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Investigating the Incidence of Pulmonary Embolism and Related Risk Factors Despite Administrating Prophylaxis to All Surgical Patients

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Abstract

Background: Pulmonary embolism (PE) is a life-threatening condition or complication that continues to pose a significant risk of morbidity and mortality.

Objectives: This study aims to identify the perioperative risk factors associated with PE and to examine its prevalence and consequences in patients who have undergone major surgery.

Methods: This cross-sectional analytical study reviewed the medical records of 30 consecutive patients admitted to the general surgery ward who developed in-hospital PE. The study aimed to extract risk factors, including demographic and clinical features, such as body mass index (BMI), smoking history, hospitalization history, hypertension, cardiovascular complications, history of oral contraception pill (OCP) usage, diabetes, history of cancer, trauma, intensive care unit (ICU) hospitalization, and the type of surgery.

Results: Among all PE patients, 19.7% had a normal BMI, and tobacco use was reported in 50% of these patients. Only 16.7% of PE patients had a history of OCP usage. Pulmonary and breast cancer were reported in 56.6% and 6.7% of PE patients, respectively. The most common comorbidities among PE patients were hypertension (23.3%), followed by cardiovascular issues (16.7%) and diabetes mellitus (6.7%). The majority of PE patients had ICU hospitalization (93.3%). Forty percent of PE patients experienced trauma, with 15% having hip with limb fractures, 13% experiencing chest trauma, and 12% having abdominal visceral trauma. Almost 30% of the PE patients who were admitted for general surgery and developed in-hospital PE died before discharge.

Conclusion: PE is one of the most common adverse events after surgery, despite the use of thromboprophylaxis. The major risk factors in patients with postoperative PE were found to be old age, smoking history, trauma, and cardiovascular problems.

Keywords: Incidence, Pulmonary embolism, Risk factor, Surgical complication

1. Background

Venous thromboembolism (VTE), encompassing deep vein thrombosis (DVT) and pulmonary embolism (PE), represents a significantly perilous medical condition leading to considerable morbidity and mortality rates (1). The global impact of PE remains substantial, constituting a persistent health concern (2). The occurrence of misdiagnosis in cases of PE is not uncommon due to the potential overlap of symptoms with other pulmonary disorders, such as pneumonia or asthma, thereby posing the risk of adverse consequences (3). Furthermore, PE ranks among the most prevalent causes of vascular death subsequent to myocardial infarction and stroke while concurrently representing the foremost avoidable cause of mortality for hospitalized patients (4).

Globally, almost 234 million major surgical interventions are conducted annually (5), and these procedures engender notable postoperative complications that inflict substantial morbidity, mortality, and economic strain on both patients undergoing surgery and healthcare systems (6-8). Surgical interventions expose patients to an elevated risk of developing PE, a life-threatening complication associated with VTE that significantly contributes to postoperative challenges (9). Although some individuals with PE remain asymptomatic, others may experience fatal PE as the initial manifestation of thromboembolism (10). The incidence of pulmonary embolism varies within the range of 0.3% to 1.6% in the general population who undergo surgical procedures (11, 12). Beyer et al. documented a 5.8% incidence of PE following prostate procedures in 2009 (13). Moreover, the occurrence of PE has been reported between 0.7% and 30% across all orthopedic surgical procedures and between 4.3% and 24% following hip fracture repair, primarily due to the anatomical disruption caused by the surgical site, which can impede venous return and induce stasis in the femoral vein (14).

Despite the significant progress made in the diagnosis of PE, particularly with the introduction of advanced imaging techniques, such as multi-detector computed tomography (CT) pulmonary angiography and ventilation-perfusion scintigraphy (15), PE continues to be the leading cause of preventable mortality among surgical patients, often remaining unnoticed (16).

2. Objectives

Therefore, the objective of this research was to identify the perioperative risk factors associated with PE, as well as examine its prevalence and consequences in patients who have undergone major surgery. The findings of this study will offer valuable evidence regarding the current

epidemiological landscape of PE following major surgical procedures, which can then be used to inform policymakers about the primary determinants of PE. Such insights will allow for the development of tailored control measures to effectively mitigate this burden.

3. Methods

The study was conducted under the Declaration of Helsinki and with approval from the Ethics Committee of Urmia University of Medical Sciences (IR.UMSU.REC.1400.281).

This cross-sectional analytical study reviewed the medical records of 30 consecutive patients who were admitted to the general surgery ward and developed in-hospital PE between January 2021 and December 2022 to extract risk factors, including demographic and clinical features. PE diagnostic criteria were clinical features, such as desaturation, respiratory distress, and investigation of DVT, which were evaluated by lower limb Doppler, ultrasonography, and CT angiography. All patients included in this study underwent CT angiography with a positive result for the diagnosis of PE. The research conducted in this study involved a retrospective analysis, consequently negating the need for informed consent. In this analysis, the exclusion criteria involved major risk factors, such as a history of VTE, a history of cancer, long-term immobilization, pregnancy, or objectively confirmed DVT or pulmonary thromboembolism.

Demographic and clinical variables that were analyzed and collected included age (which was divided into four groups: under 20, 20-39, 40-59, 60 years and above), body mass index (BMI), smoking history, hospitalization history, hypertension, cardiovascular complications, history of oral contraception pill (OCP) usage, diabetes, cancer history, trauma, ICU hospitalization, and the type of surgery (retroperitoneum surgery, exploratory laparotomy, cholecystitis, total abdominal hysterectomy [TAH], aortic surgery, arteriovenous fistula [AVF], arterial occlusion, pancreatitis trauma, and intestinal obstruction). All patients underwent prophylaxis for PE following the Japanese Guidelines (17) for the diagnosis, treatment, and prevention of PE until discharge.

Statistical analysis

Continuous variables were analyzed in the form of mean ± standard deviation, while categorical values were presented as absolute frequencies and percentages. The Chi-square test (or Fisher's exact test if needed) was utilized to compare the frequency of qualitative variables. The data were processed and analyzed using SPSS 21, and a p-value less than 0.05 was considered significant.

4. Results

During the study period, 30 consecutive surgical patients who developed postoperative PE were identified out of all the surgical patients admitted to the general surgical ward. Table 1 provides a detailed distribution of demographic risk factors among patients with PE. The mean age of the patients with PE was 49.5±23.1 years (ranging from 14 to 87), and the majority of them were males (n=17, 56.7%). All 30 PE patients received medical prophylaxis for PE before surgery. Among the PE patients, 19.7% had a normal BMI, and tobacco use was reported in 50% of them. Only 16.7% of PE patients had a history of OCP usage (Table 1).

According to Table 2, pulmonary and breast cancer were reported in 56.6% and 6.7% of PE patients, respectively. The most common comorbidities among PE patients were hypertension (23.3%), followed by cardiovascular conditions (16.7%), and diabetes mellitus (6.7%). The majority of PE patients required ICU hospitalization (93.3%). As indicated in Table 2, 20% of the PE patients underwent retroperitoneal surgery, and the distribution of other surgery-related variables was similar among the PE patients. Forty percent of the PE patients were trauma patients, with 15% experiencing hip and limb fractures, 13% chest trauma, and 12% abdominal visceral trauma. Nearly 30% of the PE patients were admitted for general surgery and developed in-hospital PE, resulting in death before discharge.

Table 1. Distribution of demographic risk factors of patients with PE

Variables	n (%)
Gender	
Male	17 (56.7)
Female	13 (43.3)
Age (year)	49.5±23.1
<20	5 (16.7)
20-39	6 (20)
40-59	7 (40)
>60	12 (23.3)
BMI (kg/ m^2)	34.1±8.8
Underweight (<18.5 kg/m^2)	0 (0)
Normal (18.5-24.9 kg/m^2)	5 (16.7)
Overweight (25-29.9 kg/m^2)	20 (66.6)
Obese (30-39.9 kg/m^2)	5 (16.7)

Morbidly obese (≥40 kg/m²)	0 (0)
Tobacco use	
Yes	15 (50)
No	15 (50)
OCP usage	
Yes	5 (16.7)
No	25 (83.3)

Table 2. Distribution of clinical risk factors of patients with PE

Variables	n (%)
ICU hospitalization	
Yes	28 (93.3)
No	2 (6.7)
Hospitalization history	
Yes	22 (73.4)
No	8 (56.6)
Mortality	
Yes	9 (30)
No	21 (70)
Cancer history	
Breast cancer	
Yes	2 (6.7)
No	28 (93.3)
Pulmonary cancer	
Yes	17 (56.6)
No	13 (43.4)
Major trauma	
Chest	
Yes	4 (13)
Abdominal visceral	
Yes	3 (12)
Hip fracture with a limb fracture	
Yes	5 (15)
No	18 (60)
Pancreatitis	
Yes	1 (3.3)
No	29 (96.7)
Hypertension	
Yes	7 (23.3)
No	23 (76.7)
Cardiovascular	
Yes	5 (16.7)
No	25 (83.3)
Diabetes mellitus	
Yes	2 (6.7)
No	28 (93.3)
Surgery types	
Retroperitoneum surgery	6 (20)
Exploratory laparotomy	4 (13.3)
Cholecystitis	4 (13.3)
TAH	3 (10)
Aortic surgery	3 (10)
AVF	3 (10)
Arterial occlusion	3 (10)
Intestinal obstruction	4 (13.3)

5. Discussion

Despite advancements in medical knowledge and treatment modalities, there has been a minimal change in the occurrence of PE over the past three decades (18). It is crucial for healthcare providers to recognize the risk factors associated with PE and implement preventive measures for surgical patients (19). This study revealed that the majority of the patients were aged 60 and above (40%) and male (56.7%). Although PE can affect individuals of all ages, the risk escalates after reaching the age of 60 due to age-related factors, such as muscular weakness, venous insufficiency, endothelial dysfunction, frailty, reduced mobility, and systemic diseases (20). These physiological alterations intensify the respiratory workload, lead to ventilation/perfusion imbalances, and hinder effective coughing, thereby contributing to atelectasis, aspiration, and pneumonia (21).

Previous studies have established a correlation between tobacco use, specifically consuming more than one pack per day, and the occurrence of PE (22). Our findings supported this, revealing that 50% of patients were smokers. This association can be attributed to the impact of smoking on blood coagulability, impairment of endothelial function,

and suppression of fibrinolysis (23). Consequently, it is reasonable to posit that smoking contributes to an elevated risk of PE. Conversely, several large-scale population cohorts, including the HUNT2 Study (24), Physicians' Health Study (25), Framingham Study (26), and Longitudinal Investigation of Venous Thromboembolism Study (27), have reported no discernible increase in the incidence of PE associated with smoking status.

The findings of our study demonstrated that 50% of the participants had a BMI above the normal range. In terms of identifying the risk of PE, BMI values exceeding 25 (26-28) or 30 (29) have been considered risk factors. A study conducted by Ageno et al. (28) demonstrated that individuals with obesity were approximately twice as likely to develop both PE and DVT compared to those with normal weight. However, Wang et al. (30) observed no significant disparity in the incidence of PE between normal-weight and obese patients undergoing general surgery, emphasizing the need for heightened caution, specifically during abdominal hernia repairs in obese individuals. Özkaya et al. (31) identified a history of DVT and obesity as the most prevalent individual risk factors for DVT encountered by surgeons in Turkey.

In the present study, the most common comorbidities of PE patients were reported to be hypertension, followed by cardiovascular conditions. Additionally, diabetes mellitus, pulmonary cancer, and breast cancer were reported in 56.6%, 6.7%, and 6.7% of PE patients, respectively. The occurrence of PE was found to be common in individuals with any type of cancer, and its incidence was observed to increase due to various factors, such as surgery, chemotherapy, radiotherapy, and disease progression (32). Previous research has consistently demonstrated a significant association between pre-treatment coagulation abnormalities in cancer patients and their overall survival (33). Consequently, all patients who received prophylactic treatment experienced the development of PE during the postoperative period.

According to the findings, it was observed that 20% of patients diagnosed with PE underwent retroperitoneal surgery. Likewise, previous studies have primarily documented cases of PE-related retroperitoneal surgery within the urological domain, with testicular tumor thrombus identified as the leading cause of PE thrombi rather than thrombi originating from the lower limbs (34). Moreover, in a specific case study investigating PE subsequent to retroperitoneal tumor surgery, potential factors contributing to the development of this potentially fatal condition in the patient were explored. These factors included direct compression of the retroperitoneal vessels by large pelvic radiation therapy, which resulted in greater complications compared to intraperitoneal tumors alone (35).

In the present study, exploratory laparotomy, cholecystitis, and intestinal obstruction exhibited similar occurrence rates among patients diagnosed with PE. Conversely, PE occurrences were not documented following laparoscopic cholecystectomy. Pathophysiological mechanisms that could potentially contribute to the occurrence of PE include hindrance to venous outflow during surgical pneumoperitoneum and activation of the coagulation system (36). Furthermore, another study corroborates our findings by indicating a greater incidence of PE following laparoscopic cholecystectomy compared to open cholecystectomy (37).

The investigation of patients with PE revealed the presence of various surgeries, including TAH, aortic surgery, AVF, and arterial occlusion surgeries. Aortic surgery is known to carry an elevated risk of venous thromboembolism due to increased thrombin generation and activity, as well as fibrin turnover associated with aortic arch surgery and extracorporeal circulation (38). Another study emphasizes that AVF thrombosis should be considered a significant clinical event (39). Consequently, surgery and prolonged immobilization are widely recognized as risk factors for thromboembolism. Despite the implementation of routine thromboembolism prophylaxis, pulmonary embolism was frequently observed in our study.

After conducting a comprehensive literature review, we observed a growing trend in the early detection of PE following traumatic injuries (40). Our findings align with this trend as 40% of PE cases in our study involved patients who had experienced trauma. Several studies have identified various injury characteristics that serve as predictors for the timing of PE occurrence in trauma patients. Notably, specific injury patterns, such as spinal cord injuries, traumatic brain injuries, lower extremity fractures, and severe chest trauma, have been recognized as risk factors for the development of PE (41).

In our study, approximately 30% of PE patients admitted for general surgery experienced in-hospital PE-related deaths prior to discharge. These results are consistent with earlier findings indicating that untreated cases of diagnosed PE exhibit a mortality rate of around 30%. However, when early diagnosis and treatment are implemented, the mortality rate significantly decreases to 2-8% (35). This outcome parallels other research that has identified an association between PE development and mortality, particularly within a 30-day period (42,43). It is important to note that our analysis focused solely on in-hospital mortality rates. Nonetheless, these

findings underscore the necessity of implementing preventive measures for PE to reduce patient mortality and improve overall health outcomes.

Limitations

The present study has several limitations, including the retrospective nature of data collection from the medical records of the patients, the small sample size, the short study period, and being single-centered. Therefore, a large-scale, prospective, randomized controlled trial with a long follow-up is needed to confirm the results.

6. Conclusion

Perioperative thromboprophylaxis is crucial to avoid complications with PE. Despite the implementation of thromboprophylaxis in this study, PE continues to be one of the most common adverse events following surgery. Old age, smoking history, trauma, and cardiovascular problems are major risk factors in patients with postoperative PE.

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Conflicts of interest

The authors declare that they have no conflict of interest.

References

1. Goldhaber SZ. Venous thromboembolism: epidemiology and magnitude of the problem. Best Pract Res Clin Haematol. 2012;25(3):235–242.
2. Belohlávek J, Dytrych V, Linhart A. Pulmonary embolism, part I: Epidemiology, risk factors and risk stratification, pathophysiology, clinical presentation, diagnosis and nonthrombotic pulmonary embolism. *Exp Clin Cardiol* 2013;18:129-38.
3. Kwok CS, Wong CW, Lovatt S, Myint PK, Loke YK. Misdiagnosis of pulmonary embolism and missed pulmonary embolism: A systematic review of the literature. Health Sciences Review. 2022 Mar 15:100022.
4. Jiménez D, Bikdeli B, Quezada A, Muriel A, Lobo JL, de Miguel-Diez J, Jara-Palomares L, Ruiz-Artacho P, Yusen RD, Monreal M. Hospital volume and outcomes for acute pulmonary embolism: multinational population based cohort study. bmj. 2019 July 29;366.
5. Dobson GP. Trauma of major surgery: A global problem that is not going away. Int J Surg. 2020 Sep;81:47-54. doi: 10.1016/j.ijsu.2020.07.017. Epub 2020 July 29.
6. Tekalign T, Balta H, Kelbiso L. Magnitude of postoperative mortality and associated factors among patients who underwent surgery in Wolaita Sodo teaching and referral hospital, SNNPR region, Ethiopia. Afr Health Sci. 2021 Dec;21(4):1842-1848. doi: 10.4314/ahs.v21i4.42.
7. Dencker, E.E., Bonde, A., Troelsen, A. *et al.* Postoperative complications: an observational study of trends in the United States from 2012 to 2018. *BMC Surg* **21**, 393 (2021). https://doi.org/10.1186/s12893-021-01392-z
8. Desciak MC, Martin DE. Perioperative pulmonary embolism: diagnosis and anesthetic management. Journal of Clinical Anesthesia. 2011 Mar 1;23(2):153-65.
9. Temgoua MN, Tochie JN, Noubiap JJ, Agbor VN, Danwang C, Endomba FTA, Nkemngu NJ. Global incidence and case fatality rate of pulmonary embolism following major surgery: a protocol for a systematic review and meta-analysis of cohort studies. Syst Rev. 2017 December 4;6(1):240. doi: 10.1186/s13643-017-0647-8.
10. Howard L. Acute pulmonary embolism. Clinical Medicine. 2019 May;19(3):243.
11. Kim JY, Lee YS, Park HO, Shin IW. Management of perioperative acute massive pulmonary embolism: A case series. Clin Case Rep. 2021 March 28;9(5):e04078. doi: 10.1002/ccr3.4078.
12. Aiping Y, Shuangyin Z, Yanhong X, Rongzhi Z. Management of intraoperative acute pulmonary embolism in a patient with subarachnoid haemorrhage undergoing femoral fracture repair. J Int Med Res. 2019 Oct;47(10):5307-5311. doi: 10.1177/0300060519874158.
13. Beyer J, Wessela S, Hakenberg OW, et al. Incidence, risk profile and morphological pattern of venous thromboembolism after prostate cancer surgery. J Thromb Haemost 2009;7:597-604.
14. Arcelus JI, Kudrna JC, Caprini JA. Venous thromboembolism following major orthopedic surgery: what is the risk after discharge? Orthopedics 2006;29:506-16.
15. Albrecht MH, Bickford MW, Nance Jr JW, Zhang L, De Cecco CN, Wichmann JL, Vogl TJ, Schoepf UJ. State-of-the-art pulmonary CT angiography for acute pulmonary embolism. American Journal of Roentgenology. 2017 Mar;208(3):495-504.
16. Lau BD, Haut ER. Practices to prevent venous thromboembolism: a brief review. BMJ Qual Saf. 2014;23:187–95.
17. JCS Joint Working Group. Guidelines for the diagnosis, treatment and prevention of pulmonary thromboembolism and deep vein thrombosis (JCS 2009). Circ J. 2011;75(5):1258-81. doi: 10.1253/circj.cj-88-0010.
18. Heit JA: The epidemiology of venous thromboembolism in the community. Arterioscler Thromb Vasc Biol 2008, 28:370–372.
19. Irmak B, KARADAĞ M, Emre NY. The risk factors for preoperative and postoperative deep vein thrombosis in surgical patients. Clinical and Experimental Health Sciences. 2022 Mar 3;12(1):120-7.
20. Engbers M, Hylckama Vlieg A, Rosendaal F. Venous thrombosis in the elderly: incidence, risk factors and risk groups. J Thromb Haemost 2010;8(10):2105-2112.
21. A' vila AC, Fenili R. Incidence and risk factors for postoperative pulmonary complications in patients undergoing thoracic and abdominal surgeries. Rev Col Bras Cir. 2017 May-Jun; 44(3):284–292. https://doi.org/10.1590/0100-69912017003011
22. Nijbroek S, Schultz M, Hemmes S. Prediction of postoperative pulmonary complications. Curr Opin Anaesthesiol. 2019 Jun; 32(3):443–451. https://doi.org/10.1097/ACO.0000000000000730 PMID: 30893115
23. Paulsen B, Gran OV, Severinsen MT, Hammerstrøm J, Kristensen SR, Cannegieter SC, Skille H, Tjønneland A, Rosendaal FR, Overvad K, Næss IA. Association of smoking and cancer with the risk of venous thromboembolism: the Scandinavian Thrombosis and Cancer cohort. Scientific Reports. 2021 Sep 21;11(1):18752.
24. Quist-Paulsen, P. et al. Arterial cardiovascular risk factors and venous thrombosis: Results from a population-based, prospective study (the HUNT 2). Haematologica 95(1), 119–125 (2010).
25. Glynn, R. J. & Rosner, B. Comparison of risk factors for the competing risks of coronary heart disease, stroke, and venous thromboembolism. Am. J. Epidemiol. 162(10), 975–982 (2005).

26. Goldhaber, S. Z. *et al.* Risk factors for pulmonary embolism. The Framingham study. *Am. J. Med.* **74**(6), 1023–1028 (1983).
27. Tsai, A. W. et al. Cardiovascular risk factors and venous thromboembolism incidence: The longitudinal investigation of thromboembolism etiology. Arch. Int. Med. 162(10), 1182–1189 (2002).
28. Goldhaber SZ, Bounameaux H. Pulmonary embolism and deep vein thrombosis. Lancet 2012;379(9828):1835-1846.
29. Ageno W, Becattini C, Brighton T, Selby R, Kamphuisen PW. Cardiovascular risk factors and venous thromboembolism. Circulation 2008; 117(1):93-102.
30. Wang L, Pryor AD, Altieri MS, Romeiser JL, Talamini MA, Shroyer L, Telem DA. Perioperative rates of deep vein thrombosis and pulmonary embolism in normal weight vs obese and morbidly obese surgical patients in the era post venous thromboembolism prophylaxis guidelines. Am J Surg 2015;210(5):859-863.
31. Özkaya Ö, Öztürk MB, Egemen O, Öreroğlu AR, Üsçetin İ, Tasasız K, Akan M. The approach of turkish plastic surgeons to the venous thromboembolism prophylaxis and preferred methods in prophylaxis: a survey study. Turk J PlastSurg 2013;21(2):10-15 (Turkish).
32. Biedka M, Ziółkowska E, Windorbska W. Acute pulmonary embolus in the course of cancer. Contemp Oncol (Pozn). 2012;16(5):388-93. doi: 10.5114/wo.2012.31766.
33. Bayleyegn B, Adane T, Getawa S, Aynalem M, Kifle ZD. Coagulation parameters in lung cancer patients: A systematic review and meta-analysis. J Clin Lab Anal. 2022 Jul;36(7):e24550. doi: 10.1002/jcla.24550)
34. Syncope as the initial presentation of pulmonary embolism in a young adult with testicular tumor: a case report and literature review. Song Z, Lv S, Qin L, Cao H, Wu H, Deng D. Medicine (Baltimore) 2018;97:0.
35. Karakida N, Yanazume S, Tokudome A, Sonoda M, Kobayashi H. Successful Treatment of a Life-Threatening Pulmonary Embolism Following Retroperitoneal Tumor Surgery. Cureus. 2022 Nov 14;14(11).)
36. Stein PD, Matta F, Sabra MJ. Pulmonary embolism and deep venous thrombosis following laparoscopic cholecystectomy. Clinical and Applied Thrombosis/Hemostasis. 2014 Apr;20(3):233-7.
37. Matthews BD, Williams GB. Laparoscopic cholecystectomy in an academic hospital: evaluation of changes in perioperative outcomes. JSLS. 1999 Jan-Mar;3(1):9-17
38. Liu Y, Han L, Li J. Consumption coagulopathy in acute aortic dissection: principles of management. J Cardiothorac Surg. 2017;12:50. et al. [PMC free article] [PubMed] [Google Scholar] [Ref list]
39. Girerd S, Girerd N, Frimat L, Holdaas H, Jardine AG, Schmieder RE, Fellström B, Settembre N, Malikov S, Rossignol P, Zannad F. Arteriovenous fistula thrombosis is associated with increased all-cause and cardiovascular mortality in haemodialysis patients from the AURORA trial. Clinical kidney journal. 2020 Feb;13(1):116-22.).
40. Bahloul M, Chelly H, Regaieg K, Rekik N, Bellil S, Chaari A, Bouaziz W, Chabchoub I, Haddar S, Ben Hamida C, Bouaziz M. Pulmonary embolism following severe traumatic brain injury: incidence, risk factors and impact outcome. Intensive Care Med. 2017;43:1433–1435.
41. Darabadi FK, JafariZare MA, Goodarzi ZT, Namdar P. Prevalence and main determinants of early post-traumatic thromboembolism in patients requiring ICU admission. Eur J Trauma Emerg Surg. 2018;44:133–136.
42. Canet J, Gallart L, Gomar C, Paluzie G, Vallès J, Castillo J, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. Anesthesiology. 2010 Dec; 113(6):1338–1350. https://doi.org/10.1097/ALN.0b013e3181fc6e0a PMID: 21045639
43. Nijbroek S, Schultz M, Hemmes S. Prediction of postoperative pulmonary complications. Curr Opin Anaesthesiol. 2019 Jun; 32(3):443–451. https://doi.org/10.1097/ACO.0000000000000730