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*Original Article*

# A clinical study of acute pulmonary embolism in internal medicine patients and postoperative patients

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**Abstract:** The aim of this study is to analyze the clinical characteristics of internal medicine and postoperative patients with acute pulmonary embolism (PE) in our hospital. 313 patients with acute PE were selected. Based on whether acute PE had developed postoperatively and whether other concurrent risk factors for PE were present, patients were divided into 4 groups. The oxygen partial pressure was significantly higher and the brain natriuretic peptide (BNP) level was significantly lower in group of postoperative PE patients without other concurrent risk factors compared with other 3 groups. The percentage of postoperative PE patients with other concurrent risk factors who underwent anticoagulant therapy was considerably lower than those 3 groups. There was a positive correlation between diabetes and hemorrhagic complications in internal medicine patients with PE. For all patients, deaths were positively correlated with both increased BNP levels and hypotension. In patients with postoperative PE, deaths were positively correlated with tumor and the decrease of oxygen partial pressure. In conclusion, Patients with postoperative acute PE who had no other concurrent risk factors exhibited a high cardiopulmonary compensatory capacity. For patients with postoperative acute PE who had other concurrent risk factors, the anticoagulant treatments administered by the clinicians were often inadequate. In internal medicine patients with PE, the incidence of hemorrhagic complications was related to diabetes. An elevated BNP level and hypotension increased the risk of death in patients with acute PE. Tumor and hypoxemia increased the risk of death in patients with postoperative acute PE.

**Keywords:** Pulmonary embolism, risk factors, complications, outcome

## Introduction

Pulmonary embolism (PE) is a common disease not only in Western countries but also in China. There are a number of risk factors for PE, including tumors, surgery (especially major spinal and joint surgeries), pregnancy/labor, cardiopulmonary insufficiency, atrial fibrillation, long-term immobilization of a lower extremity, obesity, and a previous history of lower extremity deep venous thrombosis (DVT) or PE. Therefore, PE occurs not only in internal medicine patients, it development in postoperative patients is not uncommon [1].

Because the clinical manifestations of PE vary considerably, some clinicians lack an awareness and alertness to PE. In clinical practice, the omission rate and misdiagnosis rate of PE are high. It has been reported that 70% to 80% of PE cases are diagnosed via autopsy [2].

In the present study, the clinical data of internal medicine patients and postoperative patients with acute PE were collected and processed to understand the respective risk factors, clinical symptoms, and characteristics of relevant examinations and laboratory indicators. In addition, treatment regimens, hemorrhagic complications, and disease outcomes were analyzed, and the indicators related to hemorrhagic complications and death were determined.

## Methods

### *Study population*

A retrospective analysis was conducted on 313 patients who were hospitalized in our hospital between March 2011 and April 2014 and diagnosed with acute PE by spiral computed tomography (CT) pulmonary angiography. Among the 313 patients, 130 were male, and 183 were

**Table 1.** Concurrent risk factors for PE in postoperative patients and internal medicine patients with PE

| Risk factors | Group B | | Group D | |
|---|---|---|---|---|
| | Number of patients | Percentage (%) | Number of patients | Percentage (%) |
| Tumor | 3 | 7.50 | 6 | 5.08 |
| Diabetes | 3 | 7.50 | 15 | 12.71 |
| Renal insufficiency | 4 | 10.00 | 9 | 7.63 |
| Coronary heart disease | 8 | 20.00 | 29 | 24.58 |
| Hypertension | 21 | 52.50 | 51 | 43.22 |
| Labor | 4 | 10.00 | 8 | 6.78 |
| Cardiac insufficiency | 2 | 5.00 | 9 | 7.63 |
| COPD | 0 | 0.00 | 7 | 5.93 |
| Stroke | 9 | 22.50 | 13 | 11.02 |
| Hyperlipidemia | 2 | 5.00 | 7 | 5.93 |
| Previous history of DVT or PE | 13 | 32.50 | 56 | 47.46 |

female. The mean age of the patients was 54.00±14.85 years. Of the 313 patients, 94 suffered postoperative PE, while 219 were internal medicine patients with PE. Based on whether acute PE had developed postoperatively and whether other concurrent risk factors for PE were present, patients included in the present study were divided into the following 4 groups: group A, 54 postoperative PE patients without other concurrent risk factors for PE; group B, 40 postoperative PE patients with other concurrent risk factors for PE; group C, 101 hospitalized internal medicine patients with PE who had no obvious risk factors for PE; and group D, 118 hospitalized internal medicine patients with PE who had risk factors for PE. In addition to surgery, other risk factors for PE included tumors, pregnancy/labor, cardiac insufficiency, chronic obstructive pulmonary disease (COPD), long-term bedrest because of internal diseases, hypertension, coronary heart disease, stroke, and previous history of DVT or PE.

*Collection of clinical data*

The risk factors for PE were analyzed and collated in all selected patients. Blood pressures (a systolic blood pressure less than 90 mmHg was defined as hypotension), respiratory rates, and heart rates of the patients at the onset of PE were recorded. A portion of the patients underwent a blood gas analysis, serum D-dimer test, and brain natriuretic peptide (BNP) test, and the relevant results were obtained. The information regarding treatment methods, hemorrhagic complications, and disease outcomes were also collected.

*Statistical methods*

Statistical analysis was performed using the R3.13 statistical software. Numeric variables are expressed as the mean ± standard deviation (SD). Blood pressure, respiratory rate, heart rate, oxygen partial pressure, serum D-dimer level, BNP level, treatment methods, hemorrhagic complications, and prognosis of the 4 groups of patients were subjected to differential analysis using the chi-square test. To determine the factors that are related to the hemorrhagic complications and disease outcomes in internal medicine patients and postoperative patients with PE, Pearson's correlation analysis was performed. To clarify whether surgery was a risk factor for hemorrhagic complications and death in the patients, a univariate analysis of variance (ANOVA) was performed.

## Results

*Concurrent PE risk factors in postoperative patients and internal medicine patients with PE*

To determine the distribution of the concurrent PE risk factors in internal medicine patients and postoperative patients with PE, we analyzed the risk factors in all patients from groups B and D. The results showed that the highest percentage of the patients in group B (52.50%) suffered hypertension. In addition, the percentages of the patients with a previous history of DVT or PE, stroke, and coronary heart disease were also high, reaching 32.5%, 22.50%, and 20.00%, respectively. In group D, the highest percentage of patients had a previous history of DVT or PE. Such patients accounted for 47.46% of all patients in group D. In addition, the percentage of patients with hypertension and the percentage of patients with coronary heart disease in group D were high, reaching

**Table 2.** General clinical data of postoperative patients and internal medicine patients with PE who had or did not have concurrent PE risk factors

| Group | | A | B | C | D | $\chi^2$ value | *P* value |
|---|---|---|---|---|---|---|---|
| Gender | Male (%) | 27 (50.00) | 17 (42.50) | 41 (40.59) | 45 (38.14) | 2.265 | 0.52 |
| | Female (%) | 27 (50.00) | 23 (57.50) | 60 (59.41) | 73 (61.86) | | |
| Age (years) | | 55.33±15.12 | 53.48±13.74 | 53.77±14.93 | 53.50±14.94 | 92.34 | 0.49 |
| Hypotension (%) | | 1 (1.85) | 2 (5.00) | 4 (3.96) | 5 (4.24) | 5.591 | 0.13 |
| Heart rate (beats/min) | | 87.15±16.45 | 83.38±11.30 | 89.5±10.08 | 84.51±13.66 | 183.91 | 0.24 |
| Respiratory rate (breaths/min) | | 21.07±3.90 | 20.83±3.96 | 21.75±2.36 | 20.20±3.26 | 63.09 | 0.53 |

**Table 3.** Hematological indices of postoperative patients and internal medicine patients with PE who had or did not have concurrent risk factors for PE

| Groups | Partial pressure of oxygen (mmHg) | D-dimer (μg/ml) | BNP (pg/ml) |
|---|---|---|---|
| | Number of patients (mean ± SD) | Number of patients (mean ± SD) | Number of patients (mean ± SD) |
| A | 21 (87.36±23.06) | 49 (2.58±3.15) | 18 (945.64±1407.64) |
| B | 16 (74.43±24.70)* | 30 (3.86±4.01) | 14 (2639.143±4070.38)** |
| C | 53 (72.93±22.95)* | 91 (5.57±16.09) | 46 (2184.34±2164.07)** |
| D | 50 (72.82±26.01)* | 100 (4.79±7.90) | 52 (2269.39±3068.81)** |

Note: *Compared with the oxygen partial pressure in group A, P<0.05; **Compared with the BNP level in group A, P<0.05.

43.22% and 24.58%, respectively. The results are presented in **Table 1**.

*Basic clinical data of postoperative patients and internal medicine patients with PE who had or did not have concurrent PE risk factors*

No statistically significant differences existed between the 4 groups of patients in terms of gender, age, incidence of hypotension, heart rate, and respiratory rate (P>0.05), see **Table 2**.

*Hematological indices of postoperative patients and internal medicine patients with PE who had or did not have concurrent PE risk factors*

In groups A, B, C, and D, 21, 16, 53, and 50 patients, respectively, were subjected to oxygen partial pressure measurement; 49, 31, 91, and 100 patients, respectively, underwent serum D-dimer testing; and 18, 14, 46, and 52 patients, respectively, underwent BNP testing. The results of the multiple-group comparison showed that there were no statistically significant differences between the 4 groups in terms of the partial pressure of oxygen, plasma D-dimer level, and BNP concentration (all P> 0.05). However, the results of 2-group comparisons revealed that the partial pressure of oxygen and BNP concentration were significantly higher in group A compared with groups B, C, and D (all P<0.05) (**Table 3**).

*Treatment regimens, hemorrhagic complications, and outcomes in postoperative patients and internal medicine patients with PE who had or did not have concurrent risk factors for PE*

The 4 groups all contained patients who underwent anticoagulant therapy, thrombolytic therapy, interventional or surgical embolectomy, and inferior vena cava filter placement. The percentages of patients in groups A, C, and D who received anticoagulant therapy were 100%, 99.00%, and 97.46%, respectively. By contrast, only 90.00% of the patients in group B underwent anticoagulant therapy, which was significantly lower compared with groups A, C, and D (P<0.05). No significant differences existed in the selection of other treatment methods between the 4 groups. In addition, there were no significant differences in the incidence of hemorrhagic complications and the prognosis of PE between the 4 groups (P>0.05) (**Table 4**).

*Correlation analysis of hemorrhagic complications in postoperative patients and internal medicine patients with PE*

Among the postoperative patients, namely the (A+B) group, 3 patients developed hemorrhagic complications. Of the internal medicine patients (the (C+D) group), 7 patients developed hemor-

**Table 4.** Treatment regimens, hemorrhagic complications, and outcomes in postoperative patients and internal medicine patients with PE who had or did not have concurrent PE risk factors

| Groups | Number of patients | Treatments | | | | Hemorrhagic complications (%) | Prognosis | |
|---|---|---|---|---|---|---|---|---|
| | | Anticoagulation (%) | Thrombolysis (%) | Interventional or surgical embolectomy (%) | Inferior vena cava filter placement (%) | | Death (%) | Improvement (%) |
| A | 54 | 54 (100.00) | 13 (24.07) | 1 (1.85) | 3 (5.56) | 1 (1.85) | 1 (1.85) | 53 (98.15) |
| B | 40 | 36 (90.00) | 9 (22.50) | 1 (2.50) | 2 (5.00) | 2 (5.00) | 5 (12.50) | 35 (87.50) |
| C | 101 | 100 (99.00) | 34 (33.67) | 4 (3.96) | 8 (7.92) | 1 (1.00) | 9 (8.91) | 99 (98.02) |
| D | 118 | 115 (97.46) | 39 (33.05) | 3 (2.54) | 7 (5.93) | 6 (5.08) | 5 (4.24) | 113 (95.76) |
| $\chi^2$ value | | 9.56 | 2.82 | 0.66 | 0.20 | 6.42 | 9.91 | |
| *P* value | | 0.02 | 0.42 | 0.88 | 0.98 | 0.38 | 0.13 | |

**Table 5.** Correlation analysis of hemorrhagic complications in postoperative patients and internal medicine patients with PE

| Factors analyzed | (A+B) group | | (C+D) group | |
|---|---|---|---|---|
| | Pearson's correlation | *P* value | Pearson's correlation | *P* value |
| Gender | 1.067 | 0.289 | 0.021 | 0.762 |
| Age | 1.411 | 0.162 | -0.100 | 0.884 |
| Treatment regimens | | | | |
| Anticoagulation | 2.784*** | 0.007 | 0.175*** | 0.009 |
| Thrombolysis | 3.128*** | 0.002 | 0.195*** | 0.004 |
| Interventional or surgical embolectomy | -0.147 | 0.884 | -0.005 | 0.946 |
| *Inferior vena cava filter placement* | -0.236 | 0.814 | -0.007 | 0.922 |
| Concurrent risk factors | | | | |
| Diabetes | -0.146 | 0.884 | 0.123* | 0.068 |
| Renal insufficiency | -0.209 | 0.834 | -0.005 | 0.938 |
| Tumor | -0.180 | 0.857 | -0.004 | 0.95 |
| Cardiac insufficiency | 3.128 | 0.002 | 0.090 | 0.183 |
| Hypertension | -0.534 | 0.594 | -0.075 | 0.272 |
| Coronary heart disease | -0.303 | 0.762 | -0.010 | 0.883 |
| Stroke | -0.324 | 0.747 | -0.006 | 0.925 |

Note: ***Indicates statistically significant differences at the 1% confidence level; *Indicates statistically significant differences at the 10% confidence level.

rhagic complications. To determine whether the occurrence of hemorrhagic complications is related to gender, age, treatment regimens, and concurrent risk factors, the corrections between the above factors and hemorrhagic complications were analyzed in the (A+B) group and in the (C+D) group. The results showed that the incidence of hemorrhagic complications was positively correlated with anticoagulant treatment and thrombolysis in both the (A+B) group and the (C+D) group (all P<0.05). Moreover, there was also a positive correlation between diabetes and hemorrhagic complications in the (C+D) group (P=0.068). The results are presented in **Table 5**; **Figures 1** and **2**.

*Correlation analysis of the disease outcomes in postoperative patients and internal medicine patients with PE*

Among the postoperative patients, namely the (A+B) group, 6 patients died. Of the internal medicine patients (the (C+D) groups), 14 patients died. To determine whether PE deaths were related to age, oxygen partial pressure, serum D-dimer level, BNP level, hypotension, treatment regimens, and concurrent risk factors, the corrections between the above factors and the incidence of death were analyzed in the (A+B) group and in the (C+D) group. The results revealed that the incidence of death was positively correlated with an increased BNP level and hypotension in both the (A+B) group and the (C+D) group. In addition, for patients in the (A+B) group, the incidence of death was positively correlated with tumor presence as well as the decreased partial pressure of oxygen, and negatively correlated with anticoagulant treatment (**Table 6**; **Figures 3** and **4**).

*Effect of surgery on hemorrhagic complications and death in patients with PE*

To clarify whether surgery itself is a risk factor for hemorrhagic complications and death, one-way ANOVA was performed. As shown in **Table**

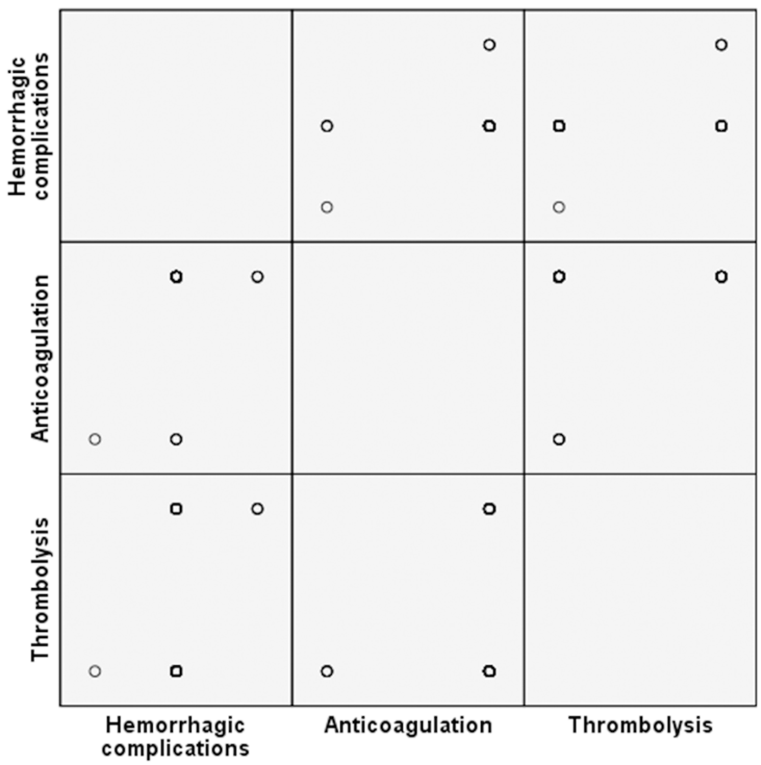


**Figure 1.** Correlation analysis of hemorrhagic complications in postoperative patients with PE.

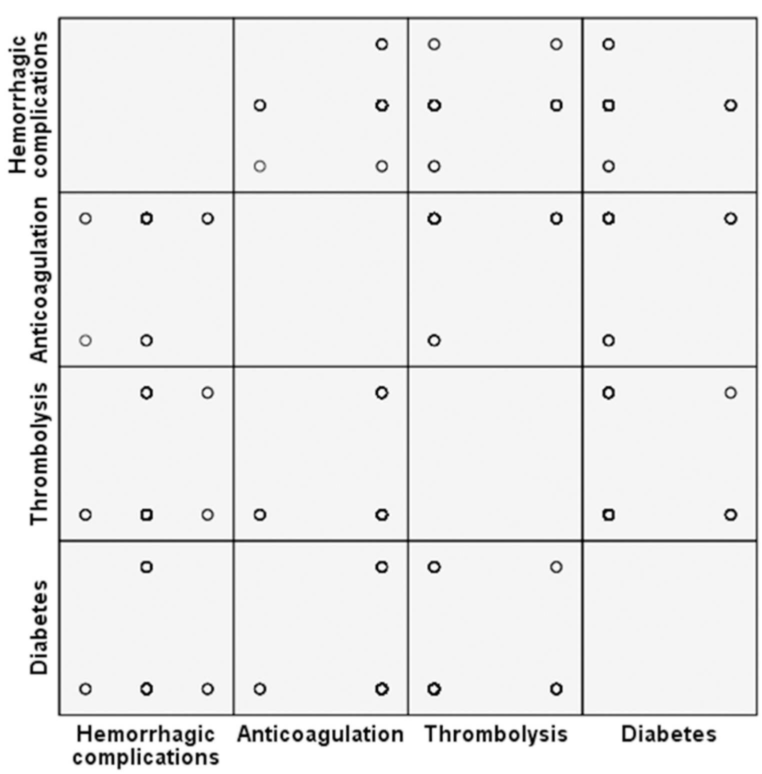


**Figure 2.** Correlation analysis of hemorrhagic complications in internal patients with PE.

**7**, surgery had no effect on hemorrhagic complications and death (the *P* values were 0.694 and 0.586, respectively).

## Discussion

In PE patients, most emboli are derived from DVTs. Therefore, some scholars believe that both PE and DVT can be classified venous thromboembolism (VTE) [3, 4]. There are a large number of risk factors for DVT/PE, including a thrombophilic tendency and acquired risk factors. Among the acquired risk factors, bone fracture (hip fracture or leg fracture), joint replacement surgery or other major surgeries, severe trauma and spinal injury are strong risk factors [5]. The following factors can trigger postoperative VTE: 1. prolonged bedrest, leading to blood stasis; 2. hemostatic drugs administered during the surgical procedure because of the likelihood of bleeding or existence of hemorrhage; 3. surgical stress and potential organ dysfunction, potentially stimulating the clotting tendency; 4. hematoma oppression, prolonged operative time, trauma in combination with secondary infection, central venous catheter insertion, and other factors, possibly causing vascular endothelial injury. (Vascular endothelial injury may cause decreased venous pressure and blood flow velocity as well as vascular lumen stenosis, which further activate the coagulation system and promote thrombosis); and 5. During surgery, anesthesia-induced limb ischemia and reduction in venous blood flow are high risk factors for

**Table 6.** Correlation analysis of the death of postoperative patients and internal medicine patients with PE

| Factors analyzed | (A+B) group | | (C+D) group | |
|---|---|---|---|---|
| | Pearson's correlation | *P* value | Pearson's correlation | *P* value |
| Age | 0.065 | 0.534 | -0.077 | 0.258 |
| Hemorrhagic *complications* | -0.027 | 0.796 | 0.094 | 0.164 |
| Treatment regimens | | | | |
| Anticoagulation | -0.376** | 0.000 | 0.036 | 0.6 |
| Thrombolysis | 0.061 | 0.558 | 0.063 | 0.351 |
| Interventional or surgical embolectomy | -0.038 | 0.713 | 0.06 | 0.381 |
| *Inferior vena cava filter placement* | -0.062 | 0.553 | 0.012 | 0.856 |
| Concurrent risk factors | | | | |
| Diabetes | -0.047 | 0.650 | 0.008 | 0.909 |
| Renal insufficiency | 0.161 | 0.122 | 0.042 | 0.536 |
| Tumor | 0.448** | 0.000 | -0.039 | 0.565 |
| Cardiac insufficiency | -0.038 | 0.713 | 0.042 | 0.536 |
| Hypertension | 0.173 | 0.095 | -0.044 | 0.522 |
| Coronary heart disease | 0.076 | 0.465 | -0.038 | 0.575 |
| Stroke | 0.112 | 0.283 | 0.017 | 0.799 |
| Previous history of lower extremity DVT or PE | 0.021 | 0.837 | 0.111 | 0.101 |
| Decreased partial pressure of oxygen | 0.211* | 0.041 | 0.109 | 0.108 |
| D-dimer | 0.000 | 0.998 | 0.058 | 0.394 |
| Increased BNP level | 0.369** | 0.000 | 0.165** | 0.015 |
| Hypotension | 0.200** | 0.048 | 0.132* | 0.051 |

Note: **Indicates statistically significant differences at the 5% confidence level; *Indicates statistically significant differences at the 10% confidence level.

the development of lower extremity DVT. In addition, malignant tumor, pregnancy/labor, a previous history of thromboembolism, advanced age, long-term immobilization of both lower limbs, underlying diseases (such as chronic cardiopulmonary insufficiency, coronary heart disease, hypertension, ischemic stroke, pancreatitis, and kidney failure), and genetic susceptibility are also risk factors that contribute to DVT/PE [5-7].

Although the relative proportion of platelets in venous thrombi is low, the platelets still interact with neutrophils, produce histone-DNA complexes, and participate in thrombosis via the release of polyphosphates, microparticles, and proinflammatory mediators [8]. In terms of preventing PE, the protection provided by aspirin cannot compete with that provided by vitamin K antagonists or novel oral anticoagulants. However, larger-scale clinical trials have shown that aspirin may play a role in the long-term secondary prevention of PE in patients at high risk of bleeding.

We analyzed the risk factors in PE patients and found that the percentage of patients with hypertension was very high among both the internal medicine patients and the postoperative patients with PE. The finding indicated that the incidence of hypertension is high in China. In addition, it is also likely that the hypertensive patients had not received any formal treatments, including blood pressure control and the necessary antiplatelet therapy. Therefore, the incidence of PE was high in such hypertensive patients. The percentage of patients with a previous history of DVT or PE was also high among both internal medicine patients and postoperative patients with PE, which confirmed the conclusion that spontaneous factors were the most important risk factors for PE recurrence [9]. The findings suggested that secondary prevention of thrombosis must be emphasized in future clinical practice for patients with a history of lower extremity venous thrombosis or PE. Such patients should be given effective anticoagulant therapy strictly according to the recommendations of the guidelines.

Oxygen partial pressure was significantly higher in patients with postoperative PE who had no

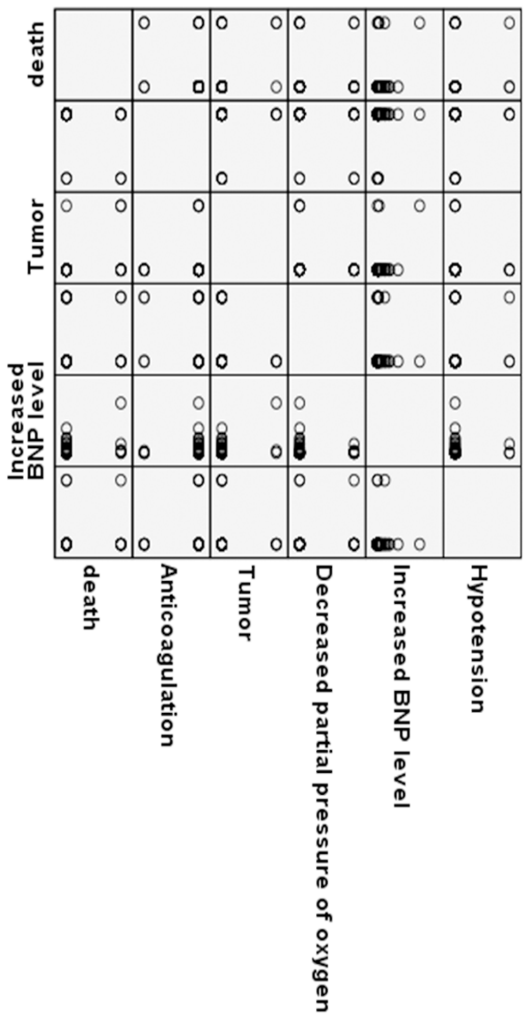


**Figure 3.** Correlation analysis of the death of postoperative patients with PE.

other concurrent risk factors compared with the other 3 groups of patients, whereas the plasma BNP levels were significantly lower compared with the other 3 groups. The results indicated that potential cardiopulmonary insufficiency existed in most of the patients with coronary heart disease, stroke, hypertension, chronic cardiopulmonary insufficiency, tumors, and a previous history of PE. In such patients, even small embolisms may cause severe hemodynamic injuries and cardiopulmonary decompensation, resulting in hypoxemia, heart failure, or further aggravation of heart failure. When the blood pressure rises in pulmonary arteries and the right ventricular after load increases, an increase in coronary blood flow is required to provide a sufficient oxygen supply for the right ventricular myocardium. If the above conditions are accompanied by decreased blood pressure, right ventricular myocardial ischemia will become aggravated, which causes a further reduction of cardiac output and even the development of acute respiratory failure and cardiac arrest. Consequently, the patient's life is endangered.

PE may occur in any patient. If a patient is highly suspected to have PE, anticoagulant therapy should be administered as soon as possible, unless the patient has contraindications to anticoagulation [10]. It is not necessary to await the diagnostic confirmation. The purpose of initial anticoagulant therapy for PE is to reduce mortality and recurrent embolism [11]. However, clinicians are usually reluctant to apply anticoagulant therapy to treat patients who are at risk of bleeding. Actually, the risk of PE is far greater than the risk of anticoagulant therapy-induced hemorrhagic complications. Bleeding can usually be controlled and will not cause long-term complications. A large number of domestic and international studies have demonstrated that compared with heparin, low-molecular-weight heparin exhibits the same effectiveness in the prevention and treatment of venous thrombosis. Moreover, low-molecular-weight heparin reduces bleeding and prevents the decrease of platelets [12]. Thrombolysis is one of the effective methods for treating massive PE. However, because systemic venous thrombolysis increases the risk of systemic bleeding, thrombolytic therapy should be chosen cautiously for patients who have recently received surgery. However, for critically ill patients, the severity of the illness and the risk of bleeding should be properly evaluated, and saving lives should be given the top priority [13]. Patients with PE are treated by interventional fragmentation and aspiration of large thrombi from the pulmonary artery. Thrombolytic therapy that combines local administration of a small dose of thrombolytic agent is suitable for treating high-risk patients with acute PE who have developed thromboembolism in the proximal segment of the pulmonary artery. If contraindications to thrombolysis exist or the thrombolytic therapy and active medical therapy are ineffective, interventional therapy will be administered. Particularly, interventional therapy should be the preferred emergency treatment method for patients suffering cardiogenic shock or right-sided cardiac insufficiency.

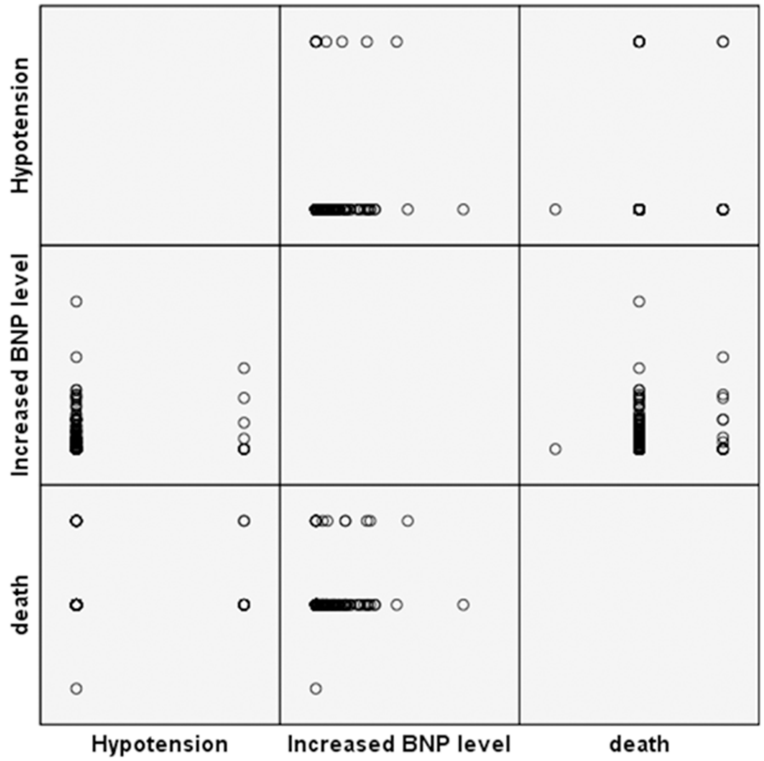


**Figure 4.** Correlation analysis of the death *of* internal patients with PE.

**Table 7.** Effect of surgery on hemorrhagic complications and outcomes in patients with PE

| | Mean square | F value | *P* value |
|---|---|---|---|
| Hemorrhagic complications | 0.013 | 0.366 | 0.694 |
| Outcome | 0.034 | 0.536 | 0.586 |

The surgical treatment of PE refers to pulmonary-artery thrombectomy that is employed to improve hemodynamics in the acute phase, which is a life-saving surgery. If the early postoperative recovery is satisfactory, a good prognosis will be achieved [14]. Inferior vena cava filter placement can be performed to treat patients with recurrent PE after full anticoagulant therapy, hemodynamically unstable patients with massive PE, patients with proximal lower-extremity venous thrombosis who have contraindications to anticoagulant therapy or suffer anticoagulant therapy-induced complications, and patients with massive proximal lower-extremity venous thrombosis before thrombolytic therapy. Inferior vena cava filter placement is capable of preventing PE that is caused by embolus shedding from the thrombus in the deep venous system of the lower extremity [5].

Our study showed that all the guideline-recommended therapies were currently used in our hospital to treat both internal medicine patients and surgical patients with acute PE. However, approximately 90% of the patients with postoperative acute PE who had other concurrent PE risk factors received anticoagulant therapy. The percentage was significantly lower compared with the internal medicine patients with PE and the patients with postoperative acute PE who had no other concurrent PE risk factors. A small percentage of the patients did not undergo anticoagulant therapy. It was likely that the patients each suffered a number of complications and that some clinicians were concerned about the risk of anticoagulation-induced bleeding.

The present investigation revealed that for all selected PE patients, anticoagulant and thrombolytic therapy are the factors related to hemorrhagic complications. However, there were no positive correlations between the deaths of the selected PE patients and either anticoagulation or thrombolysis. By contrast, anticoagulant therapy reduced the short-term risk of death in patients with postoperative acute PE. In addition, diabetes increased the risk of developing hemorrhagic complications in internal medicine patients with PE, which might be related to the microvascular diseases and coagulation disorders caused by long-term elevated blood glucose. No significant correlation existed between thrombolytic therapy and the prognosis of the patients, which might be related to factors such as the start-up time of thrombolytic therapy and whether an adequate dose of medication was administered.

Hemodynamic status is the most important prognostic factor for PE. Research has shown that the short-term mortality rate of patients with massive PE who suffer hypotension or shock is at least 15% [15]. Myocardial injury secondary to acute PE causes varying degrees of increase in the BNP level. The higher the BNP level, the more severe the myocardial injury is, and the poorer the prognosis will most likely be [16, 17]. A meta-analysis that included 13 studies has demonstrated that the BNP level is significantly correlated with short-term all-cause mortality [18]. In addition, the results of a meta-analysis of hemodynamically stable patients with PE revealed that an elevated BNP level is significantly correlated with short-term mortality [19]. The results of the present study showed that PE-induced death is significantly, positively correlated with increased BNP levels and hypotension in all selected patients, which was consistent with the reports from other researchers.

Relevant reports suggest that blood gas examination is of great value for PE patients, to determine the disease severity [20]. The present study showed that the reduced partial pressure of oxygen was positively correlated with death in patients with postoperative PE. The reasons might involve the following 3 aspects. 1. The severity of hypoxemia was closely related to the PE occurrence rate, embolus size, and location of embolism. The occurrence of acute thrombosis in large blood vessels might lead to severe hypoxemia and, ultimately, death of the patients. 2. The reason might lie in the past medical history of the patients, such as COPD or heart failure. PE is likely to trigger or exacerbate previously existing underlying diseases. In turn, the underlying diseases will most likely aggravate PE manifestations and increase PE mortality. Patients who received cardiothoracic surgery suffered an impaired cardiopulmonary reserve during the perioperative period. If PE occurred simultaneously, the two conditions influenced each other, thereby promoting the occurrence of hypoxemia and eventually leading to death of the patients.

Our results showed that tumor presence increased the short-term risk of death in patients with postoperative acute PE. The reasons might involve the poor basic conditions of such patients, the presence of surgical trauma, and potential concurrent multiple organ dysfunction. After the occurrence of PE, the above reasons exerted reciprocal causal effects on one another, forming a vicious cycle. Consequently, the death of the patients was accelerated.

In conclusion, patients with postoperative acute PE who have no other concurrent risk factors exhibit a high cardiopulmonary compensatory capacity. For patients with postoperative acute PE who have other concurrent risk factors, the anticoagulant treatments administered by clinicians are often inadequate. In patients with acute PE, the incidence of hemorrhagic complications is related to anticoagulant and thrombolytic therapy. In internal medicine patients with PE, hemorrhagic complications are also related to diabetes. Elevated BNP levels and hypotension increase the risk of death in patients with acute PE. Anticoagulant therapy reduces the risk of death in patients with postoperative acute PE, whereas tumor presence and hypoxemia increase the risk of death in such patients.

#### Disclosure of conflict of interest

None.

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