospital of Jiaxing (LS2021-KY-450).

1.2 Data Collection and Risk Factors **1.2.1 Data Collection:** General patient information was collected, including gender, age, hospital name, medical record number, discharge date, outpatient/emergency diagnosis, discharge diagnosis, and surgical procedure information. Patient identity information was de-identified.

1.2.2 Risk Factor Assessment: Common VTE risk factors were included based on assessment scales developed by CAPRINI [10] and PADUA et al. [11]. According to the National Clinical Edition 3.0 of Surgical Operation Classification Codes released by the National Health Commission, surgical procedures were categorized into four types: surgery, interventional therapy, diagnostic procedures, and therapeutic procedures [12]. Based on the surgical procedure codes in the front pages of inpatient medical records and the classification in the National Clinical Edition 3.0, we determined whether patients underwent surgical treatment. In this study, surgery included interventional therapy.

The presence of risk factors was determined according to ICD-10 codes in discharge diagnoses, and their distribution was analyzed. Malignant neoplasm corresponded to ICD-10 codes C00-C97, D00-D09, Z51.0, Z51.1, Z51.2, Z51.5, Z85, Z08; hip/pelvis/lower limb fracture corresponded to S32.1-S32.8, S72, S82, S92, T02.1, T02.3, T02.5-T02.9; heart failure corresponded to I50; respiratory failure corresponded to J80, J96, R09.2; ischemic stroke corresponded to I63; chronic obstructive pulmonary disease corresponded to J44; varicose veins corresponded to I83; sepsis corresponded to A41, R57.8, R65.9; acute myocardial infarction corresponded to I21; acute spinal cord injury corresponded to S14, S24, S34; pregnancy or postpartum corresponded to O00-O99.

1.3 Statistical Analysis SPSS 16.0 statistical software was used for data analysis. Count data were expressed as [cases (%)], and non-normally distributed measurement data were expressed as [M(P25, P75)]. The crude prevalence of VTE was calculated using the number of VTE cases as the numerator and the permanent resident population of Jiaxing from the 7th National Census in 2020 [13] as the denominator. The ^{2} test was used to compare crude prevalence rates, with test level correction for multiple pairwise comparisons. Multiple linear regression analysis was used to explore influencing factors of the number of VTE patients in hospitals, with variables entered using stepwise method. $P<0.05$ was considered statistically significant.

Results

2.1 General Patient Characteristics A total of 14,105 VTE patients were initially identified. After excluding repeated hospitalizations and cases with removal of inferior vena cava filter as the primary diagnosis, 10,758 eligible VTE patients remained, including 10,429 DVT patients and 614 PTE patients; 5,288 were male and 5,470 were female, with age ranging from 0 to 101 years and a median age of 71 (62, 79) years.

By hospital type, general hospitals had the highest number of VTE patients at 9,732 cases (90.46%), while psychiatric hospitals had the fewest at 53 cases (0.49%). By hospital level, tertiary hospitals had significantly more VTE patients than secondary hospitals [7,929 cases (73.70%) vs. 2,829 cases (26.30%)]. Analyzing the proportion of VTE patients to total discharged patients, general hospitals had the highest proportion at 1.85%, while maternal and child health hospitals had the lowest at 0.10%. The proportion in tertiary hospitals was higher than in secondary hospitals (1.80% vs. 0.97%). These results are shown in Table 1 .

The crude prevalence of VTE in Jiaxing in 2021 was 199.2 per 100,000 population. The crude prevalence was 1,950.3 per 100,000 in those aged $ 85*years*, 897.7*per*100, 000*inthoseaged*65−84*years*, 169.0*per*100, 000*inthoseaged*45−64*years*, 17.6*per*100, 000*inthoseaged*15−44*years*, *and*0.8*per*100, 000*inthoseaged*0−14*years*.*Theprevalenceof VTEdifferedsignificantlyacrossagegroups*($\chi^{2}=32,383.098, P<0.001). Further pairwise comparisons between age groups showed statistically significant differences, with higher age groups having higher VTE prevalence than lower age groups (P<0.05). The prevalence of VTE in males aged 15-44 years was significantly higher than in females (P<0.001), while no significant gender differences were observed in other age groups (P>0.05). These results are shown in Table 2 .

2.3 Distribution of VTE Risk Factors Among the 10,758 VTE patients, 4,188 (38.93%) underwent surgical treatment, 2,048 (19.04%) had malignant neoplasm, 1,844 (17.14%) had hip/pelvis/lower limb fracture, and heart failure and respiratory failure ranked fourth and fifth at 1,275 (11.85%) and 979 (9.10%) cases respectively, as shown in Table 3 .

Among the 2,048 VTE patients with malignant neoplasm, primary tumor site was identified in 1,972 cases. By tumor site, bronchial and lung malignant tumors were most common with 625 cases (31.69%), followed by colon malignant tumors with 161 cases (8.16%). The distribution of tumor sites in VTE patients with malignant neoplasm is shown in Table 4 .

2.4 Regression Analysis of Factors Influencing Hospital VTE Patient Numbers Using the number of cases with RW $\geq$ 2 as the independent variable and the number of VTE patients as the dependent variable (both assigned as measured values), multiple linear regression analysis was performed. The regression equation was: Number of VTE patients = -56.215 + 0.363 × Number of cases with RW $\geq$ 2. The results showed that the number of cases with RW $\geq$ 2 was an influencing factor on the number of VTE patients (P<0.001), with each additional case of RW $\geq$ 2 associated with an increase of 0.363 VTE cases, as shown in Table 5 .

Discussion

3.1 VTE Epidemiological Status This study found that the crude prevalence of VTE in Jiaxing in 2021 was 199.2 per 100,000 population, representing approximately a 10-fold increase from the 17.5 per 100,000 reported in 2016 [8]. The phenomenon of significantly increased VTE prevalence in elderly patients is consistent with literature reports [8,14]. The rapid growth in VTE prevalence can be attributed to several factors: First, due to VTE's insidious onset and atypical symptoms, coupled with the previous widespread belief among medical personnel that this disease had low incidence in Asia and posed less risk than in Western countries, VTE was relatively underdiagnosed [15]. Since the launch of the National Programme for Prevention and Management of Pulmonary Embolism and Deep Vein Thrombosis in 2018, hospitals have gradually established multidisciplinary prevention and control systems led by administrative departments, and healthcare workers' understanding of VTE has deepened, leading to increased diagnosis [16]. Second, population aging and rising prevalence of malignant tumors and cardiovascular diseases increase VTE risk, directly raising VTE prevalence and indirectly increasing hospitalizations [8]. Approximately half of VTE events are associated with recent hospitalization [17]. Third, insufficient prophylaxis for high-risk VTE patients. In China, the proportion of surgical inpatients at moderate to high VTE risk is 32.7% and 53.4% respectively, while the proportion of medical inpatients at high risk is 36.6%. However, the proportion receiving appropriate prophylaxis is only 9.3% in surgical patients and 6.0% in medical patients, far below the 39.5%-58.5% prophylaxis rate reported in the ENDORSE study across multiple countries [18]. Finally, this study represents regional full-sample data analysis including all secondary and above hospitals in the region. Due to significant differences in medical levels across hospitals of different levels and types, this may more accurately reflect the current epidemiological status and prevention/treatment levels of VTE in Chinese prefecture-level cities.

3.2 Distribution of VTE Risk Factors Virchow's triad for VTE risk factors includes any factors that can cause endothelial injury, blood stasis, and hypercoagulability [19]. This study found that surgical treatment ranked first among VTE risk factors, accounting for 38.93% of cases. Observational study data show that hospital-associated VTE patients (those with newly developed VTE during hospitalization or medical patients hospitalized for more than 2 days or surgical patients under anesthesia within 90 days before VTE occurrence) account for approximately 60% of all VTE patients [20]. Without prophylaxis, the incidence of DVT in general surgery patients can reach 10%-40% [21]. Therefore, surgery should be considered the primary hospital-acquired risk factor for VTE. Malignant neoplasm ranked second among VTE risk factors, accounting for 19.04% of cases, consistent with literature reporting that approximately one-fifth of VTE patients have malignant tumors [22,23]. Among VTE patients with malignant neoplasm, bronchial and lung malignant tumors were most common (31.69%), followed by colon, gastric, pancreatic, and hepatobiliary

malignant tumors. This reflects both significant differences in VTE prevalence across different tumor sites [24,25] and the influence of the underlying incidence of different malignancies. The Khorana risk assessment scale, endorsed by the latest American Society of Clinical Oncology guidelines for thromboprophylaxis in outpatient cancer patients [26], categorizes gastric, pancreatic, and brain primary malignancies as extremely high VTE risk, and lung, lymphatic, gynecologic, bladder, testicular, and renal primary malignancies as high risk. While thyroid cancer ranks among the top 10 malignancies in Jiaxing [27], VTE patients with thyroid cancer accounted for only 1.27%, indicating it is not a high VTE-risk tumor type. Conversely, brain malignancies are extremely high-risk for VTE but have low incidence or may involve patient outflow, resulting in a low proportion (0.81%) of VTE patients.

3.3 Impact of Hospital RW $\geq$ 2 Cases on VTE Patient Numbers This study found that the number of VTE patients in hospitals positively correlated with the number of cases with RW $\geq$ 2, but not with total discharged patients, CMI, or number of surgical cases. RW reflects the complexity of cases and difficulty of treatment techniques [28]. Higher numbers of RW $\geq$ 2 cases indicate more difficult and critically ill patients, likely accompanied by higher numbers of VTE high-risk patients. Therefore, the larger number of VTE patients in tertiary hospitals, especially general hospitals, may be attributed to both the greater volume of critically ill and complex cases they treat and the earlier establishment of VTE prevention and treatment systems, higher hospital emphasis, and better information technology in local tertiary general hospitals, while specialized or secondary hospitals may have lower resource availability for VTE diagnosis, relatively poorer implementation of VTE prevention systems, and insufficient information technology infrastructure [29,30].

This study has several limitations: The study population comprised inpatients only, lacking information from outpatient and emergency departments, potentially underestimating VTE prevalence. Additionally, as the analysis was primarily based on front pages of medical records, clinical information such as VTE onset time, laboratory results, and prognosis could not be obtained, preventing comprehensive in-depth analysis of the disease.

Conclusion

In summary, this study demonstrates that the prevalence of VTE in Jiaxing is 199.2 per 100,000 population, with a disease burden reaching or exceeding that of Western countries. The top five VTE risk factors were surgical treatment, malignant neoplasm, hip/pelvis/lower limb fracture, heart failure, and respiratory failure. Therefore, a comprehensive VTE prevention and treatment system integrating prevention, treatment, and research should be established to further improve VTE prevention and treatment levels in general hospitals and promote standardized VTE prevention and treatment participation and emphasis in traditional Chinese medicine hospitals, maternal and child health hospitals, and

psychiatric hospitals.

Author Contributions

HONG Ling was responsible for conceptualizing the research, designing the study protocol, data analysis, and manuscript writing. LU Liping provided research guidance and supportive contributions. CHENG Ning was responsible for data collection. SUN Qin verified the statistical results. JIANG Jianhong revised the manuscript. ZHU Liangfeng took overall responsibility for the article and supervised management.

Conflict of Interest: None declared.

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Note: Figure translations are in progress. See original paper for figures.