Prevalence of pulmonary embolism at autopsy among elderly patients in a Chinese general hospital

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Abstract

Objectives To investigate the prevalence and characteristics of pulmonary embolism (PE) at autopsy in a Chinese general hospital over a period of 10 years, and to evaluate the antemortem achievement of the prophylaxis, diagnosis, and treatment of PE. Methods All medical records of deaths from the West Branch of the Chinese People’s Liberation Army (PLA) General Hospital were retrospectively reviewed, for the period of January 1, 2006 to December 31, 2015. Cases in which autopsies had been performed were identified and further analyzed. The numbers and detailed characteristics of patients who had PEs were noted. Prophylactic measures, along with diagnosis and treatment of PE, were recorded, if performed. Results During the 10-year period, 1057 patients died in the study hospital and 278 necropsies were performed (autopsy rate: 26.3%). Nine patients were found to have PE (3.2%), and in seven of these patients (2.5%), the PE was considered to be fatal. Embolisms were found in the trunk and bilateral main branches of the pulmonary artery tree in all seven of the fatal PE cases. Right intracardiac thrombosis was detected in five of the nine PE patients (55.6%). All patients with PE had been hospitalized in medical departments, and only one had undergone surgery during hospitalization. Antemortem prophylaxis was performed in two of the nine PE cases (22.2%). None of the 9 patients had received a clinical diagnosis of PE before death. Conclusions The incidence of and death rate associated with PE may vary among different races and regions. Continuous monitoring of PE by means of necropsy in certain representative medical institutions is necessary.

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1 Introduction

Pulmonary embolism (PE) has been recognized as an important cause of death among hospital inpatients.⁰⁻⁶ Owing to the sustained high rate of missed clinical diagnosis,⁷⁻¹³ autopsy is accepted as an effective method to investigate the prevalence of PE in hospitals. A substantial amount of autopsy studies on the occurrence of PE have been published in recent decades, but these mostly report results from Western countries. Regrettfully, due to the extremely low rate of necropsy, no autopsy data regarding the prevalence of PE in China have been available to date, although China has the largest population in the world. Considering the reported differences in PE prevalence among races in previous studies,¹⁴ we believed that it would be necessary to investigate the present status of PE prevalence in a Chinese general hospital. The West Branch of the Chinese People’s Liberation Army (PLA) General Hospital, which incorporates most medical and surgical services for the health care of high-ranking military officers, has the highest necropsy rate in China. This study aimed to evaluate the prevalence and characteristics of PE at autopsy in the aforementioned hospital over the last 10 years, as well as the achievement of the antemortem prophylaxis, diagnosis, and treatment of PE patients.

2 Methods

All medical records of deaths from the West Branch of the Chinese PLA General Hospital were retrospectively reviewed, for the period of January 1, 2006 to December 31, 2015. Demographic characteristics of the patients who had died were recorded. Cases in which autopsies had been performed were identified and further analyzed.

During the routine postmortem examination, the pulmonary artery tree was dissected to at least the segmental level,
while the lung tissues were subjected to microscopic examinations; the lower limbs were not routinely examined according to the protocol. PE was classified into two categories: fatal PE (embolism occluding the proximal pulmonary arteries and determination by pathologist performing the autopsy that PE had substantially contributed to the death); or incidental PE (small pulmonary emboli, occurring in distal branches of the artery tree, not considered to be related to death).

The numbers of patients with fatal and incidental PE were recorded. The medical records of patients with PE were then subjected to detailed analysis. Details regarding associated illnesses, risk factors, clinical features, and autopsy findings of PE patients were noted. The thrombosis risk of patients with PE was assessed using the Caprini risk assessment model (2009 edition). Prophylactic measures, as well as diagnosis and treatment of PE were also recorded if performed.

All medical records and autopsy reports were manually examined by the same well-trained clinician. The identities of the dead patients were protected using code numbers.

### 3 Results

During the study period, there were a total of 34,424 inpatient admissions to the West Branch of the Chinese PLA General Hospital, and there were 1057 (3.07%) deaths of which 278 (26.3%) underwent autopsy. Details of the yearly admissions, deaths and autopsies in the studied hospital are given in Table 1. Of the patients who underwent autopsy, nine patients were shown to have PE (3.2% of all autopsies) and in seven patients (2.5% of all autopsies), the PE was considered to be fatal. Details regarding the age and sex of the patients studied are provided in Table 2.

Emboli were found in the trunk and bilateral main branches of the pulmonary artery tree in all seven fatal PE cases. Of note, right intracardiac thrombosis (IT) was detected in five of the nine PE patients and in none of the other 269 patients at autopsy. Table 3 shows the detailed demographic characteristics, autopsy findings, and Caprini scores of the patients with PE.

#### Table 1. Details of the age and sex of the patients studied.

| Year | Admissions | Deaths | Autopsies | Death rate (%) | Autopsy rate (%) |
|------|------------|--------|-----------|----------------|-----------------|
| 2006 | 2564       | 75     | 19        | 2.93%          | 25.33%          |
| 2007 | 2845       | 105    | 30        | 3.69%          | 28.57%          |
| 2008 | 2608       | 88     | 26        | 3.37%          | 29.55%          |
| 2009 | 3659       | 74     | 22        | 2.02%          | 29.73%          |
| 2010 | 3744       | 96     | 35        | 2.56%          | 36.46%          |
| 2011 | 3816       | 117    | 32        | 3.07%          | 27.35%          |
| 2012 | 3820       | 109    | 18        | 2.85%          | 16.51%          |
| 2013 | 3688       | 135    | 29        | 3.66%          | 21.48%          |
| 2014 | 3995       | 141    | 37        | 3.53%          | 26.24%          |
| 2015 | 3685       | 117    | 30        | 3.18%          | 25.64%          |
| Total| 34,424     | 1057   | 278       | 3.07%          | 26.30%          |

#### Table 2. Details of the age and sex of the patients studied.

|                           | Total number | Male   | Female  | Mean age (Range) | Number of patients aged < 60 yrs | Number of patients aged 60–79 yrs | Number of patients aged ≥ 80 yrs |
|---------------------------|--------------|--------|---------|------------------|----------------------------------|-----------------------------------|----------------------------------|
| Patients who died         | 1057         | 993 (93.9%) | 64 (6.1%) | 86.15 (44–101)   | 15 (1.4%)                        | 121 (11.5%)                        | 921 (87.1%)                      |
| Patients at autopsy       | 278          | 253 (91.0%) | 25 (9.0%) | 87.34 (44–100)   | 3 (1.1%)                         | 20 (7.2%)                         | 255 (91.7%)                      |
| Patients with PE         | 9            | 7 (77.8%)   | 2 (22.2%) | 89.00 (76–99)    | 0                                | 1 (11.1%)                         | 8 (88.9%)                        |

Data are presented as n (%), or otherwise indicated. PE: pulmonary embolism.

#### Table 3. Details of the demographic characteristics, autopsy findings, and Caprini scores of PE patients.

| Code number | Sex  | Age (yrs) | PE category | PE position                        | IT    | Caprini score |
|-------------|------|-----------|-------------|-----------------------------------|-------|---------------|
| 1           | Male | 89        | Fatal       | Trunk and bilateral main branches | No    | 13            |
| 2           | Male | 91        | Fatal       | Trunk and bilateral main branches | Yes   | 11            |
| 3           | Male | 83        | Fatal       | Trunk and bilateral main branches | No    | 11            |
| 4           | Male | 76        | Fatal       | Trunk and bilateral main branches | Yes   | 12            |
| 5           | Male | 90        | Fatal       | Trunk and bilateral main branches | Yes   | 14            |
| 6           | Female | 91    | Fatal       | Trunk and bilateral main branches | Yes   | 15            |
| 7           | Female | 99       | Fatal       | Trunk and bilateral main branches | No    | 11            |
| 8           | Male | 91        | Incidental  | Distal branches in right artery tree | No    | 11            |
| 9           | Male | 91        | Incidental  | Distal branches in left artery tree | Yes   | 9             |

IT: intracardiac thrombosis; PE: pulmonary embolism.
Table 4. Associated illnesses and risk factors of PE patients collected according to Caprini scale.

| Associated illnesses and risk factors | Represented points | Positive/Total number |
|-------------------------------------|--------------------|-----------------------|
| Age over 75 years                   | 3                  | 9/9                   |
| Patient confined to bed (> 72 h)    | 2                  | 9/9                   |
| Serious lung disease (< 1 month)    | 1                  | 9/9                   |
| Central venous access               | 2                  | 7/9                   |
| Abnormal pulmonary function (COPD)  | 1                  | 6/9                   |
| Swollen legs (current)              | 1                  | 5/9                   |
| Malignancy (present or previous)    | 2                  | 4/9                   |
| Congestive heart failure (< 1 month)| 1                  | 4/9                   |
| Acute myocardial infarction         | 1                  | 3/9                   |
| Sepsis (< 1 month)                  | 1                  | 1/9                   |
| Laparoscopic surgery (> 45 min)     | 2                  | 1/9                   |
| Hip, pelvis, or leg fracture (< 1 month) | 5                | 1/9                   |
| HIT                                 | 3                  | 1/9                   |

COPD: chronic obstructive pulmonary disease; HIT: heparin-induced thrombocytopenia; IT: intracardiac thrombosis; PE: pulmonary embolism.

The Caprini scores were extremely high in all of the PE patients at autopsy (11.9 on average, range 9–15). The top three most common risk factors were advanced age, immobility, and serious lung disease. All patients with PE had been hospitalized in medical departments, and only one had undergone surgery during hospitalization. The associated illnesses and risk factors of PE patients collected according to the Caprini scale are listed in Table 4.

Among patients with PE, all seven patients with fatal cases had antemortem complaints of dyspnea, while this symptom was not reported in either of the two incidental cases. In addition, there were three cases of asymmetric edema of the lower limbs; one case of emphysema, and one case of chest pain noted in the medical records. All patients had shown positive D-dimer test results, while only two had undergone compressed ultrasound examination of the lower extremity veins, which had negative findings. No other measures had been taken for the further diagnosis of potential PE. Only two patients were given low-molecular-weight heparin for prophylaxis, while three patients had contraindications to anticoagulation. Only one patient had clinically suspected PE before death and none had received a clinical diagnosis of PE before autopsy. Since no clinical diagnosis of PE had been made in any case, the assessment of further treatment seemed to be out of the question.

4 Discussions

Postmortem examination was suggested to all the deaths in the study hospital, but whether or not it would be done finally depends on the will of patients’ family members. The autopsy rate of this study is 26.3% while previously published studies regarding the prevalence of PE ranged from 18% to 84%.[7–9,15–19] However, we believe that the patients at autopsy can be relatively representative since the demographic features of autopsied and not autopsied groups were quite comparable.

In our study, the most notable characteristics of patients at autopsy were very old age and multiple medical conditions; according to the death certificates many died of malignancy (106 cases; 38.1% of all autopsies). It is assumed that such a population might have a relatively higher incidence of PE.[5,14,20,21] Interestingly, data from this study show that only 3.2% of all patients were found to have PE at autopsy. Moreover, PE accounts for only 2.5% of deaths in the studied patients, a rate considerably lower than the former widely quoted figure of 10%.[7,9,22] This result strongly indicates that the effect of race might play an important role in the incidence of PE, as some other studies had previously mentioned.[23–25] The incidence of PE found at autopsy varies not only among different races but also among different regions. A population-based study from Sweden reported that PE was found in 22.9% of 23,796 autopsy cases for the years 1970–1982,[17] while studies from other Western countries have reported that the incidence of PE found at autopsy ranged from 8.3% to 14.6%.[7,8,13] The proportion of deaths caused by PE also varied considerably according to previously published autopsy studies from different regions, ranging from 2% to 18.4%.[17–13,18,19,26] It has also been reported that the incidence of fatal PE found at autopsy shows a declining trend. In England, for instance, Sandler, et al.[7] reported a 10% prevalence at autopsy of PE as the cause of death for the years 1979–1983. Another study reported that fatal PE was found in 3.9% of autopsies in a London hospital during the period 1991 to 2000.[19] Furthermore, Kopcke, et al.[28] found that PE was responsible for only 2% of hospital deaths from 2007 to 2008. These changing figures are believed to be a consequence of improved clinical practices in recent years, including prophylactic anticoagulation and early mobilization. Considering the varied incidence of and death rate associated with PE in different races, regions, and time periods reported by previous studies, we believe that more specific and up-to-date epidemiological data are persistently needed.

Right IT, a potential cause of PE, was detected in five of the nine PE patients and in none of the other 269 patients at autopsy in our study. This finding demonstrates a strong connection between right IT and PE in the population studied. Ogren, et al.[17] reported that right IT was found in 6.5% of PE cases at autopsy, while our study found that more than
half of patients with PE at autopsy also had right IT. In fact, the prevalence of PE in patients with right IT was 100% in our study. Differences in the prevalence of PE combined with right IT may also be explained by the effect of race. Clinicians, particularly in China, should pay careful attention to the different sources of pulmonary emboli.

Prophylactic anticoagulants were rarely used despite the very high risk for thrombosis assessed by the Caprini scale, partly because contraindications were relatively common in the study patients (33.3%). The diagnosis of PE continues to be challenging. In the current study, the diagnosis of PE was suspected in only one of nine PE cases (11.1%), and no cases were confirmed before autopsy. There were extra difficulties related to the diagnosis of PE in the study hospital; multiple comorbidities might cause confounding of the signs and symptoms of PE with other diseases, while serious immobility made further examinations such as CT pulmonary angiography and pulmonary artery angiography unfeasible. However, such a low rate of diagnosis is still unacceptable. More active prophylaxis, diagnosis, and treatment should be achieved, since PE has long been proven to be both preventable and treatable.

There are clear limitations in our study. First, the sample size was relatively small for an autopsy study, mainly because postmortem examination is not well accepted in this country. The limited sample size decreased the reliability of the results and restricted further analysis stratified by gender, department, and disease category. Furthermore, the autopsy rate was not high enough, which may have led to a selection bias. The autopsy protocol was not specially designed for the diagnosis of PE, which may have underestimated the incidence of PE. Finally, the target population mainly included very elderly male patients, which cannot represent the general population of hospitalized patients nationwide.

Our study adds to the evidence that the incidence of and death rate associated with PE may vary among different races and regions. Continuous monitoring of PE by means of necropsy in certain representative medical institutions is necessary. Still, more efforts should be exerted to ease the potential harm from this condition.

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