ISSN: 3032-3134 (ONLINE)
InaJBCS | Indonesian Journal of Biomedicine and Clinical Sciences

Correlation between type of surgery and incidence of postoperative venous thromboembolism (VTE)

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https://doi.org/10.22146/inajbcs.v56i01.11888

Submitted: 2023-08-28
Accepted : 2023-12-21

ABSTRACT

Venous thromboembolism (VTE) is a significant complication in patients after undergoing major surgery. The type of surgery is believed correlated with the incidence of VTE. This study aimed to evaluate the correlation between type of surgery and incidence of VTE among patients who underwent major surgery. It was a retrospective study conducted in Dr. Sardjito General Hospital, Yogyakarta using medical record data of patients who underwent major surgery and were diagnosed with VTE between 2016 and 2020. Patients were grouped by surgery type, and length of stay (LoS). All caused deaths were also analyzed. Among 29,120 patients who underwent major surgery, 76 (0.26%) experienced VTE with females patients accounting for 75%. The mean age of the patients was 55 yr. All VTE cases had the mean LoS of 25 d. The highest proportion of patients who experienced VTE were patients who underwent tumor removal (67.0%) followed by trauma patients (18.4%). A significant difference in the incidence of mortality between the surgical groups was reported (p = 0.02). Post-cardiology had the highest risk of mortality (OR=7.46; 95% CI: 0.322 - 172.61) while age had the lowest risk of mortality (OR=1.01; 95% CI: 0.953 - 1.071). In conclusion, surgery type is correlated with the incidence of VTE. Surgery due to cancer and trauma has a higher risk of VTE compared to the others.

ABSTRAK

Tromboemboli vena (VTE) merupakan bentuk komplikasi nyata pada pasien setelah menjalani operasi besar. Jenis pembedahan diyakini berkorelasi dengan kejadian VTE. Penelitian ini bertujuan untuk mengevaluasi hubungan antara jenis pembedahan dan kejadian VTE. Penelitian ini merupakan penelitian retrospektif yang dilakukan di RSUP Dr. Sardjito, Yogyakarta menggunakan data rekam medis pasien yang menjalani operasi besar dan terdiagnosis VTE antara tahun 2016 hingga 2020. Pasien dikelompokkan berdasarkan jenis operasi, dan lama rawat inap. Semua penyebab kematian juga dianalisis. Di antara 29.120 pasien yang menjalani operasi besar, 76 (0,26%) mengalami VTE dengan pasien perempuan berjumlah 75%. Usia rata-rata pasien adalah 55 tahun. Semua kasus VTE memiliki rata-rata lama rawat inap sebesar 25 hari. Proporsi pasien yang mengalami VTE tertinggi adalah pasien yang menjalani pengangkatan tumor (67,0%) disusul pasien trauma (18,4%). Terdapat perbedaan nyata dalam hal kematian antara kelompok bedah yang dilaporkan (p = 0,02). Pasca kardiologi memiliki risiko kematian tertinggi (OR=7.46; 95% CI: 0.322 - 172.61) sedangkan usia memiliki risiko kematian terendah (OR=1.01; 95% CI: 0.953 - 1.071). Kesimpulannya, jenis operasi berkorelasi dengan kejadian VTE. Pembedahan akibat kanker dan trauma mempunyai risiko terjadinya VTE lebih tinggi dibandingkan tindakan bedah lainnya.

Keywords:
major surgery;
venous thromboembolism;
thrombosis;
cancer;
prophylaxis

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INTRODUCTION

Venous thromboembolism (VTE) is a condition that occurs when a blood clot forms in a vein. It includes deep vein thrombosis (DVT) and pulmonary embolism (PE). Deep vein thrombosis occurs when a blood clot develops in the deep veins, usually in the large veins located in the legs or pelvis. Whereas, PE occurs when a part of the DVT clot detach from the vein walls and travel to the lungs.[1,2] Thrombotic occurs due to a decrease or insufficient in antithrombotic factors or an increase in coagulation factors. The thrombotic can be caused by abnormalities in the vessel walls or an increase in thrombogenic substances circulating in the bloodstream.[1]

The World Health Organization (WHO) reported an annual VTE incidence of 1-2 per 1000 individuals. The patient's age is reported as a major risk factor for VTE. Furthermore, women in their reproductive phase are at higher risk of VTE than other age groups. Those with a history of cancer or surgery are also at an increased risk of VTE[2]. Asian people demonstrate a lower susceptibility to develop VTE compared to Caucasians and African Americans. In Indonesia, a multi-center study disclosed that the incidence of DVT is between 37 and 40% among patients with acute medical illnesses.[3] This study just focused on the incidence rate of DVT, the type of surgery associated with VTE incidence has not been investigated, yet.

The incidence of VTE is affected by Virchow's triad, which includes stasis in blood flow, blood hypercoagulability, and damage to the vein endothelial. Immobilization due to surgery is a major risk factor for VTE. The surgeries lasting over 2 hr have a higher risk.[4] The immobilization inhibits the blood flow which triggers VTE development. As many as 15 to 30% of surgical cases lasting more than 2 hr without thromboprophylaxis cause VTE.[5] Coronary artery bypass surgery, major urological surgery, gynaecological surgery for cancer, major orthopedic surgery, and trauma are also associated with a higher risk of VTE.[6]

A minimum of 20 to 30 major operations are performed in Dr. Sardjito General Hospital, Yogyakarta daily which increases the risk of postoperative complications including VTE. This study aimed to evaluate the correlation between the type of surgery and the incidence of VTE among patients who underwent major surgery in Dr. Sardjito General Hospital, Yogyakarta. The results can inform the development of strategies to reduce the risk of VTE and to improve patient outcomes. The risk factors of VTE among patients who underwent major surgery were also evaluated.

MATERIAL AND METHODS

Design and subjects

This retrospective study was conducted in Dr. Sardjito General Hospital, Yogyakarta using medical record data to investigate the demographic conditions of patients who experienced postoperative VTE. The study was approved by the Health and Medical Research Ethics Committee of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada/ Dr. Sardjito General Hospital with reference number KE/FK/0612/EC/2022.

Procedure

Data between 2016 and 2020 were collected based on the ICD-10 diagnostic code recorded on venous thromboembolism (I80). Patients who underwent major surgery and were diagnosed with VTE were included in this study. Patients who had been diagnosed with VTE before undergoing surgery, pregnant women, and those with a history of blood thinner usage

or coagulation disorders before surgery were excluded. The subjects were then grouped based on the type of surgery, including oncology, cardiothoracic, vascular, digestive, genitourinary, and trauma. Length of stay and mortality that cause of death were also collected.

Statistical analysis

Kruskal Wallis was used to analyze differences among groups, Chi-square for categorical analysis, and Cochrane-Armitage test for trend assessment in the year. The association between risk factors and mortality was evaluated using a multivariable logistic regression model. Univariate analysis was performed first and then variables with p-value <0.25 was included in multivariate analysis in one-step analysis. All tests were considered significant with a p-value of <0.05. All statistical analyses were performed using MedCalc software version 19.6.

RESULTS

A total of 76 subjects (0.26%) among 29120 patients who underwent surgery experienced VTE. The number of female patients (75%) was higher than male subjects. The mean subject aged was 55 yr with the lowest age was 17 yr and the oldest was 85 yr. All VTE subjects had DVT in the lower limb. The mean length of stay (LoS) of the subjects was 25 d. The highest proportion of patients who experienced VTE were patients who underwent tumor removal (67%) followed by trauma patients (18.4%). There was no difference in LoS between the surgical group (p = 0.58). The longest median LoS was experienced by patients in the vascular group (34.5 d) while the fastest was in the trauma group (10 d) (TABLE 1).

The results of logistic regression analysis are presented in TABLE 2. A significant difference in the incidence of subject mortality between the surgical groups was reported (p = 0.02). However, no significant trend of surgery procedures between 21016 and 2020 was observed (p>0.05). The multivariate logistic analysis showed that post-cardiology subjects with post-cardiology has the highest risk of mortality (OR=7.46; 95% CI: 0.322 - 172.61) while age had the lowest risk of mortality (OR=1.01; 95% CI: 0.953 - 1.071).

TABLE 1. Characteristics of subjects by year

Variable	2016 (n=16)	2017 (n=12)	2018 (n=17)	2019 (n=18)	2020 (n=13)	Total (n=76)
Age [median (IQR) yr]	51 (36; 81)	51 (30; 73)	59 (18; 82)	55 (17; 71)	57 (41; 85)	55 (17; 85)
Male [n (%)]	3 (18.8)	4 (33.3)	4 (23.5)	7 (38.9)	1 (7.7)	19 (25.0)
Female [n (%)]	13 (81.2)	8 (66.7)	13 (76.5)	11 (61.1)	12 (92.3)	57 (75.0)
Surgery [n (%)]						
• Malignancy	12 (75)	7 (58.3)	11 (64.7)	13 (72.2)	8 (61.5)	51 (67.1)
• Cardiothoracic	0 (0)	1 (8.3)	1 (5.9)	0 (0)	0 (0)	2 (2.6)
• Vascular	1 (6.2)	2 (16.7)	0 (0)	2 (11.1)	0 (0)	5 (6.6)
• Abdominal	0 (0)	0 (0)	1 (5.9)	1 (5.6)	0 (0)	2 (2.6)
• Genitourinary	0 (0)	1 (8.3)	0 (0)	0 (0)	1 (7.7)	2 (2.6)
• Trauma	3 (18.8)	1 (8.3)	4 (23.5)	2 (11.1)	4 (30.8)	14 (18.4)
LoS [median (IQR) d]	24 (12; 38)	15 (9; 32)	18 (6; 56)	14,5 (5; 45)	16 (8; 32)	18 (5; 38)
Death [n (%)]	4 (25)	1 (8.3)	4 (23.5)	2 (11.1)	1 (7.7)	12 (15.8)

IQR: inter-quartile range; LoS: length of stay

TABLE 2. Logistic regression analysis

Variable	Univariate (OR; 95% CI)	Multivariate (OR; 95% CI)
Gender[1]	1.63 (0.431 - 6.190)	
Age	0.97 (0.93 - 1.014)	1.01 (0.953 - 1.071)
LoS	1.01 (0.987 - 1.042)	
Surgery[2]		
• Cardiothoracic	6.29 (0.351 - 112.460)	7.46 (0.322 - 172.608)
• Vascular	1.57 (0.153 - 16.183)	
• Abdominal	NA	
• Genitourinary	NA	
• Trauma	0.484 (0.054 - 4.298)	

[1]female as reference; [2]malignancies as reference

DISCUSSION

Venous thromboembolism remains a prevalent occurrence after surgery, particularly in major surgical procedures. It typically occurs as a complication stemming from conditions involving the formation of blood clots within deep veins. These clots can manifest in various veins, although they most frequently develop in the deep veins of the lower leg (DVT) or the lungs (PE).[2] The occurrence of symptomatic VTE within the initial month following surgery is approximately 2% for patients undergoing abdominal or pelvic surgical interventions.[7] Recent studies demonstrated that the risk of clotting in postoperative patients persists for at least 3 mo following the surgery.

The postoperative VTE is influenced by intrinsic factors inherent to the patient and extrinsic factors related to the surgical procedure. These extrinsic factors encompass elements like the duration of the surgery, the extent of immobility during the perioperative period, and the emergence of postoperative complications.[7,8] For instance, in non-oncologic general surgery cases, the median period until VTE occurrence was found to be 16 d.[8] The majority of these instances (77%) happened after the first week, and a quarter (25%) took place after 30 d. The incidence of VTE escalates after the discontinuation of prophylactic measures. This study showed that age and gender are not associated with the frequency of VTE occurrences. The average age of the patients was approximately 55 yr (17–85 yr). However, it is worth noting that age usually serves as a substantial risk factor for VTE. This is primarily due to increased blood coagulability, which is more prevalent in older people. Moreover, advanced age is linked to a higher occurrence of risk factors for VTE such as cancer, immobility, hospitalization, and surgery. Notably, around 75% of the post-surgery VTE cases in this study involved female patients.[9,10]

Gender also exerts an impact on VTE risk, with age-adjusted incidence rates being higher for men compared to women (130 per 100,000 versus 100 per 100,000 population). Nevertheless, in the younger adult population, women experience a slightly elevated annual VTE incidence due to hormonal factors like pregnancy, the postpartum period, and the use of oral contraceptives. The

use of external hormones, including oral contraceptive therapy, is linked to a 1.5-fold increased risk of incident VTE in women.[9,10] Pregnant and postpartum women face a notably higher VTE risk than those who are not pregnant, with the risk during these periods being up to 6 times greater. This risk amplifies as the pregnancy progresses, reaching up to 9 times higher in the third trimester. This heightened risk arises from physiological changes, including elevated clotting factors, reduced levels of available free protein S, and diminished fibrinolytic factors. Several other factors contribute to the risk of VTE during pregnancy and the postpartum phase, such as increased venous capacitance and pooling, physical compression of the left iliac vein, and immunological shifts. Risk factors for VTE during pregnancy and postpartum encompass caesarean section delivery, preeclampsia, and thrombophilia.[11,12] Additionally, disparities in VTE incidence have been observed among different race and ethnic groups. Hispanics and Asians exhibit notably lower rates compared to Caucasians or African Americans. For example, African Americans have a higher case-fatality rate for unexplained VTE. Furthermore, the likelihood of developing cancer-associated blood clots is lower in certain cancer types among Asian and Pacific Islanders compared with Caucasians (HR: 0.2–0.9).[13]

This study demonstrated that 67.1% of patients who underwent surgery were diagnosed with malignancy. Venous thromboembolism is a common complication in cancer patients, occurring as a result of various factors associated with the disease.[14] The pathophysiology of VTE in cancer patients involves a hypercoagulability mechanism. This mechanism can be attributed to the direct activation of procoagulant pathways by cancer cells or the indirect systemic effects of cancer on various cell types, including leukocytes, endothelial cells, and platelets. Cancer cells activate the procoagulant pathway through abnormal tissue factor expression, release of tissue factor-containing microparticles, and activation of other surface proteases. In certain cancers, neutrophils release neutrophil extracellular traps (NETs), which lead to procoagulant pathway activation and platelet activation. A bidirectional relationship exists between cancer and thrombosis, where increased tumor burden raises the risk of VTE, while VTE can serve as an indicator of tumor aggressiveness and poor prognosis.

Various tumor types increase platelet and leukocyte counts in the bloodstream, thereby raising the risk of venous thrombosis through the formation of NETs or release of tissue factor (TF). Tumors can also release extracellular vesicles (EVs) containing TF, polyphosphate, or podoplanin (PDPN). TF-containing EVs activate the blood coagulation process, polyphosphate-containing EVs activate factor XII (FXII) and platelets, while PDPN-containing EVs activate platelets. Additionally, tumors release plasminogen activator inhibitor 1 (PAI1), which inhibits fibrinolysis.[15]

Studies showed that cancer patients have a higher relative risk of developing VTE compared to the general population. Malignancy has been associated with almost 20% of VTE cases that are newly diagnosed. However, among these cancer patients small number as 8% were diagnosed with VTE within a year after cancer diagnosis, highlighting the need for early recognition and treatment of this condition in cancer patients.[16] Notably, VTE stands as the second leading cause of death among cancer patients, following the cancer itself. The incidence of VTE during hospitalization varies across different cancer types, with pancreatic and lung cancer patients having the highest risk. A previous study reported that pancreatic cancer patients have the greatest risk of hospitalization due to VTE, followed by lung cancer

patients. Increased tumor burden heightens the risk of VTE, while VTE can also serve as an indicator of tumor aggressiveness and poor prognosis in cancer patients.[17]

Various patient-related risk factors contribute to VTE development in patients with malignancy. These risk factors include advanced age, obesity, black ethnicity, and comorbidities such as infections, anemia, kidney disease, and lung disease. Identifying these risk factors is crucial for identifying high-risk cancer patients and implementing appropriate preventive measures.[18]

The incidence of VTE among cancer patients is 13.9 cases per 1,000 person/yr, while high-risk patients have an overall incidence of VTE rate of 68 per 1,000 person/yr. The risk of VTE ranges 4 to 7 time greater in patients with cancer than in the general population. As much as 20% of cancer patients experienced VTE. The first 12 mo after patients diagnosed with cancer have highest VTE incidence due to intensive therapies. However, the type of cancer is greatly associated the incidence of VTE. Certain types of cancers such as cancer of pancreas, brain, lung, stomach, and ovaries have a higher risk of the VTE incidence compared to the breast and prostate cancers. The risk of VTE is increased by hematological malignancies, particularly lymphoma. Furthermore, systemic chemotherapeutic treatment is also associated to an increased risk of VTE.[14,16,17,19]

Based on their characteristics and propensity to cause blood clots, certain cancer types are categorized as high risk or very high risk for VTE using the Khorana score and Vienna cancer and thrombosis study (CATS) score. Lung, gynecologic, lymphoma, bladder, and testicular cancer are categorized as high-risk tumors, whereas pancreatic and stomach tumors are categorized as very high-risk. Additionally, the degree of malignancy at the time of the first cancer diagnosis is associated with VTE. Metastatic cancer is a significant predictor of thrombosis.[20,21]

Cancer patients who undergo systemic chemotherapy drugs, antiangiogenic agents, and hormonal therapy are at a higher risk of developing VTE. As a result, thromboprophylaxis is often considered for these patients to prevent the occurrence of blood clots. While the thrombotic risk associated with immunotherapy is currently unknown, reports show that the incidence of VTE in cancer patients can be as high as 30%. Therefore, healthcare providers need to monitor cancer patients for signs and symptoms of VTE, especially during the first year after diagnosis or progression, and provide timely intervention to prevent this potentially life-threatening complication.[16,22]

The mortality rate reported in this study was 15.8% (TABEL 1), which is higher than reported in other studies. A greater number of patients with malignancy may be associated with this result. The higher mortality rates of VTE in cancer patients is associated with outpatient chemotherapy. The 1-year survival rate is lower for cancer patients with VTE (12%) than for those without VTE (36%).[23] The mortality rate was 26.4% among cancer patients and 4.1% among those without cancer.[24] Age > 80 yr, stage of malignancy, and previous incident of VTE are the strongest death predictor. However, the last predictor increased the mortality risk, regardless of the primary cancer site. Patients with cancer-associated thrombosis may die due to fatal thrombotic events or bleeding complications related to therapeutic anticoagulation, which are more common in malignancy patients.[25]

The majority of patients who develop VTE besides malignancy have undergone surgical procedures due to trauma (18.4%) or vascular problems (6.6%). Orthopedic and trauma surgeries, particularly total hip replacement (THR) and total knee

replacement (TKR), have a high risk of VTE development if thromboprophylaxis is not used, with up to 50% of orthopedic patients experiencing DVT. According to data from the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) from 2008 to 2016, the overall 30-d VTE rate was 0.6% for THR and 1.4% for TKR. Moreover, major thoracolumbar spine surgery has a PE prevalence of 0.88% and DVT prevalence of 0.66%, with a higher risk if surgeries involve more than 5 segments.[26,27]

It was also found that vascular surgery has a higher incidence of VTE compared to other surgeries. This is linear with a retrospective analysis of the ACS NSQIP. It was found that the incidence of DVT was higher among vascular surgery patients compared to general surgery patients, with rates of 0.99 and 0.66%, respectively. A study that compared LMWH and UFH as thromboprophylaxis found that patients undergoing aortic surgery have a higher incidence of DVT (7.5%) than those undergoing surgery for PAD (3.4%). Despite receiving thromboprophylaxis, patients who underwent major lower extremity amputation still had a relatively high incidence of DVT at 10.7%.[28-30]

Cardiothoracic surgery poses a significant risk for VTE, with an incidence of 2.6%. Patients undergoing major thoracic surgery are at even higher risk, with a 3.8% chance of developing VTE. The risk of developing DVT and PE after cardiothoracic surgery is 1.62 and 0.38%, respectively. A history of VTE, getting older, being obese, having left or right ventricular failure, being mechanically ventilated for an extended period, using a central venous catheter, and not using any anticoagulant or antiplatelet medications are all risk factors for VTE after cardiac surgery.[31-33]

The occurrence of DVT and PE during digestive surgery is expected to range from 2.75 to 8.9%, with colorectal cancer and inflammatory bowel disease being the primary risk factors. For liver resection and significant abdominal surgery without prophylaxis, the prevalence of VTE was 0.7 and 0.5%, respectively. The probability of developing DVT after significant abdominal surgery is most significant within the first two wk following the operation, while complications such as PE can manifest even later.[34-36]

Vein thromboembolism is uncommon during genitourinary surgery, with a DVT incidence of 5.54% in urologic procedures. Transurethral resection of the prostate or bladder tumor is a low-risk procedure for VTE, with reported incidence rates of 0.11 to 0.2% for DVT and 0.1 to 0.45% for PE. In contrast, open surgery for prostatectomy has a VTE incidence of 2.2%, while robotic-assisted laparoscopic procedures have lower incidence rates of 0.5 to 1.8%. The VTE incidence rates for radical nephrectomy, partial nephrectomy, and nephroureterectomy are 1.1, 1.0, and 1.9%, respectively. Despite these low incidence rates, extended thromboprophylaxis is typically recommended in urologic surgery.[37,38]

A study that evaluated the association between surgery duration and the risk of VTE in cancer patients was reported. Longer surgical procedures are linked to an increased risk of DVT in the lower extremities. Prolonged immobilization resulting from lengthy surgeries can cause blood stagnation, heightened coagulation, and damage to blood vessel endothelium. Patients undergoing lengthier surgeries are more likely to experience blood stagnation, hypercoagulability, and vascular trauma, all contributing to the development of VTE. Hence, longer surgical durations should be considered as a potential risk factor for VTE in cancer patients.[39]

The frequency of VTE events also varies depending on the LoS. A study by Amin *et al.*[40] reported that the highest

VTE occurrence during hospitalization within 6 mo after discharge was observed in patients with stays of ≥7 d, followed by those with stays of 4 to 6 d, and 1 to 3 d. The majority of VTE occurs within the first 40 d after admission, irrespective of the LoS. The cumulative VTE rate during this period also varies based on the LoS, with higher rates in patients with longer stays. For instance, the cumulative VTE rate during the initial 40 d after admission is 1.5% for patients with stays of 1 to 3 days, 2.3% for 4 to 6 d, and 6.6% for ≥7 d. This underscores the importance of assessing VTE risk and implementing appropriate prophylaxis in cancer patients with extended hospital stays to reduce the risk of severe VTE events.[40]

Patients undergoing major surgeries are advised to use both medicine-based and mechanical methods to prevent complications. Mechanical techniques are preferred if medication isn't used, with intermittent compression devices being a better choice than graduated compression stockings. To prevent VTE, it is recommended to combine mechanical and medication-based approaches rather than relying solely on medication. The choice to combine methods depends on the patient's risk of VTE and bleeding, as well as the specific surgery they're having. However, it's important to note that using inferior vena cava filters to prevent VTE in major surgery patients isn't recommended. When it comes to antithrombotic prophylaxis duration, using an extended plan is better than a short-term one. This means starting antithrombotic prophylaxis either soon after surgery or with a delay of up to 3 wk. The point where early and delayed antithrombotic administration is differentiated is the 12-hr mark after surgery. According to the recommendations from the American Society of Hematology, patients undergoing various surgical procedures should use medication-based prevention to reduce the risk of VTE. For individuals having total hip or knee arthroplasty, using aspirin or anticoagulants is suggested. In the case of hip fracture repair, it's advised to consider using low molecular weight heparin (LMWH) or unfractionated heparin (UFH). Generally, medication-based prevention is recommended for significant general surgeries, except for laparoscopic cholecystectomy and major neurosurgical procedures. For transurethral resection of the prostate (TURP), medication-based prevention is not recommended. However, considering LMWH or UFH might be appropriate for patients undergoing radical prostatectomy, major vascular or cardiac surgery, and significant gynecological surgery. Additionally, patients facing major trauma with a low to moderate risk of bleeding are advised to use medication-based prevention.[40,41]

This study has limitations. First off, the information used in this study came from a registry that tracks instances of symptomatic VTE. This suggests that we were missing data on surgery patients who were not affected by this specific consequence. We could have determined the occurrence rate for each event and compared the two groups if we had data on such cases. Due to the fact that all patients in the sample had VTE, we are unable to demonstrate a direct causal link between the use of prophylaxis and the prevention of VTE.

Furthermore, the registry does not collect information on variables like the length of the surgical process, the occurrence of further surgical problems, the urgency of the treatments, or the use of mechanical prophylaxis. Additionally, we didn't record information regarding the anesthetic type applied, the patient's comorbidity index, or any other elements that would have indicated how serious the patient's condition was. Last but not least, our analysis excluded gynecological and obstetric surgery, including as cesarean sections and other operations connected to gynecological cancers.

CONCLUSION

Vein thromboembolism is a common complication following surgery, and postoperative patients are at a persistent risk of VTE, which is influenced by intrinsic and extrinsic factors. Surgery type affects surgery duration, perioperative immobilization, and postoperative complications. Surgery due to cancer and trauma have a higher risk of VTE compared to other type of surgery, although the incidence of VTE may vary based on cancer type and malignancy extent at initial diagnosis. Combined prophylaxis with mechanical and pharmacological intervention is generally recommended based on individual patient risk of VTE and bleeding, as well as the type of surgical procedure.

ACKNOWLEDGEMENT

The authors declare that there is no conflict of interest. This research is granted funding from the Deputy for Strengthening Research and Development, the Ministry of Research and Technology/National Innovation Agency, Republic of Indonesia.

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