

The Acute Presentation of Pulmonary Thromboembolism: A Retrospective Viewpoint

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Abstract

Introduction: Acute pulmonary thromboembolism (PE) has been considered rare among Asians. We aim to describe the frequency and clinical features of this condition in a hospital in Singapore. Among patients admitted by the Emergency Department (ED), comparisons were made between those primarily diagnosed in the ED and those who were not. **Materials and Methods:** Retrospective review of all cases of radiologically proven acute PE over a 20-month period. **Results:** Sixty-two patients were identified. The mean age was 61.5 ± 18.0 years with a female to male ratio of 1.8:1. There were more Malays compared to other races. There were also more Caucasians, given the proximity of the hospital to the airport and the inclusion of tourists. The commonest symptoms were dyspnoea and chest pain, while the commonest signs were tachycardia and tachypnoea. Prolonged immobilisation was the commonest risk factor. Electrocardiographic $S_1Q_3T_3$ pattern was seen in more patients compared to Western studies. Cardiomegaly was the commonest chest X-ray finding. Thirty-two patients were identified to have a source of embolisation. Overall mortality rate was 21%. The ED diagnosed 36% of the cases. Alternative admitting diagnoses were predominantly ischaemic heart disease and pneumonia. The group diagnosed in the ED were notably female ($P = 0.044$), Caucasian ($P = 0.002$) and had prolonged immobilisation ($P = 0.025$) prior to the onset of PE. **Conclusion:** Acute PE is not as rare here as previously thought. Clinical features reveal more similarities than differences compared to other studies in the literature. We advocate a high index of suspicion for earlier diagnosis in the ED.

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Key words: Asians, Clinical presentation, Emergency department, Pulmonary embolism

Introduction

Pulmonary thromboembolism (PE) has historically been considered a rarity in the Asian population.^{1,2} Although well studied in the West, Asian literature on this condition has been sporadic. A search for local literature revealed predominantly case reports and autopsy studies.³⁻⁶ In 1995, the necropsy prevalence of PE in Singapore was found to be 1.05%⁶ compared to 0.08% cited by Hwang¹ in 1968. Most antemortem clinical studies on the Asian population had focused on deep vein thrombosis (DVT) with acute PE mentioned as a complication of the former.⁷⁻¹³ A recent large multicentre study in Japan on acute PE showed that the clinical characteristics of Japanese patients were almost similar to those in Western populations.¹⁴

We describe our experience with acute PE in a local hospital and assess the characteristics of the patients with

this disease, comparing them to those of patients in local, regional and Western literature. We also compare patients who were diagnosed correctly in the Emergency Department (ED) with those in whom the diagnosis was missed in the ED, in a bid to identify factors that may have led to a missed diagnosis.

Materials and Methods

This was a retrospective, descriptive study conducted in Changi General Hospital. The hospital is a regional centre serving the eastern and northeastern parts of Singapore. It does not have an obstetric and gynaecological or a paediatric department. It is also the hospital nearest to Changi International Airport, the main commercial airport serving the whole country.

All records of cases with a principal or secondary discharge

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diagnosis of acute PE over a 20-month period between October 1998 and May 2000 were reviewed retrospectively. The cases were identified by a computer search using the International Classification of Disease 9th Revision-Clinical Modification (ICD-9-CM) diagnosis code of 415.1. Only those with the diagnosis confirmed radiologically were included. Clinical features, previously identified in the literature to be associated with the diagnosis of acute PE, were extracted from the records. These included demographics, presenting symptoms and signs, risk factors for thromboembolic disease, chest X-rays (CXRs), electrocardiograms (ECGs), arterial blood gases (ABGs), presence of DVT or other source of emboli. Mortality was also recorded.

Symptoms and signs that were studied were those documented at the time of the acute presentation that suggested the possibility of PE and prompted further investigation. For the group of patients admitted by the ED, they were taken as those at ED presentation, regardless of whether the diagnosis of PE was made at the ED. The frequency of each symptom and sign referred to the percentage of patients who had the symptom or sign relative to the number of patients for whom the information was recorded.

Tests for protein S, protein C and antithrombin III deficiencies and for autoimmune diseases were subjected to the varying clinical practice of the attending physicians in charge of the cases in the ward. CXRs were interpreted by a radiologist who was not blinded to the patients' diagnoses. ECGs and ABGs selected for interpretation were those done closest in time prior to when the diagnosis was made.

Oxygen therapy during the time when ABG was sampled was not standardised as the study was retrospective and treatment varied with individual practice. Alveolar-arterial (A-a) gradients were calculated based on the formula $[(\text{FiO}_2 \times 713) - 1.2 (\text{PaCO}_2)] - \text{PaO}_2$, where FiO_2 equals concentration of oxygen inspired, PaCO_2 and PaO_2 equal partial pressures of carbon dioxide and oxygen in arterial blood, respectively. These were interpreted according to patient's age using normal as less than age/4 plus 4 mm Hg.¹⁵

Patients admitted by the ED with acute presentation of the disease were further sub-divided into those who were primarily diagnosed by the ED and those who were subsequently diagnosed in the ward after being admitted with an alternative diagnosis. Comparisons were made between the clinical variables of the patients in each group. Tests of significance of categorical variables were conducted using Pearson's chi-square or Fisher's exact tests, where appropriate. Continuous variables were compared using Mann-Whitney U test. A non-parametric

test was chosen as no assumptions of normality were made of the small sample size. A *P* value of less than 0.05 was considered statistically significant. Variables in which there were missing data due to inadequate documentation were not used in the calculation. Variables studied were demographics, presence of dyspnoea, chest pain, crepitations on lung auscultation, presence of heart rate of 100 per minute or higher, respiratory rate of higher than 20 per minute, temperature of 37.5°C or higher, systolic blood pressure of 90 mm Hg or lower, risk factors of prolonged immobilisation, previous PE/DVT, recent surgery, malignancy, ECG features, prior cardiopulmonary diseases (including ischaemic heart disease, heart failure and chronic lung diseases) and mortality rates.

Results

During the 20-month period of the study, there were 59,000 admissions to the hospital. A total of 63 cases of acute PE were identified retrospectively. One case was excluded from analysis as the patient died before radiological confirmation. Sixty-two cases were included, yielding a frequency rate of 1.05 per 1000 admissions. With the exclusion of tourists, the frequency rate was 0.92 per 1000 admissions. The ED admitted 42 cases for acute presentation of the disease. The remaining 20 were diagnosed as a secondary disease entity while the patients were in the hospital for other reasons. Among these, 9 cases developed acute PE after operative procedures.

Mode of Radiological Diagnosis

Sixty-one helical computed tomogram (CT) pulmonary angiograms were done. Three negative and one equivocal CT scan findings were eventually confirmed by high probability ventilation/perfusion (V/Q) scans. One patient was diagnosed solely by a high probability V/Q scan while another had both CT and V/Q scans. No invasive pulmonary angiogram was performed.

Demographics

The mean age was 61.5 years [standard deviation (SD) = 18; range, 24 to 92 years]. 59.7% were aged 60 and above. 64.5% were female, giving a female to male ratio of 1.8:1. There were 48.4% Chinese, 30.6% Malays, 4.8% Indians/Sikhs and 16.1% Caucasians. Out of the 10 Caucasians, 8 were tourists who arrived by air and brought directly to the hospital from the airport for being ill, while the rest were Singapore residents.

Presenting Symptoms and Signs

Two cases were excluded from the analysis of some of the presenting symptoms, i.e. chest pain, dyspnoea, palpitation, cough and syncope, because the patients were intubated and too ill to give a history at the time of

onset of acute PE.

The presenting symptoms are summarised in Table I. The two commonest presenting symptoms were dyspnoea (70.0%) and chest pain (46.7%). 39.3% of chest pain were pleuritic in nature, while 28.6% were non-pleuritic. The nature of the chest pain was not mentioned in 32.1%. A combination of dyspnoea and chest pain occurred in 40.0%, while 23.3% presented with neither.

Table II summarises the presenting signs. The mean heart rate was 102 beats per minute (SD = 20), while the mean respiratory rate was 24 breaths per minute (SD = 6). Thirty-one percent of patients with dyspnoea did not have tachypnoea. Respiratory rates were not taken into consideration for 2 patients as they were intubated and mechanically ventilated at the time of assessment. The mean systolic blood pressure was 124 mm Hg (SD = 21) and the mean diastolic blood pressure was 74 mm Hg (SD = 15).

Risk Factors

The risk factors studied and their occurrences are shown in Table III. Prolonged immobilisation was the commonest risk factor. The reasons for immobilisation included long-range travel (9 patients), postoperative bed-rest (9 patients), stroke (4 patients) and concurrent illness (4 patients). Four

patients had also been immobilised for at least a year for reasons other than stroke. Length of travel averaged 10.3 hours (SD = 3.4; range, 5 to 15 hours). All patients travelled by air except one who travelled by bus. The air travellers were all Caucasians while the bus passenger was Chinese.

Five out of 9 operations were for orthopaedic procedures, involving the lower limbs, while the rest were abdominal and pelvic procedures.

Protein C and S levels were determined in 17 (27.4%) patients, while antithrombin III level in 13 (21.0%). Four of those patients who were not tested were below the age of 40. Of those who were tested, 2 were tested while they were on heparin, which may give rise to falsely low levels. None of these tests were repeated during follow-up of the patients.

The 6 patients with autoimmune diseases included a known case of rheumatoid arthritis, a case of systemic lupus erythematosus and a case of primary antiphospholipid syndrome; the latter 2 cases were diagnosed concurrently with the diagnosis of PE. One patient tested positive for rheumatoid factor, one for anticardiolipin antibody and one for both antinuclear and antiphospholipid antibodies.

No patient had nephrotic syndrome or myeloproliferative diseases.

Obesity was not analysed as a risk factor because this information, as well as height and weight, were not captured in most patients. For 12 patients who were documented as "obese", we did not have objective evidence like body mass index to verify its presence.

Chest X-rays

CXRs were done for all except 2 patients. One X-ray was not retrievable from the medical records office, giving a total of 59 X-rays read. Thirteen (22%) were normal. The X-ray features of PE and their frequency of occurrence are shown in Table IV.

TABLE I: PRESENTING SYMPTOMS (ALL CASES)

Symptom	Present	Absent	Total	%	Missing data
Dyspnoea	42	18	60	70.0	2*
Chest pain	28	32	60	46.7	2*
Cough	12	26	38	31.6	22*
Syncope	10	36	46	21.7	14*
Haemoptysis	4	18	22	18.2	40
Palpitation	1	17	18	5.6	42*

* inclusive of 2 patients who were intubated and sedated

TABLE II: PRESENTING SIGNS (ALL CASES)

Sign	Present	Absent	Total	%	Missing data
Heart rate ≥ 100 beats/min	38	24	62	61.3	0
Respiratory rate > 20 breaths/min	33	27	60	55.0	2*
Temperature $\geq 37.5^\circ\text{C}$	11	51	62	17.7	0
Systolic blood pressure ≤ 90 mm Hg	5	57	62	8.1	0
Diaphoresis	15	21	36	41.7	26
Neck vein distension	13	29	42	31.0	20
Crepitations	18	41	59	30.5	3
Loud second heart sound	7	26	33	21.2	29
Wheezing	8	50	58	13.8	4
Decreased breath sounds	7	49	56	12.5	6
Cardiac murmur	6	51	57	10.5	5
Pleural rub	1	40	41	2.4	21

* unable to assess for 2 patients because intubated and sedated

TABLE III: RISK FACTORS FOR THROMBOEMBOLIC DISEASE (ALL CASES)

Risk factor	Present	Absent	Total	%	Missing data
Prolonged immobilisation	30	32	62	48.4	0
Recent surgery	9	53	62	14.5	0
Malignancy	6	56	62	9.7	0
Varicose veins	12	36	48	25.0	14
Heart failure	10	52	62	16.1	0
Atrial fibrillation	7	55	62	11.3	0
Chronic lung disease	3	59	62	4.8	0
Previous PE	2	60	62	3.2	0
Previous DVT	2	60	62	3.2	0
Postpartum	1	39	40	2.5	22*
Oestrogen therapy	3	17	20	15.0	42*
Autoimmune disease	6	19	25	24.0	37
Protein C deficiency	6	11	17	35.3	45
Protein S deficiency	3	14	17	17.6	45
Antithrombin III deficiency	2	11	13	15.4	49

DVT: deep vein thrombosis; PE: pulmonary thromboembolism

* risk factors only applicable to females

TABLE IV: CHEST X-RAY FEATURES (n = 59)

Feature	Present	Absent	Total	%
Cardiomegaly	26	32	58*	44.8
Consolidation	20	39	59	33.9
Pleural effusion	16	43	59	27.1
Atelectasis	15	44	59	25.4
Dilated main pulmonary arteries	8	51	59	13.6
Pulmonary oedema	4	54	58*	6.9
Elevated hemidiaphragm	3	56	59	5.1
Oligaemic lung field	3	56	59	5.1
Pleural opacity	1	57	58*	1.7
Hampton's hump	1	58	59	1.7
Westermarck sign	0	59	59	0

* unable to assess these features for one patient because of presence of large pleural effusion

Electrocardiograms

ECGs were done for all patients. Only 1 (1.6%) ECG was normal. The various ECG abnormalities in the remainder are highlighted in Table V. Among them, sinus tachycardia, $S_1Q_3T_3$ pattern and T wave inversions in leads V_1 and V_2 were the commonest findings. Other ECG features included atrial fibrillation (6 patients), T inversion in V_3 (3 patients) and ventricular bigeminy (1 patient).

Arterial Blood Gases

ABG was sampled in 59 patients. Three refused testing. Overall, the pCO_2 was 32.0 mm Hg (SD = 8.1). Of the 26 samples taken while the patients were breathing room air, the mean pO_2 was 76.0 mm Hg (SD = 20.2), the mean pCO_2 was 33.0 mm Hg (SD = 7.4) and 4 patients were found to have hypoxaemia ($pO_2 < 60$ mm Hg). Mean pO_2 was not calculated for the other 33 patients because they were on varying amounts of supplemental oxygen. Eight patients were found to have normal A-a gradients. All 8 patients

TABLE V: ELECTROCARDIOGRAM FEATURES (n = 62)

Feature	Present	Absent	%
Sinus tachycardia	29	33	46.8
$S_1Q_3T_3$ pattern	26	36	41.9
T inversions in V_1 and V_2	21	41	33.9
Left axis deviation	14	48	22.6
Right bundle branch block	12	50	19.4
Non-specific ST-T changes	11	51	17.7
Right axis deviation	10	52	16.1
ST depression	9	53	14.5
Peaked P wave	3	59	4.8

were sampled on room air, where the FiO_2 was known with certainty.

Source of Embolisation

Fifty patients were investigated for a source of embolisation. Doppler ultrasonography of the lower limbs was done in 47 patients and venogram in 1 patient. One ultrasonography report was not retrievable from the medical record office. Thirty patients were found to have lower limb DVT, out of which 27 were in proximal veins. Among the 17 patients with negative Doppler ultrasonography or venogram of the lower limbs, 10 were further investigated by CT abdomen/pelvis with one positive finding of thrombosis in the right femoral vein and inferior vena cava. One other patient had inferior vena caval thrombosis secondary to renal cell carcinoma. The thrombosis was detected incidentally when he underwent CT abdomen to assess an abdominal mass after his PE was diagnosed. A patient was diagnosed to have left axillary vein thrombosis based on clinical suspicion. He died before any investigation could be performed. The reasons why some of the patients did not undergo investigations to diagnose DVT included

early death, transfer of patients to another hospital, negative Doppler ultrasonography for DVT done 2 months prior to onset of PE and no consent in patients who opted for conservative management. In 2 patients, the diagnosis of DVT preceded that of PE. They were put on anticoagulation therapy for treatment of DVT 5 and 13 days, respectively, prior to the diagnosis of PE.

Mortality

The mortality rate was 21.0%. None of the mortality cases underwent autopsy.

Department of Initial Diagnosis

Of the patients admitted by the ED with acute presentation of the disease, 15 cases were suspected or confirmed in the ED, of whom 8 were Caucasians. The other 27 cases were unsuspected and were diagnosed in the wards after they were admitted with alternative diagnoses. Among these, ischaemic heart disease/angina pectoris (9/27) and heart failure (7/27) were the most common, followed by pneumonia (5/27). Comparison showed that among patients who were diagnosed correctly in the ED, there were predominantly females ($P = 0.044$), Caucasians ($P = 0.002$) and more patients who had a history of prolonged immobilisation prior to the onset of the disease ($P = 0.025$). In addition, fewer patients had crepitations in the lungs on auscultation ($P = 0.006$). No other significant differences were found between the two groups. Prior cardiopulmonary diseases were present in more patients in whom the diagnosis was missed in the ED although the difference was not statistically significant ($P = 0.068$).

Discussion

To our knowledge, this is the largest series of antemortem cases of PE described in Singapore, a country unique for its multi-ethnicity. Although the incidence of PE in this series is still relatively low compared to the 1% incidence quoted in the West,¹⁶ an average of 3.1 cases a month is by no means small.

The female to male ratio and proportion of patients aged 60 years and above were higher than that found in other local studies on PE and DVT.^{6,9} The proportions of females in the studies by Lau⁶ and Kueh⁹ were 62.9% and 56.4%, respectively. Patients aged 60 and above made up 48.3% of Lau's⁶ sample. Malays and Caucasians were over-represented in our study compared to the national population statistics as well as to the racial distribution within the districts which the hospital serves. Chinese and Indians were, on the other hand, under-represented. This is contrary to the study by Lau⁶ who found that the overall proportion of Chinese corresponded more or less to that of the local population, while Malays and Indians were under- and over-represented, respectively. The preponderance of

Caucasians in our study may be explained by the inclusion of 8 tourists who presented with acute PE after air travel. The Chinese patient who presented after travelling 8 hours by bus was later found to have protein S deficiency. He had a past history of mesenteric venous thrombosis but had not been on long-term anticoagulation therapy.

Our patients did not appear to present differently from most Western patients,¹⁷⁻²¹ with dyspnoea and chest pain being the most common complaints. However, the frequencies of these complaints were higher in other series compared to ours, ranging from 74% to 92% for dyspnoea and 49% to 74% for chest pain. Manganelli et al¹⁹ found that physical findings which were significantly more common in patients with PE included fever less than 38°C, hypotension, neck vein distension, loud second heart sound and respiratory rates (RR) more than or equal to 25 breaths per minute. Fever and hypotension were present in only a relatively small proportion of our patients, while tachycardia and tachypnoea (RR more than 20 breaths per minute) made up more than 50%.

Our percentage of patients with normal CXR (22%) was similar to that found by Elliot et al²¹ (24%) but higher compared to patients in the PIOPED (Prospective Investigation of Pulmonary Embolism Diagnosis) study²² (8%). A sub-study of PIOPED²³ showed that the combination of dyspnoea and hypoxia in patients with normal CXR was a useful clue to the diagnosis of PE. CXR features in our patients were non-specific, with cardiomegaly being the most common feature, similar to the study by Elliot et al.²¹ However, $S_1Q_3T_3$ pattern was our second most common ECG feature, after sinus tachycardia. While the latter has been described as a common ECG feature in acute PE,¹⁹ $S_1Q_3T_3$ pattern occurred more often in our series than other.^{17,19} Manganelli et al¹⁹ found $S_1Q_3T_3$ pattern in only 15% of their patients. Stein et al¹⁷ studied patients with no prior cardiopulmonary diseases and found that a normal ECG was uncommon in acute PE while right bundle branch block, $S_1Q_3T_3$ pattern or "p" pulmonale occurred in approximately one-third of patients. Left axis deviation (LAD) was found as frequently as right axis deviation (RAD) and therefore could not exclude the diagnosis. In this study, we found that LAD occurred more frequently than RAD. A point to note is that some patients in our study had underlying conditions like ischaemic heart disease, heart failure and pneumonia, which could have potentially confounded the CXR and ECG findings. Because the study was retrospective, we could not determine when and how blood for ABG should be sampled. With patients on varying levels of supplemental oxygen, there might be potential inaccuracy in the calculations of the A-a gradients, although our formula was based on FiO_2 at sea level. We thus have a wide spread of values of A-a gradients among our patients. Nevertheless, all 8 patients with normal A-a

gradients had ABG sampled on room air. The normal A-a gradient increases with age, which is the reason why we took “normal” as age/4 plus 4 mm Hg. A study which evaluated 3 definitions of normal A-a gradient, namely 1) value less than or equals to 20 mm Hg; 2) value less than or equals to age/4 plus 4; and 3) value based on age from the literature, found that the A-a gradient did not distinguish patients with acute PE from patients without PE, irrespective of how normal was defined.²⁴

In all, investigations like ECG, ABG and CXR were non-specific, especially in patients with presence of co-morbidity that could provide an alternative explanation for the abnormalities in these tests. Other studies also did not find these tests to be of sufficient discriminating value to exclude the diagnosis of PE.^{20,25}

Although we have only 9 postoperative PE patients compared to the large number of operations carried out during the period of the study, we feel that this was a potentially avoidable complication. Ho et al¹² found that 3% of Asian patients who underwent colorectal surgery developed DVT without prophylaxis compared to 0% who received enoxaparin, a low molecular weight heparin ($P = 0.045$). More than half of the patients who developed DVT went on to have PE, with 1 fatality. These authors therefore suggested routine DVT prophylaxis in Asian patients undergoing major colorectal surgery. Fong et al²⁶ found that the use of low molecular weight heparin for thromboprophylaxis in total knee arthroplasty in Asians appeared to reduce the incidence of DVT without major bleeding complications.

Close to half of our patients were immobilised prior to the onset of PE, a figure similar to that found by Lau⁶ and Kueh et al.⁹ This percentage is slightly more than the 28% to 35% quoted in Western studies.^{20,21} Risk factors like protein S, C and antithrombin III deficiencies and the presence of autoimmune disease or malignancy may not be evident initially until subsequent investigations. Only a small percentage of patients in our study had tests done to detect protein S, C and antithrombin III deficiencies. We are therefore unable to comment on the frequency of these risk factors among our patients. However, Kueh et al,⁹ albeit with only 39 patients in the study, reported that protein S and C deficiencies were primarily found in patients below the age of 40 years and recommended that these tests be done only for patients below this age. Patients below age 40 years made up only 9% of patients for whom the tests were not done. Therefore, we estimate that it is unlikely that there will be very many more cases of protein S, C and antithrombin deficiencies detected had the tests been performed for all our patients.

Not surprisingly, DVT was the main source of emboli in most of our patients. Investigation for DVT was largely

performed after PE was diagnosed or suspected. One study found that 82% of patients with acute PE still had detectable residual DVT, and that DVT was asymptomatic in nearly two-thirds of these patients.²⁷ This underlines the importance of screening for DVT routinely in patients in whom the diagnosis of acute PE is made.

Signs and symptoms of acute PE are often absent or non-specific,¹⁸ and may be equally well explained by alternative diagnoses. Our most common alternative diagnoses were ischaemic heart disease and heart failure. Paradoxically, heart failure and chronic lung diseases, while obscuring early diagnosis, are themselves risk factors for the development of pulmonary embolus. The reason we made a comparison between patients who were diagnosed and those in whom the diagnosis was missed in the ED was because, though elusive, early diagnosis would allow early treatment and appropriate disposition of the patient to a facility where they could be closely monitored. The design of our study did not permit further analysis of other possible reasons for missed diagnosis in the ED.

This study is subject to the limitations of retrospective studies, including dependence on the quality of medical record documentation and lack of standardised definitions for clinical findings. In addition, due to lack of blinding, CXR and ECG were subject to over-interpretation by hindsight. Nevertheless, because PE is a relatively uncommon condition locally, prospective data will be difficult to collect.

The main radiological method used for diagnosis of PE was helical CT pulmonary angiogram. Although not the gold standard, helical CT pulmonary angiogram has been shown to be a reliable imaging tool for excluding clinically important PE, with a negative predictive value of up to 99%, similar to that of a negative or low probability V/Q scan.^{28,29} In any case, as we are only studying patients with a positive diagnosis of PE, we feel that the lack of sensitivity of helical CT pulmonary angiogram for sub-segmental emboli would unlikely have adversely affected our results.

Another limitation is that this study did not include patients with acute PE unsuspected antemortem but diagnosed at autopsy.

Conclusion

Acute PE is not as common locally as it is in the West but we found a substantial caseload of patients. Comparison with foreign and local literature revealed more similarities than differences in the clinical features of these patients. Due to the poor sensitivity and specificity of most of the clinical, instrumental and laboratory findings, the optimal approach to the diagnosis of acute PE is still controversial. However, a strong index of suspicion is almost always recommended. It is not within the scope of this study to

suggest any means of making the diagnosis easier. Nevertheless, by highlighting the regular occurrence of a condition which has historically been thought to be rare in our local population, we hope PE may be considered more frequently in the differential diagnosis in relevant clinical settings. A special subgroup is the long-distance traveller. DVT/PE prophylaxis may also be considered for patients under certain circumstances.

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REFERENCES

- Hwang W S. The rarity of pulmonary thromboembolism in Asians. *Singapore Med J* 1968; 9:276-9.
- Tinckler L F. Absence of pulmonary embolism in Asians [correspondence]. *BMJ* 1964; i:502.
- Kam R M L, Tan A T H, Chee T S, Wong J. Massive acute pulmonary embolism in protein S deficiency—a case report. *Ann Acad Med Singapore* 1994; 23:396-9.
- Chen L H, Yeong C T, Yeo G S H. Three cases of fatal pulmonary embolism in obstetrics. *Ann Acad Med Singapore* 1997; 26:356-9.
- Teo C E S. A study of coroner's cases from hospitals: a comparison of autopsy and clinical diagnosis. *Ann Acad Med Singapore* 1993; 22:3-7.
- Lau G. Pulmonary thromboembolism is not uncommon—results and implications of a five-year study of 116 necropsies. *Ann Acad Med Singapore* 1995; 24:356-65.
- Inada K, Shirai N, Hayashi M, Matsumoto K, Hirose M. Postoperative deep vein thrombosis in Japan: incidence and prophylaxis. *Am J Surg* 1983; 145:775-9.
- Woo K S, Mak G Y K, Sun J J, Woo J L F, Metreweli C, Vallance-Owen J. The incidence and clinical pattern of deep vein thrombosis in the Chinese in Hong Kong. *Singapore Med J* 1988; 29:357-9.
- Kueh Y K, Wang T L, Teo C P, Tan Y O. Acute deep vein thrombosis in hospital practice. *Ann Acad Med Singapore* 1992; 21:345-8.
- Kum C K, Sim E K W, Ngoi S S. Deep vein thrombosis complicating colorectal surgery in the Chinese in Singapore. *Ann Acad Med Singapore* 1993; 22:895-7.
- Dhillon K S, Askandar A, Doraisamy S. Postoperative deep vein thrombosis in Asian patients is not a rarity: a prospective study of 88 patients with no prophylaxis. *J Bone Joint Surg* 1996; 78B:427-30.
- Ho Y H, Seow-Choen F, Leong A, Eu K W, Nyam D, Teoh M K. Randomized, controlled trial of low molecular weight heparin versus no deep vein thrombosis prophylaxis for major colon and rectal surgery in Asian patients. *Dis Colon Rectum* 1999; 42:196-202.
- Ruban P, Yeo S J, Seow K H, Tan S K, Ng S C K. Deep vein thrombosis after total knee replacement. *Ann Acad Med Singapore* 2000; 29:428-33.
- Nakamura M, Fujioka H, Yamada N, Sakuma M, Okada O, Nakanishi N, et al. Clinical characteristics of acute pulmonary thromboembolism in Japan: results of a multicenter registry in the Japanese Society of Pulmonary Embolism Research. *Clin Cardiol* 2001; 24:132-8.
- Hockberger R S. Pulmonary embolism. In: Tintinalli J E, Ruiz E, Krome R L, editors. *Emergency Medicine: A Comprehensive Study Guide*. 4th ed. New York: McGraw-Hill, 1996:370-4.
- Stein P D, Henry J W. Prevalence of acute pulmonary embolism among patients in a general hospital and at autopsy. *Chest* 1995; 108:978-81.
- Stein P D, Willis P W, DeMets D L. History and physical examination in acute pulmonary embolism in patients without preexisting cardiac and pulmonary disease. *Am J Cardiol* 1981; 47:218-23.
- Hoellerich V L, Wigton R S. Diagnosing pulmonary embolism using clinical findings. *Arch Intern Med* 1986; 146:1699-704.
- Manganelli D, Palla A, Donnamaria V, Giuntini C. Clinical features of pulmonary embolism: doubts and certainties. *Chest* 1995; 107(1 Suppl):25S-32S.
- Susac Jr O, Boudrow D, Kline J A. The clinical features of acute pulmonary embolism in ambulatory patients. *Acad Emerg Med* 1997; 4:891-7.
- Elliot C G, Goldhaber S Z, Visani L, DeRosa M. Chest radiographs in acute pulmonary embolism: results from the International Cooperative Pulmonary Embolism Registry. *Chest* 2000; 118:33-8.
- The PIOPED Investigators. Value of the ventilation/perfusion scan in acute pulmonary embolism: results of the Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED). *JAMA* 1990; 263:2753-9.
- Stein P D, Alavi A, Gottshalk A, Hales C A, Saltzman H A, Vreim C E, et al. Usefulness of non-invasive diagnostic tools for diagnosis of acute pulmonary embolism in patients with a normal chest radiograph. *Am J Cardiol* 1991; 67:1117-20.
- Stein P D, Goldhaber S Z, Henry J W. Alveolar-arterial gradient in the assessment of acute pulmonary embolism. *Chest* 1995; 107:139-43.
- Stein P D, Goldhaber S Z, Henry J W, Miller A C. Arterial blood gas analysis in the assessment of suspected acute pulmonary embolism. *Chest* 1996; 109:78-81.
- Fong Y K, Ruban P, Yeo S J, Lee B P H, Lo N N, Seow K H, et al. Use of low molecular weight heparin for prevention of deep vein thrombosis in total knee arthroplasty—a study of its efficacy in an Asian population. *Ann Acad Med Singapore* 2000; 29:439-41.
- Girard P, Musset D, Parent F, Maitre S, Philippoteau C, Simonneau G. High prevalence of detectable deep vein thrombosis in patients with acute pulmonary embolism. *Chest* 1999; 116:903-8.
- Garg K, Sieler H, Welsh C H, Johnston R J, Russ P D. Clinical validity of helical CT being interpreted as negative for pulmonary embolism: implications for patient treatment. *AJR Am J Roentgenol* 1999; 172:1627-31.
- Goodman L R, Lipchik R J, Kuzo R S, Liu Y, McAuliffe T L, O'Brien D J. Subsequent pulmonary embolism: risk after a negative helical CT pulmonary angiogram—prospective comparison with scintigraphy. *Radiology* 2000; 215:535-42.