The value of COMPASS-CAT risk assessment model in predicting venous thromboembolism in hospitalized patients with breast cancer, lung cancer, colorectal cancer and ovarian cancer

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Research Article

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Abstract

Objective

To explore the clinical value of COMPASS-CAT risk assessment model in predicting venous thromboembolism (VTE) in tumor patients.

Methods

482 patients with breast cancer, lung cancer, colorectal cancer, and ovarian cancer admitted to the oncology department were scored using the COMPASS-CAT risk assessment model and the Khorana risk assessment scale, respectively. The predictive value of the two models for VTE was compared.

Results

The proportion of platelet > 350x10^9 / L, hemoglobin < 100g / L, leukocyte > 11 x 10^9 / L, COMPASS-CAT ≥ 7 and Khorana score ≥ 2 in the VTE group was significantly higher than that in the non-VTE group. The sensitivity, specificity, Jordan index, positive predictive value and negative predictive value of COMPASS-CAT model ≥ 7 in the diagnosis of VTE were 69.81%, 98.13%, 67.94%, 82.22% and 96.33%, respectively. The sensitivity, specificity, Jordan index, positive predictive value and negative predictive value of Khorana model ≥ 2 for diagnosis of VTE were 79.24%, 81.77%, 61.01%, 35.00% and 96.95%, respectively. The AUC of VTE diagnosed by COMPASS-CAT model and Khorana model was 0.913 (95%CI:0.858–0.967) and 0.695 (95%CI: 0.617–0.773). Multivariate Logistic regression analysis showed that COMPASS-CAT model score ≥ 7 and Khorana model score ≥ 2 were independent risk factors for VTE in tumor patients.

Conclusion

COMPASS-CAT model is superior to Khorana model in diagnosing VTE in tumor patients, and it is more suitable for VTE risk assessment in tumor patients.

Introduction

Most patients with malignant tumors have rapid blood coagulation and are easy to form thrombosis, among which venous thromboembolism (VTE) is a common thrombotic disease[1]. Evidence-based medicine evidence shows that the risk of thrombosis in tumor patients is 4.1 times higher than that in normal people, and 6.5 times higher in chemotherapy patients[2]. Studies have shown that appropriate preventive measures can reduce the relative risk of deep vein thrombosis and pulmonary embolism by 50% ~ 60% and 66.7%, respectively. Therefore, it is necessary to predict the risk of VTE in cancer patients, so as to give targeted intervention in the process of clinical treatment and nursing, so as to
improve the prognosis of patients, reduce the disability and mortality of VTE, improve the quality of life and prolong the survival time[3]. There are many international studies on VTE risk assessment models, but they are still deepening. There are few studies on this in China, especially in malignant tumors. There is no standardized tumor venous thrombosis prevention system, and foreign scales are often used for evaluation. However, whether it is suitable for China has not been determined. At present, the commonly used risk assessment tools for cancer patients in China are Caprini risk assessment model and Khorana risk assessment model, the former is mainly suitable for surgical inpatients[4]; the latter is often used to determine the VTE risk of outpatients with cancer[5]. COMPASS-CAT risk assessment model is a VTE risk assessment tool for cancer patients based on European COMPASS studies. It has been successfully applied in the anti-tumor process of lung cancer, ovarian cancer, colorectal cancer and breast cancer[6]. In this study, Khorana risk assessment scale was used as the standard to evaluate the effect of COMPASS-CAT risk assessment model on VTE risk assessment of tumor patients.

Materials and methods

A total of 482 patients with breast cancer, lung cancer, colorectal cancer and ovarian cancer treated in the Department of Oncology, Hebei Provincial people's Hospital from October 2018 to October 2021 were selected as subjects. Inclusion criteria: (1) patients with malignant tumor diagnosed by cytology or histopathology; (2) received systematic treatment; (3) confirmed VTE; by imaging and biochemical examination; (4) complete clinical data. Exclusion criteria: (1) complicated with multiple malignant tumors or unclear pathological diagnosis;(2) patients with deep venous thrombosis or symptoms, but imaging findings do not support the diagnosis. The data of general clinical characteristics (sex, height, body mass, clinical stage, KPS score, pathological type), treatment plan, platelet, hemoglobin and white blood cell before treatment were collected.

According to the occurrence of VTE, the patients were divided into VTE group and non-VTE group. Then COMPASS-CAT risk assessment model and Khorana risk assessment scale were used for scoring. The specific scoring rules are as follows.

COMPASS-CAT model[6]: including cancer-related risk factors, such as hormone receptor positive endocrine therapy or anthracycline therapy (6 points), cancer diagnosis time \( \leq 6 \) months (4 points), central venous catheterization (3 points) and advanced cancer (2 points); Risk factors include cardiovascular risk factors (including at least two predictors: personal history of peripheral artery disease, ischemic stroke, coronary artery disease, hypertension, hyperlipidemia, diabetes, obesity, BMI \( \geq 30 \)kg/m2) (5 points). Recent acute medical hospitalization (5 points), personal history of VTE (1 point), platelet count \( \geq 350 \times 10^9 \) / L (2 points) and total score \( \geq 7 \) were divided into high risk of VTE. Khorana risk assessment scale[7]: it includes cancer location, such as stomach, pancreas, brain and other high-risk cancer types (2 points), other high-risk cancer types such as lung, lymphoid, digestive tract, bladder, testis and kidney (1 point); platelet count \( \geq 350 \times 10^9 \)/L(1 point) before chemotherapy. Hemoglobin level < 10g/dL or using erythrocyte growth factor (1 point), Hemoglobin level < 100g/L or red blood cell growth
factor (1 point), WBC count > 11×10^9 (1 point); BMI ≥ 35 kg/m² (1 point), ≥ 2 as high risk, < 2 as low risk.

Input all the data into Excel 2010 to establish a database, and use Medcalc software for statistical analysis. The working characteristic curve (ROC) of the subjects was drawn, and the area under the curve (AUC), sensitivity, specificity, Jordan index, positive predictive value and negative predictive value were calculated. Multivariate Logistic regression analysis was used to compare the predictive efficiency of VTE. Jordan index was equal to Sensitivity plus Specificity minus 1, representing the performance of the classification model. A significance criterion of $P < 0.05$ was used in the analysis.

This study was approved by the Institutional Review Board of the Ethics Center of Hebei General Hospital (20190354).

Results

2.1 Comparison of general data between the two groups

Between October 2018 and October 2021, a total of 482 patients were enrolled and VTE were confirmed in 53 (11.0%) patients. There was no significant difference in mean age, gender composition, tumor site, clinical stage, Coexisting diseases, and BMI between the VTE group and the non-VTE group. The percentages of platelet > 350 × 10^9 / L, hemoglobin < 100g / L, leukocyte > 11 × 10^9 / L, COMPASS-CAT ≥ 7 and Khorana score ≥ 2 in the VTE group were significantly higher than those in the non-VTE group. The general information of patients is shown in Table 1.
Table 1
Comparison of general data between VTE group and non-VTE group

<table>
<thead>
<tr>
<th>General Information</th>
<th>VTE(n = 53)</th>
<th>non-VTE(n = 429)</th>
<th>t/χ²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Age (years)</td>
<td>66.24 ± 11.00</td>
<td>64.28 ± 12.54</td>
<td>1.087</td>
<td>0.278</td>
</tr>
<tr>
<td>Gender Composition (male/female)</td>
<td>20/33</td>
<td>169/260</td>
<td>0.054</td>
<td>0.816</td>
</tr>
<tr>
<td>Tumor site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung Cancer</td>
<td>29</td>
<td>231</td>
<td>0.014</td>
<td>0.904</td>
</tr>
<tr>
<td>Ovarian cancer</td>
<td>6</td>
<td>51</td>
<td>0.015</td>
<td>0.904</td>
</tr>
<tr>
<td>Breast Cancer</td>
<td>6</td>
<td>45</td>
<td>0.034</td>
<td>0.853</td>
</tr>
<tr>
<td>Colon cancer</td>
<td>7</td>
<td>59</td>
<td>0.012</td>
<td>0.913</td>
</tr>
<tr>
<td>Rectal cancer</td>
<td>5</td>
<td>43</td>
<td>0.018</td>
<td>0.892</td>
</tr>
<tr>
<td>Clinical staging</td>
<td></td>
<td></td>
<td>1.366</td>
<td>0.242</td>
</tr>
<tr>
<td>1 ~ 2</td>
<td>6</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 ~ 4</td>
<td>47</td>
<td>353</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coexisting disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>18</td>
<td>133</td>
<td>0.192</td>
<td>0.661</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>6</td>
<td>43</td>
<td>0.087</td>
<td>0.768</td>
</tr>
<tr>
<td>Diabetes</td>
<td>5</td>
<td>47</td>
<td>0.113</td>
<td>0.736</td>
</tr>
<tr>
<td>Hyperlipemia</td>
<td>4</td>
<td>39</td>
<td>0.138</td>
<td>0.710</td>
</tr>
<tr>
<td>cerebral apoplexy</td>
<td>11</td>
<td>3</td>
<td>62.277</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Recent emergency admissions</td>
<td>15</td>
<td>87</td>
<td>1.820</td>
<td>0.177</td>
</tr>
<tr>
<td>BMI(kg/m²)</td>
<td>24.08 ± 3.50</td>
<td>23.69 ± 3.87</td>
<td>0.699</td>
<td>0.485</td>
</tr>
<tr>
<td>Central Venous Catheter</td>
<td>13</td>
<td>34</td>
<td>14.776</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Platelets &gt; 350×10⁹/L</td>
<td>8</td>
<td>12</td>
<td>17.936</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hemoglobin &lt; 100 g/L</td>
<td>16</td>
<td>35</td>
<td>24.197</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>White blood cells &gt; 11×10⁹/L</td>
<td>10</td>
<td>29</td>
<td>9.299</td>
<td>0.002</td>
</tr>
<tr>
<td>COMPASS-CAT score ≥ 7</td>
<td>37</td>
<td>8</td>
<td>257.289</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Khorana score ≥ 2</td>
<td>42</td>
<td>78</td>
<td>94.07</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
2.2 Comparison of sensitivity, specificity, Jordan index, positive predictive value and negative predictive value between the two models in the diagnosis of VTE.

The sensitivity, specificity, Jordan index, positive predictive value and negative predictive value of COMPASS-CAT model in diagnosing VTE were 69.81%, 98.13%, 67.94%, 82.22% and 96.33%, respectively. The sensitivity, specificity, Jordan index, positive predictive value and negative predictive value of Khorana model in diagnosing VTE were 79.24%, 81.77%, 61.01%, 35.00% and 96.95%, respectively. The specificity, Jordan index and positive predictive value of COMPASS-CAT model in diagnosing VTE were higher than those of Khorana model.

2.3 AUC comparison of two models in diagnosing VTE

The AUC of COMPASS-CAT model and Khorana model for diagnosing VTE were 0.913 (95%CI: 0.858 ~ 0.967) and 0.695 (95%CI:0.617 ~ 0.773), respectively. There was a statistically significant difference in AUC between the two models (Z = 3.162, P < 0.05). See Fig. 1.

2.4 Multivariate Logistic regression analysis of VTE occurrence risk

Multivariate Logistic regression analysis showed that COMPASS-CAT model score ≥ 7 and Khorana model score ≥ 2 were independent risk factors for VTE in tumor patients. (P < 0.05). See Table 2.

<table>
<thead>
<tr>
<th>Factor</th>
<th>B</th>
<th>SE</th>
<th>Wald</th>
<th>P</th>
<th>OR</th>
<th>OR 95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPASS-CAT score ≥ 7</td>
<td>3.028</td>
<td>0.372</td>
<td>66.256</td>
<td>&lt; 0.05</td>
<td>20.656</td>
<td>9.963 ~ 42.825</td>
</tr>
<tr>
<td>Khorana score ≥ 2</td>
<td>1.182</td>
<td>0.206</td>
<td>32.923</td>
<td>&lt; 0.05</td>
<td>3.261</td>
<td>2.178 ~ 4.883</td>
</tr>
</tbody>
</table>

Discussion

The incidence of VTE in cancer patients is high. Taking lung cancer as an example, the incidence of VTE can reach 3.0%-13.8%[8, 9]. The National Comprehensive Cancer Network (NCCN) and the Clinical Oncology Collaborative Committee of China Anti-Cancer Association (CSCO) recommend and encourage VTE risk assessment for all hospitalized cancer patients and targeted care and treatment interventions for high-risk patients to improve their quality of life[10, 11]. Various guidelines at home and abroad have also formulated clinical guidelines for VTE related to malignant tumor patients[12–14]. However, in the actual clinical work, most patients do not get proper thrombus risk assessment and preventive
intervention, and only less than 50% of the patients receive appropriate preventive treatment. How to screen tumor patients who need preventive treatment is still an urgent problem for clinicians.

At present, the commonly used VTE risk assessment models include Caprini model and Khorana model. The former is mainly used for surgical inpatients, but not for advanced cancer patients who cannot be treated surgically[15]. The latter is mainly used for VTE risk assessment of outpatient cancer patients, but there are few studies among inpatients. It has been reported that the Khorana model cannot effectively distinguish between low-risk and high-risk patients with VTE in breast cancer and lung cancer, and its clinical practicability is still controversial[16, 17]. In 2017, an international multicenter prospective study on the prediction of thrombosis associated with breast cancer, colorectal cancer, lung cancer and ovarian cancer developed a COMPASS-CAT risk assessment model, covering eight major contents, including anthracycline or anti-hormone therapy, time since cancer diagnosis, presence or absence of central venous catheter, cancer stage, cardiovascular risk factors, recent hospitalization for acute diseases, individuals with VTE, and platelet count. Compared with Khorana score, it is suitable for VTE assessment after anticancer treatment in patients with solid tumors[6], subgroup analysis was conducted in 2021. Analysis from the COMPASS-CAT revealed a significant correlation between radiotherapy and VTE in patients with cancer[18]. In recent years, there have been some related studies, but the number of studies is relatively small, and most of them are retrospective studies. Nikolakopoulos et al[19] further reviewed and verified the COMPASS-CAT risk assessment model by using big data. Abdel-Razeq Hikmat et al[20] compared the COMPASS-CAT versus Khorana risk assessment model for predicting venous thromboembolic events in patients with non-small cell lung cancer on active treatment with chemotherapy and/or immunotherapy. Compared to Khorana risk assessment model, COMPASS-CAT risk assessment model was better in identifying more patients in high-risk group, with higher VTE rate. Pestana, RMC et al[21] conducted a study on breast cancer, all 80 patients presented a high risk for VTE when evaluated by COMPASS-CAT model (score ≥ 7) and a positive correlation was observed between IL-10 plasma levels and VTE risk score.

In this study, we compared the clinical efficacy of COMPASS-CAT model and Khorana model in predicting VTE in tumor patients. The results showed that the specificity, Jordan index and positive predictive value of VTE in patients with tumor diagnosed by COMPASS-CAT model ≥ 7 were higher than those in Khorana model. The AUC of COMPASS-CAT model and Khorana model in diagnosis of VTE were 0.913 (95%CI:0.858 ~ 0.967) and 0.695 (95%CI:0.617 ~ 0.773), respectively. The difference was statistically significant (P<0.05). Multivariate Logistic regression analysis showed that COMPASS-CAT model score ≥ 7 and Khorana model score ≥ 2 were independent risk factors for VTE in tumor patients. Wang Yanfeng et al[22] compared the predictive value of COMPASS-CAT model and Khorana model on the risk of VTE in patients with lung cancer. The results showed that the diagnostic specificity, Jordan index and AUC of COMPASS-CAT model were higher than those of Khorana model. Manar Mosaad et al[23] also made a comparison, Khorana risk score still offers the best available risk assessment model when used for high-risk populations with a threshold of 2 and above. However, KRS has a limitation of failure to stratify low-risk patients. The COMPASS-CAT score showed the best performance in the lung carcinoma patients who have a higher prevalence of thrombosis than other malignancy subtypes.
Conclusion

In summary, the COMPASS-CAT model is superior to the Khorana model in the diagnosis of VTE in cancer patients, and is more suitable for VTE risk assessment in patients with breast cancer, lung cancer, colorectal cancer, ovarian cancer and other tumor types. The sample size is relatively limited, and the proportion of lung cancer patients in the study cases is relatively large, so the results may be biased. It is still necessary to conduct a large sample of multicenter, multi-tumor patients to determine the effectiveness of COMPASS-CAT model in evaluating the occurrence of VTE in patients with different tumors.

Declarations

Conflict of interest

All authors report no relevant disclosures.

Ethics approval

This study was approved by the Institutional Review Board of the Ethics Center of Hebei General Hospital. Shijiazhuang, China. April 1, 2019.

Funding

None

Author Contribution

HLW conceived and designed the study. HLW, WH collected the data. HLW, WH analyzed and interpreted the data. HLW, XBZ performed the statistical analysis. HLW drafted the manuscript. XBZ, MZ supervised the study. All authors read and approved the final manuscript.

Data Availability

All data and materials are available from the corresponding authors upon written request.

References


**Figures**
Figure 1

Compass-CAT and Khorana models diagnose ROC of VTE