

Original article

Incidence, risk factors of symptomatic venous thromboembolism and risk prediction score in hospitalized cancer patients at Ubon Ratchathani Cancer Hospital

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Abstract:

Introduction: Cancer patients have a higher risk for venous thromboembolism (VTE) which can lead to significant morbidity and mortality. Therefore, identifying high-risk groups for appropriate prevention is essential. **Objective:** This study aimed to determine the incidence and risk factors for VTE in cancer patients receiving treatment at Ubon Ratchathani Cancer Hospital. **Methods:** This prospective observational cohort study collected patient baseline data and followed-ups at 30, 60 and 90 days. Patients with suspected VTE, based on the Padua score and Caprini score, underwent Doppler ultrasonography or CT angiography. The calculated sample size was 185. **Results:** Among 185 cancer patients, the incidence of VTE was 21.1%. The locations included the leg (52.6%), lungs (18.4%), neck (10.5%), abdomen (10%) and kidney (5.2%), while 2 patients died from pulmonary embolism. Patients with ECOG performance status (PS) grades 3-4 comprised 28.7%. The most common cancer type was gynecological (28.7%), followed by head and neck cancers (21.1%). Patients at stages 3-4 accounted for 68.1%, and 53% (98 patients) underwent surgery. Multivariable logistic regression analysis identified risk factors for VTE: female [adjusted odds ratio (AdjOR) = 3.87, 95% confidence interval (CI) = 1.46-10.27], ECOG PS grades 3-4 (AdjOR = 4.74, 95%CI: 1.82-12.32) and surgical intervention (AdjOR = 2.46, 95%CI: 1.01-5.96). Patients with 2 and 3 risk factors had VTE incidence rates of 19.2% and 67.9%, respectively. **Conclusion:** VTE is a common complication among cancer patients. The risk factors included PS, sex and surgery. Patients with two or more of these factors should be considered for appropriate preventive measures.

Keywords : ● Cancer ● Venous thromboembolism ● Postoperative ● Low molecular weight heparin
● Heparin ● Warfarin

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นิพนธ์ต้นฉบับ

อุบัติการณ์ ปัจจัยเสี่ยงของภาวะลิ่มเลือดอุดตันในหลอดเลือดดำที่มีอาการ และคะแนนการพยากรณ์โรคในผู้ป่วยมะเร็งที่เข้ารับการรักษา ในโรงพยาบาลมะเร็งอุบลราชธานี

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บทคัดย่อ

บทนำ ผู้ป่วยมะเร็งมีโอกาสเกิดภาวะหลอดเลือดดำอุดตัน (venous thromboembolism, VTE) มากขึ้นซึ่งอาจทำให้ผู้ป่วยเสียชีวิตหรือมีภาวะแทรกซ้อนทั้งจากโรคหรือการรักษา จึงควรหากกลุ่มที่มีความเสี่ยงสูงเพื่อรับการป้องกัน **วัตถุประสงค์** เพื่อศึกษาอุบัติการณ์และปัจจัยเสี่ยงต่อ VTE ของผู้ป่วยมะเร็งที่ได้รับการรักษาในโรงพยาบาลมะเร็งอุบลราชธานี **วิธีศึกษา** การศึกษา prospective observational cohort เก็บข้อมูลพื้นฐานและติดตามอาการที่ 30, 60 และ 90 วัน ในผู้ป่วยที่มีอาการสงสัย VTE จาก Padua score และ Caprini score จะได้รับการทำ Doppler ultrasonography หรือ CT angiography คำนวณขนาดตัวอย่างได้ 185 คน **ผลการศึกษา** ผู้ป่วยทั้งหมด 185 คน เกิด VTE ร้อยละ 21.1 (39 ราย) เกิดที่ตำแหน่งหลอดเลือดดำที่ขา ร้อยละ 52.6 ที่ปอด ร้อยละ 18.4 ที่คอ ร้อยละ 10.5 ในช่องท้อง ร้อยละ 10 และที่ไต ร้อยละ 5.2 ผู้ป่วย 2 ราย เสียชีวิตจาก pulmonary embolism ผู้ป่วย ECOG performance status (PS) grade 3-4 ร้อยละ 28.7 มะเร็งที่รื้อพบมากที่สุดร้อยละ 28.7 รองลงมาเป็นมะเร็งหูดอกจุก ร้อยละ 21.1 ระยะที่ 3-4 ร้อยละ 68.1 ได้รับการรักษาด้วยการผ่าตัดทั้งสิ้นร้อยละ 53 การวิเคราะห์แบบพหุตัวแปร พบปัจจัยที่มีความสัมพันธ์กับการเกิด VTE ได้แก่ เพศหญิง [adjusted odds ratio (AdjOR) = 3.87, 95% confidence interval (CI): 1.46-10.27], ECOG PS grade 3-4 (AdjOR = 4.74, 95%CI: 1.82-12.32) และ ผู้ป่วยที่ได้รับการผ่าตัด (AdjOR = 2.46, 95%CI: 1.01-5.96) โดยผู้ป่วยที่มี 2 และ 3 ปัจจัยเสี่ยงนี้มีโอกาสเกิด VTE ร้อยละ 19.2 และ 67.9 ตามลำดับ **สรุป** หลอดเลือดดำอุดตันเป็นภาวะแทรกซ้อนที่พบบ่อยมากในผู้ป่วยโรคมะเร็งโดยมีปัจจัยเสี่ยงได้แก่ PS, เพศ และการผ่าตัด ผู้ป่วยที่มี 2 ปัจจัยเสี่ยงนี้ขึ้นไป ควรพิจารณาให้การป้องกันที่เหมาะสม

คำสำคัญ : ● มะเร็ง ● ภาวะลิ่มเลือดอุดตันในหลอดเลือดดำ ● หลังการผ่าตัด ● เฮปารินน้ำหนักโมเลกุลต่ำ ● เฮปาริน ● วอร์ฟาริน

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Introduction

Venous thromboembolism (VTE) is a condition that can lead to mortality from massive pulmonary embolism or chronic complications from both the disease itself and anticoagulant therapy. Cancer patients have a higher risk of VTE, with a mortality rate up to six times higher compared to non-cancer patients. Knowledge about the relationship between VTE and cancer has been documented for over 150 years¹. Since then, numerous studies have been conducted on the association between cancer and VTE, gaining increasing acceptance within the medical community. Surgical patients also exhibit a significant risk of developing VTE.

The incidence of VTE among cancer patients may have changed in the past decade. Danish medical registries were used to identify 499,092 patients with a first time cancer diagnosis between 1997 and 2017, who were matched to 1,497,276 comparison individuals without cancer from the general population. Data comprised computed cumulative incidences of VTE at 6 and 12 months after diagnosis. The cumulative incidence of VTE 12 months after a cancer diagnosis was 2.3% [95% confidence interval (CI), 2.2%-2.3%] in the cancer cohort and 0.35% (95%CI: 0.34% to 0.36%) in the comparison cohort (HR, 8.5; 95%CI: 8.2-8.8).² In 2023, one review article showed that the incidence of VTE varied across countries. Intrinsic and environmental risk factors may lead to VTE through several difference mechanisms. Amon several risk factors, cancer and surgery are significant contributors.³

One prospective study concerning the population of Minnesota, conducted since 1966, reported that the annual incidence of a first episode of deep vein thrombosis (DVT) or pulmonary embolism (PE) in the general population was 117 of 100,000⁶. Cancer alone was associated with a 4.1-fold increased risk of thrombosis, whereas chemotherapy increased the risk 6.5-fold⁷. Combining these estimates yields an approximate annual incidence of VTE of 1 of 200 in a population of cancer patients.⁵ A study

investigating cancer patients undergoing surgery found that the risk of developing VTE post-surgery could reach 50% without preventative measures. The likelihood of VTE depended on the type of surgery, and the use of anticoagulants was shown to reduce the incidence of VTE by 50% to 80%.⁸

In 2006, a randomized study at the Centre for Surgical Sciences in London investigated 6,124 cancer patients and 16,954 non-cancer patients undergoing surgeries lasting longer than 30 minutes. They found that, after 7 to 4 days, anticoagulant treatment reduced the risk of symptomatic DVT in the legs by 1.3% and decreased mortality from PE by 0.4%.⁹

A prospective cohort study in 2006 with 2,373 cancer patients noted that 40% developed symptomatic VTE at least 30 days post-surgery, with 46% of those who died experiencing a fatal PE. Significant risk factors included anesthesia duration over two hours, bed rest longer than four days, advanced cancer stages and age over 60.¹⁰

From this literature review, it can be concluded that VTE is strongly associated with cancer, particularly in surgeries performed in the abdominal and pelvic regions, where the risk of DVT and PE is high post-surgery without prophylactic anticoagulant therapy. Therefore, we are interested in studying the incidence of VTE among cancer patients receiving treatment at Ubon Ratchathani Cancer Hospital and identifying VTE risk factors in these patients. This information will serve as a foundation for future studies, particularly regarding appropriate preventive measures for post-operative VTE in cancer patients.

Materials and Methods

This prospective observational cohort study was conducted from January 2019 to December 2023 at Ubon Ratchathani Cancer Hospital, Ubon Ratchathani Province, Thailand. Patients admitted to the hospital with newly and definitely diagnosed cancer were enrolled.

They either underwent abdominal or pelvic surgery or received chemotherapy and/or radiation therapy in the hospital for more than five days. The exclusion criteria included pregnancy, anticoagulant uses, a history of thrombophilia or previous VTE, hormonal treatment and being bedridden since the date of hospitalization.

The sample size was calculated using the specified values of $\alpha = 0.05$, $\beta = 0.2$, $p_1(\text{VTE in cancer surgery}) = 0.33$ and $p_2(\text{VTE in non-surgical patients}) = 0.09^9$. The total subjects were 185. After obtaining informed consent, a medical history review and physical examination were conducted to record baseline data including cancer types, disease stage, size of the largest tumor, type of surgery, duration of surgery, history of previous VTE, and comorbidities such as diabetes, hypertension, hyperlipidemia, smoking, use of estrogen hormones and age over 60 years.

The Padua and Caprini scores were evaluated.^{3,14} If the score indicated a moderate-to-high risk or if patients presented with leg swelling, shortness of breath, chest pain, or hemoptysis, they were referred for Doppler ultrasonography or CT angiography as appropriate. Moderate-to-high risk patients were also followed-up via telephone to check VTE symptoms at 30, 60 and 90 days post-discharge. If DVT or PE was suspected, the patient was advised to return for Doppler ultrasonography or CT angiography, accordingly (Figure 1).

Statistical analysis was performed using STATA 18 Software. Variables associated with VTE, including surgery, ECOG performance status, sex, age and primary cancer, were analyzed for odds ratios (ORs) with 95%CI using the Chi-square test, binary logistic regression analysis and multivariable logistic regression analysis. Moreover, a scoring system was developed to create a risk score.

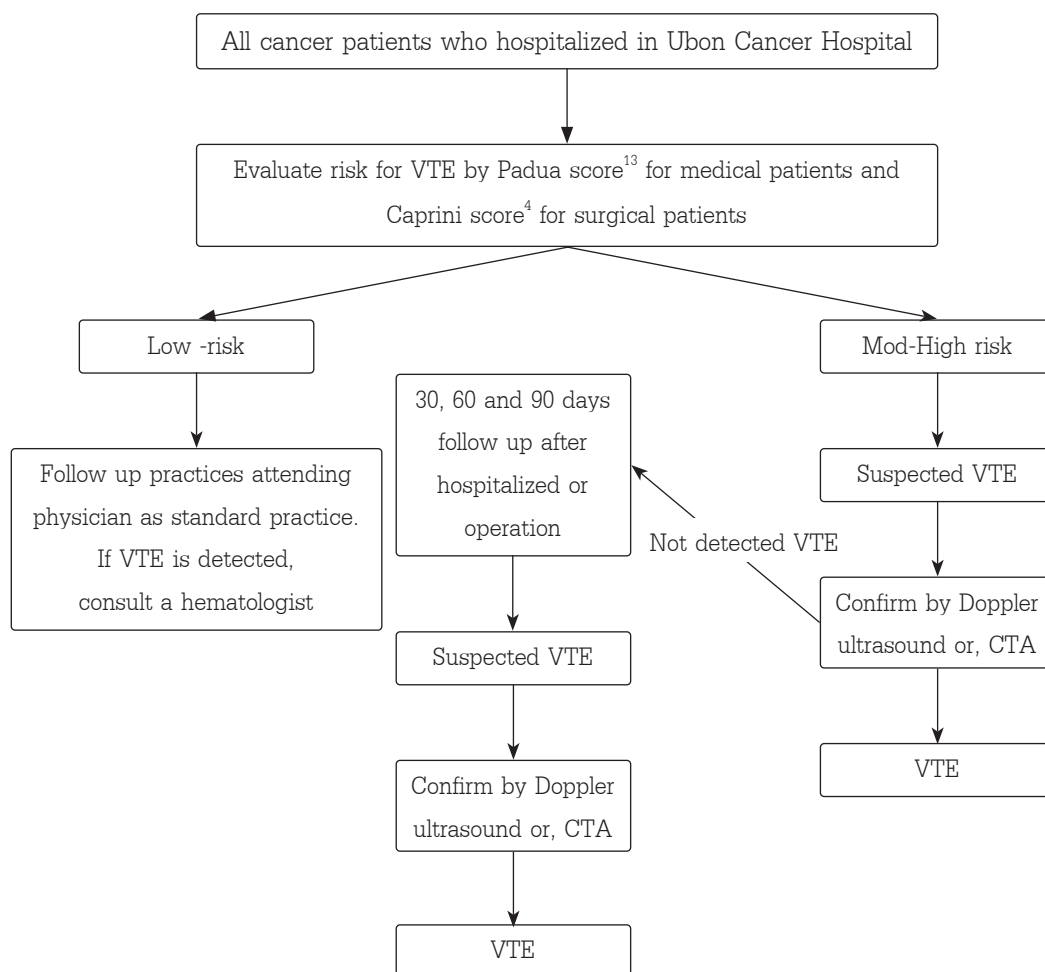


Figure1 Flow chart of the research methodology

Results

Baseline characteristics

Among 185 cancer patients, 54% were female with an average age of 58.4 years (standard deviation [SD] 13.24). Surgical patients comprised 53%. There were 39 cases (21.1%) of VTE diagnosed during the 90-day follow-up period. The median time to VTE occurrence after surgery was 59 days. Some cases developed during chemotherapy and palliative radiation treatment, approximately 30 to 60 days post-surgery. One case occurred 15 days after surgery, and another occurred 3 days after surgery. The locations of thrombosis included the femoral vein (52.6%), PE (18.4%), internal jugular vein (10.5%), inferior vena cava (5.2%), inferior mesenteric vein (5.2%) and renal vein (5.2%). Two deaths resulted from PE. The comorbidities included diabetes (26%), hypertension (39%), hyperlipidemia (25%), chronic kidney disease (2.9%) and cerebrovascular disease (5.8%). The characteristics of patients are displayed in Table 1.

VTE in patients undergoing surgery

In the group of cancer patients who underwent surgery (98 cases), the types of surgery and VTE incidence rates were as followed: pelvic surgery accounted for 40.8% (40 cases) with a VTE incidence rate of 22.5% (9 cases); breast surgery accounted for 23.5% (23 cases) with a VTE incidence rate of 17.3% (4 cases); abdominal surgery accounted for 22.4% (22 cases) with a VTE incidence rate of 40.9% (9 cases); ENT (ear, nose, and throat) surgery accounted for 12.2% (12 cases) with a VTE incidence rate of 25% (3 cases); and leg surgery due to pathological fracture accounted for 1% (1 case) with a VTE incidence rate of 100% (1 case). The overall VTE incidence rate was 26.5% (26 cases), as shown in Table 2-1

Cancer patients who underwent surgery had a higher incidence of VTE compared to those who did not undergo surgery (26.5% vs. 14.9%, respectively) as shown in Table 2. However, this difference was not statistically significant ($p = 0.054$).

Factors associated with VTE in cancer patients

Using binary logistic regression analysis, female patients had a 2.80 times higher risk of developing VTE compared to male patients (OR 2.80, 95%CI: 1.41-5.56). Additionally, patients with ECOG grades 3-4 were 2.63 times more likely to develop VTE compared to those with ECOG grades 0-2 (OR 2.63, 95%CI: 1.36-5.08). Additionally, cancer patients who underwent hemicolectomy had a 4.06 times higher risk of developing VTE compared to patients who did not undergo surgery (OR = 4.06, 95%CI: 1.12-14.77), with statistical significance at a p -value of less than 0.05. Other factors such as age, primary cancer type, disease stage, treatment and comorbidities did not show significant associations, as illustrated in Table 2.

Multivariable logistic regression analysis revealed that female cancer patients had a 3.87 times higher risk of developing VTE compared to male patients (AdjOR 3.87, 95%CI: 1.46-10.27). Patients with ECOG grades 3-4 had a 4.74 times higher risk of VTE compared to those with ECOG grade 0-2 (AdjOR 4.74, 95%CI: 1.82-12.32). Cancer patients who underwent surgery had a 2.46 times higher risk of VTE compared to those who did not undergo surgery (AdjOR 2.46, 95%CI: 1.01-5.96). These findings were statistically significant, with a p -value of less than 0.05. No significant associations were found for age, primary cancer type, disease stage or comorbidities, as illustrated in Table 3.

VTE risk score calculation for cancer patients

A risk score system was developed to predict VTE based on several factors, with point assignments as follow: female (1 point), ECOG performance status > 2 (1 point) and surgical intervention (1 point).

A logistic regression model was created to predict VTE using these predictors: ECOG performance status (< 2 or > 2), sex (female or not) and treatment (surgery or not). Internal validation was conducted using a bootstrap resampling procedure with 200 iterations to assess model performance and overfitting.

Table 1 Characteristics of Cancer Patients Classified by Occurrence of VTE

Variable	VTE occurrence	No VTE occurrence	Total	p-value
	N (%)	N (%)	N = 185	
	39(21.1)	146(78.9)		
Gender				0.001*
Female	30 (30.0)	70 (70.0)	100 (54.0)	
Male	9 (10.6)	76 (89.4)	85 (46.0)	
Age (years)				0.295
18-40	6 (35.3)	11 (64.7)	17 (9.19)	
41-60	16 (21.1)	60 (79.9)	76 (41.1)	
> 60	17 (18.5)	75 (81.5)	92 (49.8)	
ECOG Performance status				0.022*
0	0	6(100.0)	6(3.2)	
1	2(18.2)	9(81.8)	11(5.9)	
2	8(11.3)	63(88.7)	71(38.4)	
3	11(25.0)	33(75.0)	44(23.8)	
4	18(34.0)	35(66.0)	53(28.7)	
Primary Cancer				0.113
Breast	4(17.4)	19(82.6)	23(12.4)	
Gynecology	14(26.4)	39(73.6)	53(28.7)	
Head and neck	2(5.2)	37(94.9)	39(21.1)	
Lung	3(18.8)	13(81.2)	16(8.6)	
Gastrointestinal cancer	9(33.3)	18(66.7)	27(14.6)	
Hematology	4(30.8)	9(69.2)	13(7.0)	
Others	3(21.4)	11(78.6)	14(7.6)	
Stage				0.159
1	1(4.3)	22(95.7)	23(12.4)	
2	10(27.8)	26(72.2)	36(19.5)	
3	10(20.0)	40(80.0)	50(27.0)	
4	18(23.7)	58(76.3)	76(41.1)	
Surgical Treatment				0.054
Surgery	26(26.5)	72(73.5)	98(53.0)	
No surgery	13(14.9)	74(85.1)	87(47.0)	
Type of surgery				0.594
Modified radical mastectomy	4(28.5)	14(77.8)	18(9.7)	
TAH with BSO	7(21.8)	25(78.1)	32(17.3)	
Hemicolectomy	5(41.6)	7(58.3)	12(6.5)	
RHND with BSO	3(27.2)	8(72.7)	11(5.9)	
Colostomy	3(27.2)	8(72.7)	11(5.9)	
Tracheostomy	2(28.5)	5(71.4)	7(3.8)	
Excision neck mass	1(14.2)	6(85.7)	7(3.8)	
Radiotherapy				0.094
Radiation	4(9.3)	39(90.7)	43(23.2)	
No radiation	34(23.9)	108(76.1)	142(76.8)	
Chemical treatment				0.422
Chemotherapy	27(22.8)	90(76.3)	118(63.8)	
Non chemotherapy	11(16.4)	56(83.6)	67(36.2)	
Cisplatin regimen				0.795
Cisplatin	2(14.2)	12(85.7)	14(7.6)	
Non cisplatin	37(21.6)	134(78.4)	171(92.4)	
Comorbidities				0.97
Yes	14(21.2)	52(78.8)	66(35.7)	
No	25(21.0)	94(79.0)	119(64.3)	

Table 2-1 Summary of the proportion of patients undergoing each type of surgery and the incidence rate of VTE for each group.

Type of surgery	Number of patients (%)	VTE occurrence	VTE incidence rate(%)
Pelvic surgery	40(40.3%)	9	22.5%
Breast surgery	23(23.5%)	4	17.4%
Abdominal surgery	22(22.4%)	9	40.9%
ENT surgery	12(12.2%)	3	25%
Leg surgery due to pathological fracture	1(1%)	1	100%
total	98(100%)	26	26.5%

Table 2 Factors Associated with VTE in Cancer Patients Using Univariate Analysis

Factors	VTE occurrence N (%) 39(21.1)	Non VTE occurrence N (%) 146(78.9)	OR	95%CI	p-value
Gender					
Female	30(16.3)	70(38.0)	2.80	1.41-5.56	0.002*
Male	9(4.9)	75(40.8)	1.00		
Age (years)					
18-60	22(11.9)	71(38.4)	1.28	0.73-2.25	0.494
> 60	17(9.2)	75(40.5)	1.00		
ECOG Performance status					
3-4	29(15.7)	68(36.8)	2.63	1.36-5.08	0.003*
0-2	10(5.4)	78(42.2)	1.00		
Primary cancer					
Breast	4(2.2)	19(10.3)	1.00		
Gynecology	14(7.6)	39(21.1)	1.70	0.49-5.89	0.559
Head and neck	2(1.1)	37(20.0)	0.26	0.04-1.53	0.183
Lung	3(1.6)	13(7.0)	1.10	0.21-5.74	1.000
Gastrointestinal cancer	9(4.9)	18(9.7)	2.38	0.62-9.09	0.332
Hematology	4(2.2)	9(4.9)	2.11	0.43-10.42	0.422
Other	3(1.6)	14(7.6)	1.02	0.11-5.29	1.000
Stage					
3-4	28(15.1)	98(53.0)	1.19	0.64-2.23	0.717
1-2	11(5.9)	48(25.9)	1.00		
Treatment					
Surgery	26(14.1)	72(38.9)	1.78	0.98-3.23	0.080
No Surgery	13(7.0)	74(40.0)	1.00		
Comorbidity					
Yes	14(7.6)	52(28.1)	1.01	0.56-1.80	0.974
No	25(13.5)	94(50.8)	1.00		
Type of surgery					
Modified radical mastectomy	4(2.2)	14(7.6)	1.63	0.46-5.72	.485
TAH with BSO	9(4.9)	25(13.5)	2.05	0.78-5.37	.189
Hemicolectomy	5(2.7)	7(3.8)	4.06	1.12-14.77	.039*
RHND with BSO	2(1.1)	8(4.3)	1.42	0.27-7.47	.650
Colostomy	2(1.1)	8(4.3)	1.42	0.27-7.47	.650
Tracheostomy	1(0.5)	4(2.2)	1.42	0.15-13.76	.571
Excision neck mass	3(1.6)	8(3.2)	2.13	0.50-9.12	.381

OR, Odds ratio; CI, confidence Interval

For the variables primary cancer and type of surgery, Fisher's Exact Test is used because the expected count in some cells is less than 5, and more than 20% of the cells have an expected count of less than 5.

Table 3 Factors Associated with VTE in Cancer Patients Using Multivariable Analysis

Factors	Crude OR (95%CI)	p-value	Adjusted OR (95%CI)	p-value
Gender				
Female	2.80(1.41-5.56)	<0.002*	3.87(1.46-10.27)	<0.007*
Male	1.00		1.00	
Age (years)				
18-60	1.28(0.73-2.25)	0.494	1.20(0.52-2.76)	0.664
> 60	1.00		1.00	
ECOG Performance status				
3-4	2.63(1.36-5.08)	0.003*	4.74(1.82-12.32)	0.001*
0-2	1.00		1.00	
Primary Cancer				
Gynecology	1.39(0.79-2.47)	0.353	2.58(1.93-3.45)	0.596
Other cancer	1.00		1.00	
Stage				
3-4	1.19(0.64-2.23)	0.717	1.14(0.44-2.94)	0.794
1-2	1.00		1.00	
Treatment				
Surgery	1.78(0.98-3.23)	0.080	2.46(1.01-5.96)	0.047*
No Surgery	1.00		1.00	
Comorbidity				
Yes	1.01(0.56-1.80)	0.974	1.12(0.48-2.60)	0.789
No	1.00		1.00	

*p-value < 0.05; Goodness of fit, 0.015; Adjusted for sex and ECOGOR, Odds ratio, CI, confidence Interval

Table 4 Risk Score for Predicting VTE in Cancer patients

Risk classes	Score	VTE Occurrence	Patients in Each Class (N, %)
Low risk	0	0(0%)	23 (12.4%)
Moderate risk	1	5(8.9%)	56 (30.3%)
High risk	2	15(19.2%)	78 (42.2%)
Very high risk	3	19(67.9%)	28 (15.1%)

The original model's area under the receiver operating characteristic curve (AUC) was 0.7548, demonstrating good discriminative ability. The bootstrapping process revealed a mean optimism of 0.0146. The optimism-adjusted AUC was 0.7472, indicating the model's predictive performance was stable across resampled datasets, with minimal overfitting. These results suggest that the logistic regression model has robust discriminatory power and is not prone to overfitting. The total score is categorized into four levels of risk, as illustrated in Table 4.

Discussion

This prospective observational study found a notably high incidence of VTE among cancer patients hospitalized at Ubon Ratchathani Cancer Hospital, reaching 21%. Notably, surgical patients had a 2.46 times higher risk of developing VTE compared with nonsurgical patients, (AdjOR 2.46, 95%CI: 1.01-5.96), a statistically significant finding from the multivariate analysis. Female patients were found to be 3.87 times more likely to experience VTE than males (AdjOR 3.87, 95%CI: 1.46-10.27), and those with ECOG grades 3-4 had a 4.74 times higher

risk than those with ECOG grades 0-2 (AdjOR 4.74, 95%CI: 1.82-12.32). The risk score developed from these three factors, as shown in Table 4, effectively stratified patients according to their risk levels.

Compared to previous studies focusing on patients undergoing abdominal, pelvic and urinary tract surgeries, the current study findings differed significantly. Earlier studies assessed VTE incidence within 30±5 days post-surgery or longer, revealing that prolonged hospitalization (beyond 35 days) often led to VTE being a common cause of death within 30 days post-operation. The study found that the incidence of VTE was 2.83% in general surgeries, 2.0% in urological surgeries and 0.87% in other urological procedures. Notably, 40% of these events occurred more than 21 days post-surgery. The overall mortality rate was 1.72%, with 46.3% of the deaths attributed to VTE. Using multivariate analysis, five risk factors were identified: age over 60 years (OR 2.63, 95%CI: 1.21-5.71), VTE history (OR 5.98, 95%CI: 2.13-16.80), advanced-stage cancer (OR 2.68, 95%CI: 1.37-5.24), anesthesia lasting longer than two hours (OR 4.50, 95%CI: 1.06-19.04) and bed rest more than three days (OR 4.37, 95%CI: 2.45-7.78).¹⁰ The reason for the higher VTE incidence rate in this study compared with that of the previous study is likely because the population in this study consisted of cancer patients, who have a higher risk of VTE. In contrast, the previous study included a general patient population, not limited to cancer patients. This study included patients with asymptomatic VTE, meaning some patients may have been diagnosed with VTE before surgery. This factor could contribute to an increased incidence of VTE. Another reason is that the patients who underwent surgery in this study did not receive anticoagulant for VTE prevention. Therefore, this study in cancer patients resulted in a significantly higher VTE incidence rate, explaining the difference from the earlier study.

In a study of patients undergoing major surgeries for cancers of the bladder, breast, colon or rectum, gynecological organs, kidneys and upper urinary tract,

lungs, prostate or gastrointestinal tract, the incidence of VTE increased significantly during cancer-related surgeries. The elevated risk persisted for approximately two to four months post-surgery, although the degree of risk varied depending on the type of cancer. The increased rate is likely due to the underlying cancer itself and the adjuvant therapies provided.¹²

The current study's high VTE incidence may stem from a lack of standard prophylactic anticoagulation treatments for surgical cancer patients in Thailand, while anticoagulation is routinely administered in many other countries. Moreover, risk factors differed from those identified in international studies, highlighting the need for local research to better understand VTE risk in the Thai context.

The study successfully applied risk factors to create a risk score using three parameters: female gender, ECOG > 2 and surgical history. A score of 2 or more indicates a high risk, suggesting a greater than 19% likelihood of VTE occurrence. The results of the internal validation analysis of the risk prediction score, conducted to confirm the model's performance and its suitability for use in the cancer patient group, showed a KMO value of 0.883 (p -value < 0.001). Based on this, it can be concluded that the model is appropriate for use in this patient group. Therefore, prophylactic measures such as anticoagulants and/or pneumatic compression should be considered during hospitalization and potentially continued post-discharge for high-risk patients.

The pathophysiology of VTE in cancer patients is influenced by multiple mechanisms, with gender, cancer type, surgery, and performance status all contributing to the pathophysiology of thrombosis, aligning with the principles of Virchow's Triad. Understanding these factors is crucial for assessing and managing VTE risk in cancer patients.

The study's limitations include a relatively small population size, which may explain the lack of statistically significant associations between VTE incidence and certain risk factors in univariate analysis. Future

research should involve larger populations to uncover additional risk factors, such as age, cancer stage, type and comorbidities. Furthermore, the study did not assess asymptomatic VTE prior to surgical intervention, which could mean some cases were present before surgery. The reported mortality rate due to pulmonary embolism might also underestimate the true situation, as some patients may have died unexpectedly without autopsy.

Conclusion

This study reveals a high incidence of VTE among cancer patients treated at Ubon Ratchathani Cancer Center, with identified risk factors including surgery, female gender and poor performance status. Patients with multiple risk factors should be considered for appropriate prophylactic measures.

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