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Original Article

Risk Assessment in Chinese Hospitalized Patients Comparing the Padua and Caprini Scoring Algorithms

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Abstract

The current venous thromboembolism (VTE) guidelines recommend all patients to be assessed for the risk of VTE using risk assessment models (RAMs). The study was to evaluate the performance of the Caprini and Padua RAMs among Chinese hospitalized patients. We reviewed data from 189 patients with deep venous thrombosis (DVT) and 201 non-DVT patients. Deep venous thrombosis risk factors were obtained from all patients. The sensitivity and specificity of the Caprini and Padua scores for all patients were calculated. The receiver operating curve (ROC) and the area under the ROC curve (AUC) were used to evaluate the performance of each score. We documented that age, acute infection, prothrombin time (PT), D-dimer, erythrocyte sedimentation rate, blood platelets, and anticoagulation were significantly associated with the occurrence of DVT ($P < .05$). These results were true for all medical and surgical patients group (G1), as well as the analysis of medical versus surgical patients (G2). Finally, analysis of the scores in patients with and without cancer was also done (G3). The Caprini has a higher sensitivity but a lower specificity than the Padua ($P < .05$). Caprini has a better predictive ability for the first 2 groups ($P < .05$). We found Caprini and Padua scores have a similar predictive value for patients with cancer ($P > .05$), while Caprini has a higher predictive ability for no cancer patients in G3 than Padua ($P < .05$). For Chinese hospitalized patients, Caprini has a higher sensitivity but a lower specificity than Padua. Overall, Caprini RAM has a better predictive ability than Padua RAM.

Keywords

Caprini, Padua, comparison, Chinese hospitalized patients

Introduction

Venous thromboembolism (VTE) includes both deep vein thrombosis (DVT) and pulmonary embolism (PE) and is a common cause of morbidity and mortality in hospitalized patients. Venous thromboembolism represents a significant burden on society and has serious economic consequences. It is very important for doctors to recognize VTE and take thrombosis prophylaxis very seriously. Venous thromboembolism is an enormous worldwide problem and various risk assessment models (RAMs) have been adopted by different countries to lower the incidence of VTE.[1]

In the past, risk assessment was done according to groups in order to simplify the risk assessment process. Surgical patients, for example, were assigned to 1 of 4 VTE risk levels based on the type of operation age and the presence of additional risk factors such as cancer or previous VTE.[2] Since that time the importance of individual risk assessment has been recognized and a number of assessment schemes have been proposed. These include Caprini,[3] Padua,[4] Autar,[5] Kucher,[6] Improve (Spyropoulos), and others. These RAMs consisted of many risk factors, like age, gender, presenting illness, history of serious

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medical illnesses, and blood test changes. All but one of these assessments lack documenting family history of thrombosis or obstetrical misadventures which are serious omissions. The Caprini score tracks family history of thrombosis including first-, second-, and third-degree relatives as well as obstetrical misadventures which can be indicative of the presence of anticardiolipin antibodies or beta2 glycoproteins. These factors greatly elevate thrombotic risk. It has become popular to weight risk factors and assign a score to each patient which is more meaningful than merely listing the factors. This allows patients to be classified into various levels of risk and prophylaxis can be adjusted accordingly.

In 2012, 2 individualized assessments were recommended to prevent VTE in the ninth edition of the clinical practice guidelines developed by the American College of Chest Physicians.[7] These included the Caprini RAM which was suggested for nonorthopedic surgical patients. The Padua RAM was selected and recommended to be used in internal medical patients for VTE risk assessment. The tools were also recommended by the Chinese expert consensus on the prevention of venous thrombosis.[8] It must be noted that these RAMs were designed according to the Western population.

The incidence of VTE ranges from 10% to 40% in medical and surgery patients in the absence of appropriate thrombosis prophylaxis.[9] It also has been reported that the risk of VTE may have been underestimated in patients where risk assessment was not used in the Western population.[10] In China, this problem was much greater than reported in Western developed countries.[11] The Caprini RAM has been validated both in internal medical patients and surgical patients in Western countries.[12-15] The Padua RAM on the other hand has not been validated in surgery patients. In China, there have been several studies comparing the 2 RAMs.[16-18] Our current study involves a detailed analysis of the performance of each score in Chinese patients in our comprehensive hospital which includes patients in multiple specialties. We realize that having more than 1 risk model in the hospital could be quite confusing. We decided to test the Caprini RAM in Chinese medical patients and the Padua RAM in Chinese surgical patients. We were hoping that by performing this exercise we could decide on using a single RAM for all patients.

Materials and Methods

The study was a part of Chinese hospital (a 2000-bed comprehensive teaching hospital) quality management and was approved by the ethics committee of Beijing Shijitan Hospital. In the retrospective study, we consecutively reviewed data from 189 patients with DVT and 201 non-DVT patients during April 1, 2017, and June 30, 2017. Through logistic regression, we derived risk factors of the patients with DVT. We analyzed the sensitivity and specificity of the Caprini and Padua scores in 3 groups of patients as follows: (1) all medical and surgical patients, (2) medical versus surgical patients, and (3) patients with and without cancer. The receiver operating characteristic (ROC) curve and the area under the ROC curve (AUC) were used to evaluate the performance of each score to assess the risk of VTE in each of the 3 groups. Routine screening for DVT was done for high-risk patients who were assessed more than 3 points by Caprini RAM and more than 4 points by Padua RAM, respectively. We identified all cases of isolated DVT diagnosed by lower extremity venous duplex compression ultrasonography after admission. The inclusion criteria of the DVT group were as follows: an age of $\geq$18 years, more than 2 days duration of hospitalization, and confirmed DVT by lower extremity venous duplex compression ultrasonography. The exclusion criteria were as follows: an age of <18 years, DVT before admission, less than 2 days duration of hospitalization, and superficial vein thrombosis. The non-DVT group includes the randomly selected patients who had no DVT and admitted to the same departments during the periods mentioned above. Caprini RAM includes 41 risk factors with 1, 2, 3, and 5 scoring points: low risk (0-1), moderate risk (2), high risk (3-4), or highest risk ($\geq$5). Whereas Padua RAM includes 11 risk factors with 1, 2, and 3 scoring points: low risk (<4), high risk ($\geq$4). The retrospective data were collected through the electronic medical record system. Two trained investigators were responsible for collecting the data. The same investigators determined each DVT patient's risk for Caprini and Padua RAMs.

Statistical Analyses

In the study, discrete features (such as sex etc, which only includes 2 values, YES or NO) were evaluated by χ^2 test and continuous features (such as age etc, which include any one of the values between 0 and positive infinity) were evaluated by 2-sample Mann-Whitney test. In the study, true positives are the patients with VTE. Sensitivity is defined as the rate of true positives over total positives which include true positives and false positives. Specificity is defined as the proportion of true negatives over total negatives which include true negatives and false negatives. Based on sensitivity and specificity, ROC curve is drawn and the value of AUC is defined as the AUC. All statistical analyses are performed on R (version 3.4.2). This study is not based on a prospectively powered sample size and therefore is only of exploratory nature.

Results

In the DVT group (total 189 patients), there were 37 (19.58%) surgical patients and 152 (80.42%) internal medical patients, including 57 patients with cancer in the DVT group. In the non-DVT group (total 201 patients), there were 46 (22.89%) surgical patients and 155 (77.11%) internal medical patients, including 54 patients with cancer in the non-DVT group. One patient who diagnosed lung cancer was hospitalized in oncologic and is part of the 54 patients (Table 1).

In the DVT group, the elderly patients and those with lower limb edema were much more prevalent than in the control group ($P < .05$). We found that in the DVT group patients-suffering from acute infection, chronic obstructive pulmonary disease (COPD), respiratory failure, coronary heart disease,

Table 1. Composition of the DVT and non-DVT Patients.

Department	DVT (n = 189)	Non-DVT (n = 201)
General surgery, n (%)	14 (7.41)	17 (8.46)
Orthopedics, n (%)	12 (6.35)	14 (6.97)
Thoracic surgery, n (%)	4 (2.12)	5 (2.49)
Urologic surgery, n (%)	4 (2.12)	5 (2.49)
Obstetrics and gynecology, n (%)	1 (0.53)	2 (1.00)
Cerebral surgery, n (%)	2 (1.06)	3 (1.49)
Brain glioma, n (%)	11 (5.82)	11 (5.47)
Intensive care unit, n (%)	33 (17.46)	35 (17.41)
Neurology, n (%)	23 (12.17)	24 (11.94)
Geriatrics, n (%)	5 (2.65)	5 (2.49)
Respiratory, n (%)	40 (21.16)	41 (20.40)
Emergency, n (%)	12 (6.35)	10 (4.98)
Cardiovascular, n (%)	16 (8.47)	16 (7.96)
Hematologic, n (%)	2 (1.06)	2 (1.00)
Nephrologic, n (%)	2 (1.06)	2 (1.00)
Traditional Chinese medicine, n (%)	3 (1.59)	3 (1.49)
Rheumatologic and immunologic, n (%)	1 (0.53)	1 (0.50)
Endocrine, n (%)	3 (1.59)	4 (1.99)
Oncologic, n (%)	1 (0.53)	1 (0.50)

Abbreviation: DVT, deep venous thrombosis.

septicemia, and with central vein catheterization were more prevalent than in the non-DVT group ($P < .05$). The operation time was more than 45 minutes in the DVT group ($P < .05$). In terms of laboratory examination, in the DVT group, D-dimer, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), percent of neutrophil (N%), blood platelet (PLT) were significantly higher than in the control group ($P < .05$). In control group, prothrombin time (PT), procalcitonin (PCT), and hemoglobin were higher than in the DVT group ($P < .05$). The number of patients receiving low-molecular-weight heparin anticoagulation in the DVT group was higher than the number of patients receiving anticoagulation in the control group ($P < .05$), and not surprisingly the prognosis of non-DVT group patients was much better than that of those patients in the DVT group ($P < .05$; Table 2).

To use the selected characteristics which include 80% of above patients between DVT and non-DVT, the results show that the logistic regression model successfully captures some important characteristics, including age, acute infection, PT, D-dimer, ESR, PLT, anticoagulation, which are significantly associated with the occurrence of DVT ($P < .05$; Table 3).

From the cumulative distributions of Caprini RAM, almost 20% of patients with DVT had a score of more than 10, and almost all were correctly predicted to have VTE. However, in contrast to cumulative distributions of Padua RAM, there were only about 10% of patients with VTE with more than a risk score of 7. The results show that Caprini RAM was much more sensitive than Padua RAM (Figures 1 and 2).

It is well known that 4 and 5 are the cutoff values of high risk and highest risk in Caprini RAM, and <4 is the cutoff value of low risk, and 4 and above represents high risk in Padua RAM. In order to explore the suitable cutoff value for Chinese patients and reduce missed diagnosis, we assumed the following: When risk score of Caprini RAM is equal to 4 or 5, and risk score of Padua RAM is 3 or 4, we calculated the sensitivity and specificity, respectively. We found when the risk score of Caprini RAM is 4 or the risk score of Padua RAM is 3, sensitivity was higher than when the Caprini RAM is 5 and Padua RAM is 4. The results also showed that Caprini RAM has a higher sensitivity but a lower specificity than Padua RAM (Table 4).

Based on AUC values of Caprini and Padua RAMs, the AUC value of Caprini RAM (0.779 ± 0.029) is significantly higher than the value of Padua RAM (0.635 ± 0.031; $P < .05$), which means that Caprini RAM has a better predictive ability for all patient data (Figure 3).

In the comparison between internal medicine and surgery, the results showed that Caprini RAM has a higher sensitivity (0.704 and 0.875) but a lower specificity (0.609 and 0.800) than Padua RAM (0.500 and 0.675; 0.807 and 0.875; $P < .05$; Table 5).

The AUC value of Caprini RAM (0.737 ± 0.023) was significantly higher than the value of the Padua RAM (0.623 ± 0.033; $P < .05$), which means that the Caprini RAM has a better predictive ability for internal medical patients (Figure 4). The AUC value of Caprini RAM (0.825 ± 0.064) was significantly higher than the value of Padua RAM (0.609 ± 0.048; $P < .05$), which means that the Caprini RAM also has a better predictive ability for surgical patients (Figure 5).

Comparing patients with and without cancer, the study showed that Caprini RAM has higher sensitivity (0.852 and 0.689) but lower specificity (0.537 and 0.680) than Padua RAM (0.741 and 0.418; 0.741 and 0.828) based on the presence or absence of cancer ($P < .05$; Table 6).

According to AUC, the value of the Caprini RAM (0.795 ± 0.045) was not significantly higher than the value of Padua RAM (0.778 ± 0.056; $P < .05$), which means that the Caprini and Padua RAMs have a similarly predictive ability for patients with cancer (Figure 6). The AUC value of Caprini RAM (0.736 ± 0.036) was significantly higher than the value of Padua RAM (0.541 ± 0.037) ($P < .05$), which means that Caprini RAM has a higher predictive ability for noncancer patients than the Padua RAM (Figure 7). Intriguingly, the predictive performance of Padua RAM on patients with cancer was remarkably higher than patients without cancer.

Discussion

In our study, the mean age was 75.40 ± 12.94 years in the DVT group. According to WHO criteria for developing countries,[19] elderly patients are defined more than 60 years old, so there is no doubt that elderly age is one risk factor associated with DVT. This agrees with other researchers[20] who found that the risk of VTE is significantly increased when the age of the patient is over 40 years, and the VTE risk increases with advancing age. It is well known that hypercoagulability and slow blood flow are the basis of thrombosis.[21] With age, increasing clotting activity occurs as a result of increased coagulation factor activity.[22] The blood stasis area of the gastrocnemius muscle side valve is

Table 2. Characteristics of the DVT and non-DVT patients.

Characteristic	DVT (n = 189)	Non-DVT (n = 201)	*P* Value
Age (years)	75.40 (12.94)	72.79 (13.43)	.0311
Gender (male/female)	94/95	106/95	.6110
BMI (kg/m^2)	23.83 (3.83)	22.21 (6.89)	.3760
Bed rest, n (%)	73 (38.62)	59 (29.35)	.0650
Lower limb edema, n (%)	36 (19.05)	16 (7.96)	.0020
Acute infection, n (%)	84 (44.44)	61 (30.35)	.0075
COPD, n (%)	34 (17.99)	16 (7.96)	.0065
Respiratory failure, n (%)	44 (23.28)	19 (9.45)	.0005
Cardiac failure, n (%)	36 (19.05)	27 (13.42)	.1790
Coronary heart disease, n (%)	100 (52.91)	80 (39.8)	.0155
Nephrotic syndrome, n (%)	5 (2.65)	5 (2.49)	1.0000
Septicemia, n (%)	33 (17.46)	13 (6.47)	.0010
Cancer, n (%)	57 (30.16)	54 (20.87)	.5650
Thrombocytosis, n (%)	1 (0.53%)	7 (3.48)	.0630
CVC, n (%)	45 (23.81)	1 (0.49)	.0005
Operation time (45 min), n (%)	42 (22.22)	16 (7.96)	.0005
Laparoscopic surgery, n (%)	3 (1.59)	0	.1290
Arthroscopic surgery, n (%)	2 (1.06)	0	.2260
Other operation, n (%)	23 (12.17)	18 (8.96)	.3970
VTE history, n (%)	4 (2.12)	8 (3.98)	.4000
PT (s)	12.86 (5.26)	12.91 (13.19)	.0350
INR	1.20 ± 0.83	1.73 ± 8.41	.0687
APTT (s)	31.38 ± 7.00	33.10 ± 29.76	.1410
D-D (mg/L)	2469.59 (5559.02)	803.43 (1954.09)	<.0001
CRP (mg/L)	56.18 (75.07)	42.25 (62.15)	.0002
ESR (mm/h)	40.89 (47.03)	20.95 (27.90)	<.0001
PCT (ng/mL)	0.98 (3.76)	1.30 (9.63)	<.0001
WBC ($\times 10^9$/L)	8.13 (4.50)	9.76 (26.17)	.0448
N (%)	72.35 (12.35)	67.24 (15.87)	.0010
Hb (g/L)	114.86 (26.65)	119.54 (27.45)	.0152
PLT ($\times 10^9$/L)	218.08 (91.33)	198.15 (86.19)	.0376
Prognosis (recovery)	168 (88.89%)	185 (92.04%)	.0995
Anticoagulation (Y/N)	123/66	34/163	.0005

Abbreviations: APTT, activated partial thromboplastin time; BMI, body mass index; COPD, chronic obstructive pulmonary disease; CVC, central vein catheterization; CRP: C-reactive protein; D-D, D-dimer; DVT, deep venous thrombosis; ESR, erythrocyte sedimentation rate; Hb, hemoglobin; INR, international normalized ratio; N%, percent of neutrophil; PT, prothrombin time; PCT, procalcitonin; PLT, blood platelet; VTE, venous thromboembolism; WBC, leukocyte.

Table 3. Logistic Regression Analysis of DVT Risk Factors.

Characteristic	OR	CI (2.5%)	CI (97.5%)	*P* Value
Age (years)	0.96	0.87	1.05	.0200[a]
Acute infection (%)	8.23	1.44	67.86	<.0001[b]
Coronary heart disease (%)	0.97	0.16	5.44	0.1400
PT (s)	0.76	0.53	1.17	.0400[a]
D-D (mg/L)	1.00	1.00	1.01	<.0001[b]
CRP (mg/L)	1.01	1.00	1.02	.2400
ESR (mm/h)	1.02	1.00	1.06	.0400[a]
PCT (ng/mL)	1.00	0.00	1.09	.7200
WBC ($\times 10^9$/L)	0.78	0.57	1.04	.3800
N (%)	1.07	0.98	1.17	.1200
Hb (g/L)	1.01	0.97	1.05	.7000
PLT ($\times 10^9$/L)	1.01	1.00	1.02	.0070[c]
Anticoagulation (Y%)	13.01	2.34	102.18	.0030[c]

Abbreviations: CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; Hb, hemoglobin; N%, percent of neutrophil; PT, prothrombin time; PCT, procalcitonin; PLT, blood platelet; WBC, leukocyte.
[a]$P < 0.05$, [b]$P < 0.0001$, [c]$P < 0.01$.

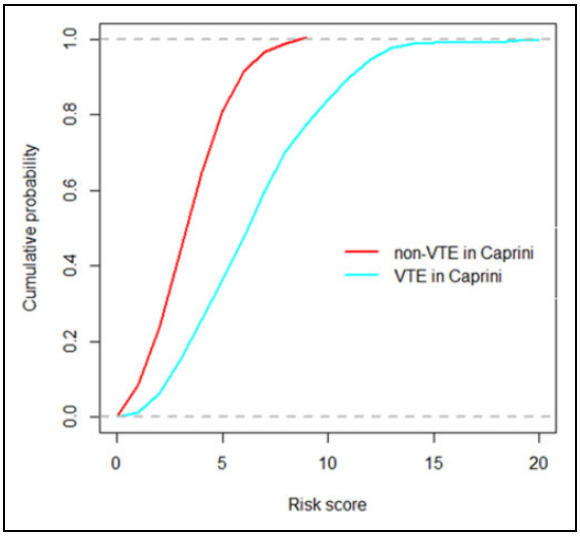

Figure 1. Cumulative distribution of risk score for Caprini.

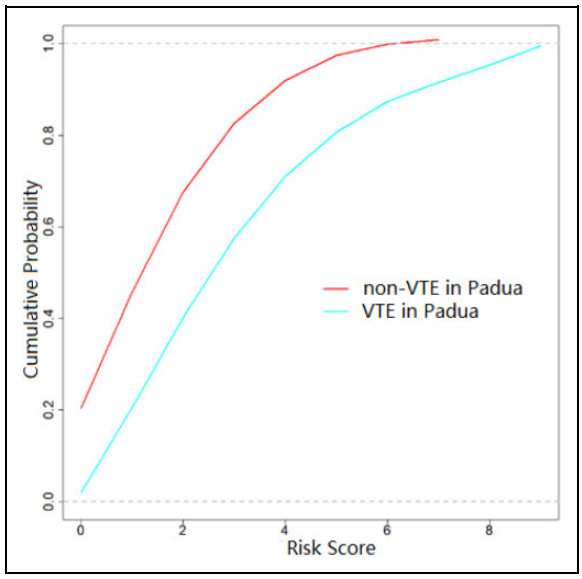

Figure 2. Cumulative distribution of risk score for Padua.

Table 4. Comparison of Caprini and Padua RAMs in all Patients.

	Score	Sensitivity	Specificity	*P* Value
Caprini	4	0.738	0.647	<.0001
	5	0.628	0.826	<.0001
Padua	3	0.535	0.821	<.0001
	4	0.421	0.925	<.0001

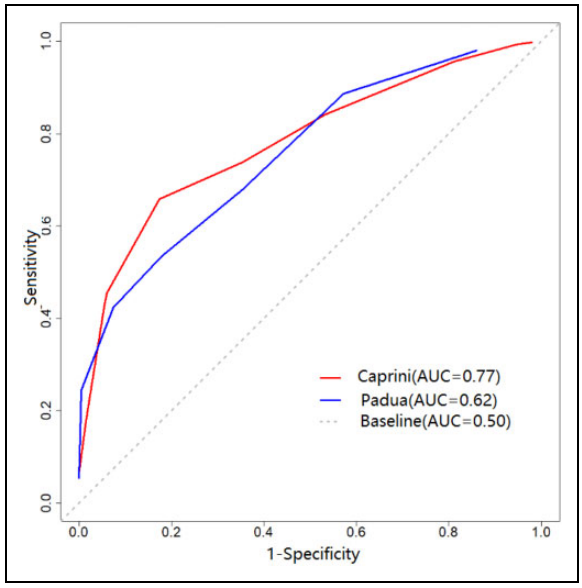

Figure 3. Receiver operating characteristic (ROC) curve of the Caprini and Padua risk assessment models in all patients.

enlarged, blood flow is slow, and DVT forms more readily. We found that the number of patients with unilateral lower extremity edema in the DVT group was more than the non-DVT group, and unilateral lower extremity edema would be a sign of DVT.

Table 5. Comparison of Caprini and Padua Between Internal Medical and Surgical Patients.

		Sensitivity	Specificity	*P* Value
Internal medicine	Caprini	0.704	0.609	<.0001
	Padua	0.500	0.807	<.0001
Surgery	Caprini	0.875	0.800	<.0001
	Padua	0.675	0.875	<.0001

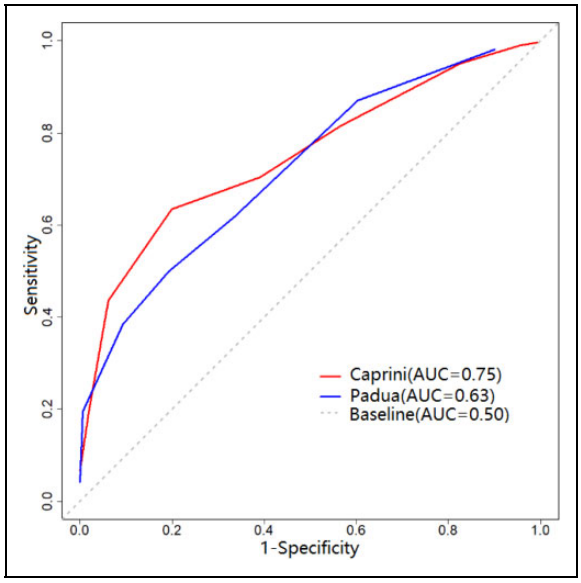

Figure 4. Receiver operating characteristic (ROC) curve of the Caprini and Padua risk assessment models in internal medical patients.

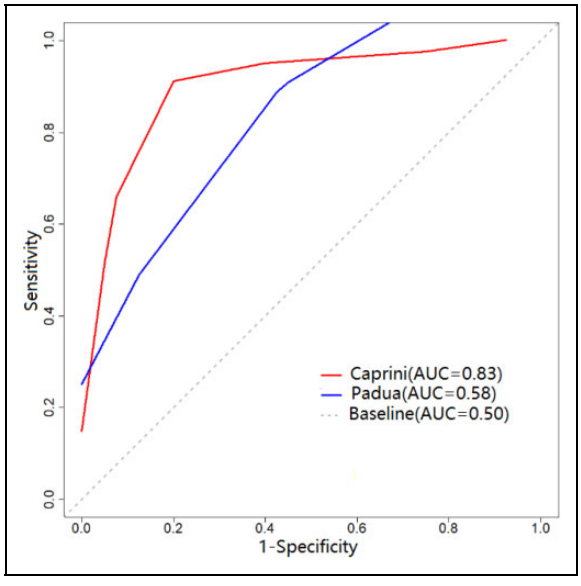

Figure 5. Receiver operating characteristic (ROC) curve of the Caprini and Padua risk assessment models in surgical patients.

This finding agrees with other researchers[23] who have reported that DVT usually presents with unilateral painful swelling in the limb in Western countries.

Table 6. Comparison of the Caprini and Padua RAM's Between Those With and Without Cancer.

		Sensitivity	Specificity	*P* Value
Oncology	Caprini	0.852	0.537	<.0001
	Padua	0.741	0.741	<.0001
Nononcology	Caprini	0.689	0.680	<.0001
	Padua	0.418	0.828	.0002

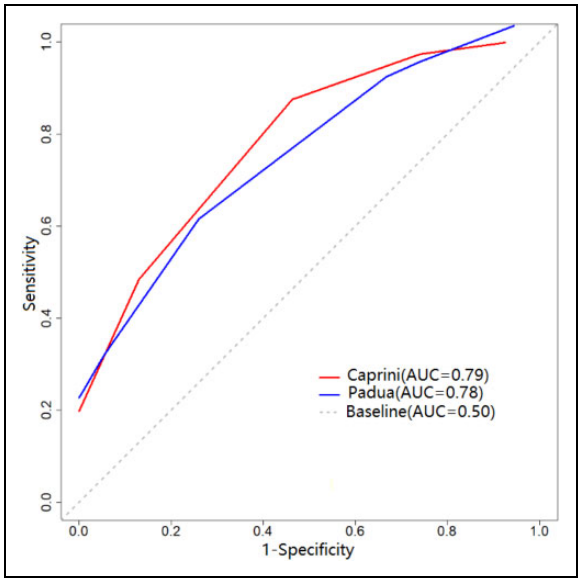

Figure 6. Receiver operating characteristic (ROC) curve of the Caprini and Padua risk assessment models in oncology.

The distribution of disease in our study included finding that the number of patients with acute infection, COPD, respiratory failure, coronary heart disease, and sepsis were greater in the DVT group than those without DVT. We speculate that the occurrence of VTE in China was closely associated with infection. In recent years, many studies have shown that there are inflammatory mediators activated including recruitment CD39, intercellular adhesion molecule 1, and vascular cell adhesion molecule 1 expression found in the vascular wall of the thrombus site. The inflammatory response-mediated complex agglutination cascade results in impaired vascular cells, which can induce thrombus along with activation of inflammatory cells resulting in an inflammation–thrombosis cycle.[24-26] One study included 220 (62.1%) patients in the medical ward and 134 (37.9%) in the surgical ward. Patients with respiratory infection had the highest incidence of high or highest Caprini risk (78.1%).[27] The likelihood of developing VTE doubled in the first 2 weeks after admission in respiratory infectious disease.[28] Our findings are consistent with the above studies. However, our results may be related to patients where respiratory disease was more prevalent than in other departments. We found more central venous catheterization and postoperative patients in the DVT group than were seen in the non-DVT group. Venous catheterization and prolonged operative time more than 3 hours

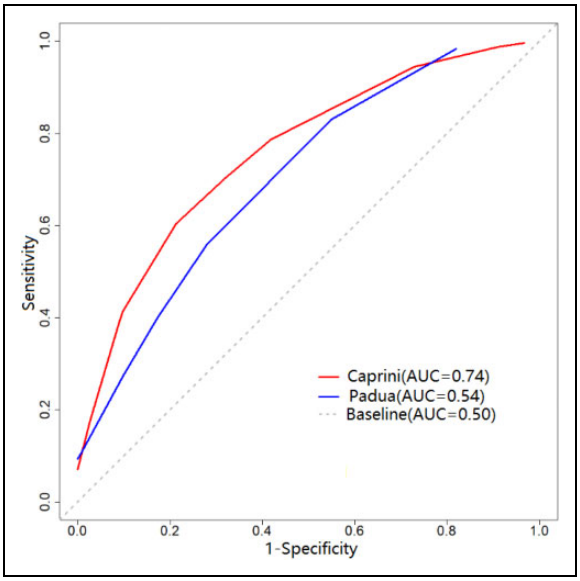

Figure 7. Receiver operating characteristic (ROC) curve of the Caprini and Padua risk assessment models in nononcology.

have been shown to be independent risk factors for thrombosis in mastectomy patients.[29] In our study, the results of laboratory examination showed that the levels of inflammatory markers (like CRP, ESR, PCT), N%, and PLT in the DVT group were significantly higher than those in the non-DVT group. Another Chinese study[30] also showed that N%, CRP, and ESR were often higher in patients with VTE. There is a common pathway and interaction between inflammatory response and coagulation. The inflammatory process may occur by pro-inflammatory cytokines activating coagulation and inducing the tissue factor pathway of coagulation. Activated clotting may affect specific inflammatory cells and endothelial cell receptors, thus exacerbating the inflammatory reaction, producing a cascade effect. Over the past several years, studies have shown that inflammation plays a pivotal role in the pathophysiology of thrombosis.[31] In our study, we found the number of patients who received low-molecular-weight heparin anticoagulation in the DVT group was significantly more than those in the non-DVT group. This may be the result of the Chinese medical staff and hospital president paying more and more attention to the prevention of VTE. It is known that the management of VTE has been an important goal of medical quality management in Chinese hospitals. For our 2000-bed teaching hospital, VTE multidisciplinary consultation was carried out, and every VTE patient was treated with a vascular surgery consultation, and standard anticoagulant therapy was given according to the guidelines. The prognosis of patients without DVT was much better than those suffering from DVT and that may be due to the fact that our patients without DVT were younger, had fewer underlying diseases, and were less bedridden than patients with DVT.

The Caprini and Padua RAMs are based on Western populations, and the cutoff values of Caprini and Padua RAMs may be different in the Chinese population, which may result in

improper assessment. Our study found that the sensitivity of Caprini RAM in Chinese patients was significantly higher than Padua RAM. The possibility of VTE occurrence was greater when the risk score of the Caprini RAM was above or equal to 4, or the risk score of Padua RAM was greater or equal to 3, and as such could be considered as the DVT cutoff level for Chinese patient.

It is well known that Caprini RAM is mainly recommended for surgical patients and Padua is recommend for internal medical patients according to the 2012 CHEST consensus document. Akai[32] found that up to 21.5% of VTE occurred in nonsurgical wards and studied 3 VTE RAMs, and that only the Caprini RAM could effectively distinguish VTE high-risk and low-risk patients. The assignment of the relevant risk factors in the model was based on the Western population. However, there are several small clinical research studies in China. One study[33] evaluated the prediction of VTE by Geneva, Wells, Caprini, and Padua in patients with type 2 diabetes. It showed that the sensitivity of the Caprini score was also higher than Padua score, and the Padua score remained inefficient in predicting VTE in these patients. One study compared Caprini and Padua scores just in hospitalized medical patients.[34] The patients we studied were different from the above. Our retrospective study compared Caprini and Padua scores in different departments, such as internal medicine, surgery, and oncology. We found that the Caprini RAM was more sensitive and less specific than Padua RAM for Chinese hospitalized patients. We concluded that since the Caprini RAM included more risk factors (such as patients confined to bed >72 hours, central venous access, or varicose veins) than Padua RAM, patients were more likely to be assessed as moderate risk or high risk. The Padua score does not include family history of thrombosis which is a powerful predictor of VTE. This means that any score which does not account for this risk factor may underestimate the risk of the patient. The specificity of the Caprini RAM was shown to be lower than the Padua RAM. This result illustrated high accuracy in the evaluation of low-risk patients by the Padua RAM. On the contrary, some Chinese researchers[27,35] found no statistically significant difference between surgical and medical patients who were scored by the Caprini RAM. We infer from above studies that the Caprini RAM may also be used for medical patients, and physicians could identify more VTE high-risk internal medical patients. It will be possible to have one scoring system for the entire hospital to simplify the risk assessment process and improve compliance.

Since our hospital's population includes a majority of patients with cancer, we divided the analysis into patients with cancer and patients without cancer. Patients with cancer are at high risk of VTE, and some studies have reported a 6-fold increased risk of VTE along with the risk of VTE recurrence being higher in patients with cancer compared to those with benign disease.[36] But we did not observe a significant difference of the predictive value between Caprini and Padua RAMs in patients with cancer. It is possible that these 2 assessments lack specific indicators for patients with cancer, such as the primary types of tumor, tumor staging, tumor treatment (radiotherapy or chemotherapy), and other factors. Underpower may be another reason for these negative results because we did not conduct a prospective sample size estimation.

Limitations

There are the limitations of our study as follows. Firstly, our study was a retrospective study. And we did not conduct a prospective sample size calculation. In this sense, our study was only an exploratory study. Further prospective studies with proper sample size assumptions need to confirm our results. Secondly, although others have reported that protein C, protein S, and antithrombin were found deficient in Asians,[37] we did not study them since these tests are expensive, and most of our population are elderly patients with other disease-related reasons for developing VTE. Thirdly, we did not compare our results with the tumor-associated VTE RAMs; therefore, the validity of RAMs may not be well evaluated in patients with cancer. Fourthly, our study was not a multicenter, large sample, randomized controlled study.

Conclusion

Although the specificity of Padua RAM was higher than Caprini RAM, our study demonstrates that the Caprini RAM was significantly superior to Padua RAM in sensitivity and prediction of VTE in Chinese patients. Venous thromboembolism may lead to fatal consequences which stress the importance of the Caprini RAM to screen high-risk populations for VTE. This allows appropriate prophylaxis regimes including anticoagulant and physical measures to prevent VTE. Our next step is to develop a Chinese RAMs, and we will compare it with classic Caprini and Padua models. Furthermore, we will conduct a multicenter, large sample, retrospective study and prospective study in China. The issue of family history of thrombosis also requires further study and needs to be included in future studies. It is also suggested that a patient-friendly questionnaire be used that was recently published in order to more completely score patients using the Caprini tool and reduce the time for the assessment process (https://www.ncbi.nlm.nih.gov/pubmed/29258392/).

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