BJMS
Borneo Journal of Medical Sciences

ORIGINAL ARTICLE

A Single Centre Annual Audit on Computed Tomography Pulmonary Angiogram: Demographic, Clinical Scoring System, Patients' Outcome

Low Qin Jian[1], Teo Kuo Zhau[1], Mohd Nadzri Misni[2], Cheo Seng Wee[3]

[1] Department of Internal Medicine, Hospital Sultanah Nora Ismail, Batu Pahat, Johor, Malaysia
[2] Department of Radiology, Hospital Sultanah Nora Ismail, Batu Pahat, Johor, Malaysia
[3] Department of Internal Medicine, Hospital Lahad Datu, Lahad Datu, Sabah, Malaysia

*Corresponding author's email: lowqinjian@moh.gov.com

Received: 15 September 2019

Accepted: 20 March 2020

Keywords: audit, computed tomography pulmonary angiogram (CTPA), clinical scoring system, pulmonary embolism

ABSTRACT

Computed tomography pulmonary angiogram (CTPA) is widely used in the investigation of suspected pulmonary embolism. CTPA is not without adverse effects as it involves intravenous contrast injection and radiation exposure. The annual incidence of pulmonary embolism is 60 – 70 per 100,000 populations and CTPA remains the commonest imaging modality1. This study aims to audit all CTPA performed at Hospital Sultanah Nora Ismail, Batu Pahat, Johor for the entire year of 2018 to illustrate the demographic data, symptoms, risk factors, clinical scoring system applied and patients' outcome. A retrospective study was conducted to audit all CTPA performed between 1st January to 31st December 2018 via the radiology department electronic records and patients' records. There were a total of 60 CTPA performed in the entire year of 2018 with 16 positive and 44 negative scans. Among the 16 positive scans, 7 (44%) had a Wells score above 6, 6 (38%) had a Wells score between 2 – 6 and 3 (18%) had a Wells score less than 2. Out of the 16 positive scans, 4 (25%) were known malignancy and 1 was a known case of anti-phospholipid syndrome. All 60 patients had electrographs and arterial blood gases performed prior to CTPA. D dimer was performed in 15 cases (5%). Among the 16 positive scan patients, 4 (25%) passed away during the same admission directly or indirectly related to pulmonary embolism. This annual computed tomography audit report will assist clinicians in making better diagnostic decision when dealing with patients with suspected pulmonary embolism.

INTRODUCTION

Pulmonary embolism (PE) is commonly seen in our daily practice and can be life threatening and sometimes fatal[1]. The overall incidence of PE is approximately 112 cases per 100,000 populations. Early recognition of this potentially fatal disease is hence very important. Pulmonary embolism accounts for up to 6% of hospital death[1]. Pulmonary embolism is slightly more common in males than females and incidence increases with age. In Malaysia, the incidence of venous thromboembolism is on the rise due to an aging population, higher rates of complex surgery, high rates of caesarean section deliveries, rise in obesity and cancer cases, and a low rate of thromboprophylaxis[2, 4]. Pulmonary embolism is due to an obstruction of a pulmonary artery or one of its branches by any material such as a thrombus, tumour, air or fat that originated elsewhere in the body. Acquired factors such as immobilization, malignancy, infections, advancing age, heart disease, major surgery increase the risk of venous thromboembolism. The pathogenesis of pulmonary embolism was explained by Virchow as venous stasis, endothelial injury and hypercoagulability[4]. All risk factors for venous thromboembolism influence at least one of these three Virchow's criteria. Venous thrombi generated in venous pocket at sites of venous stasis or following vessel wall injury[1]. Wide variety of clinical manifestations of pulmonary embolism may impede early diagnosis of this disease[2, 4]. CTPA is widely accepted as one of the first line modalities to diagnose pulmonary embolism[4, 5]. Even though this imaging modality is widely available in Malaysia, clinical decision to subject a patient to this imaging is often difficult. CTPA exposes patients to radiation and intravenous contrast agents. Pre-test probability such as Wells score, Modified Wells score, or Modified Geneva score have been developed to assist busy clinicians to make important decision, however a significant percentage of patients are too unstable and unsafe to undergo this imaging. The aim of this study was to conduct an annual audit on all CTPA cases performed between 1st January 2018 and 31st December 2018 by assessing the patients' demographics, clinical scoring systems and outcome in Hospital Sultanah Nora Ismail, Batu Pahat, Johor, Malaysia.

MATERIALS AND METHODS

Study Design and Population

This is a single centre annual audit to evaluate all the CTPA performed in Hospital Sultanah Nora Ismail, Batu Pahat, Johor between 1st January 2018 and 31st December 2018. There were no missing data in this study. All data were collected from our radiology department records and patient's case notes. This audit was approved by the Malaysian Ministry of Health Institutional Review Board and Medical Research Ethics Committee. A standard questionnaire was used to record the demographic, venous thromboembolism risk factors, pulmonary embolism rule out rule (PERC rule) and Wells clinical scoring and patients' outcome.

Clinical scoring system

The pulmonary embolism rule out criteria (PERC rule) consists of eight criteria are age less than 50 years old, heart rate less than 100 beats per minute, oxyhaemoglobin saturation more than 95 per cent, no haemoptysis, no oestrogen use, no prior deep venous thrombosis or pulmonary embolism, no unilateral leg swelling and no surgery/trauma requiring hospitalization within the prior four weeks[2]. It is used to identify patients with low clinical probability of pulmonary embolism in whom the risk of a CTPA study outweighs the risk of pulmonary embolism[2]. This rule is valid in patients with a low clinical probability of pulmonary embolism (gestalt estimate less than fifteen percent). In patients with a low probability of pulmonary embolism who fulfil all eight criteria, the likelihood of pulmonary embolism is low, and no further testing is required.

The Wells score for pulmonary embolism consists of physical findings suggestive of deep vein thrombosis, no alternative diagnosis to explain the illness, tachycardia with pulse more than 100 beats per minute, immobilization for more than 3 days or surgery in the previous four weeks, prior history of DVT or PE, presence of haemoptysis and presence of malignancy. In the Wells risk score interpretation, a score of more than 6 indicates high probability, score of 2-6 indicates moderate probability while a score of less than 2 indicates low pulmonary embolism probability[4].

Statistical Analysis

Descriptive analysis was presented as counts and percentages for categorial variables. The distribution of data was conducted using Fisher's exact test. Statistical significance was set at p-value < 0.05. Data analysis was done via statistical package for social science (SPSS). (version 25; SPSS Inc., Chicago, IL. United States of America).

RESULTS

Table 1 shows the demographic and clinical characteristic of the 60 subjects. There were no significant association between the different demographic variables and CTPA outcome. The average mean age of patients with no pulmonary embolism and pulmonary embolism are 52.12 and 46.5 years old.

Table 1 Demographic and clinical characteristics of no pulmonary embolism (PE) and PE cases (n = 60)

Demographic	No pulmonary embolism (n = 44)		Pulmonary embolism (n = 16)		*P* value
	Mean (SD)	*n* (%)	Mean (SD)	*n* (%)	
Age	52.12 (17.6)[a]		46.5(23)[a]		0.318[b]
< 20 years		3(0.07)		0(0)	
21 – 40 years		8(0.18)		3(0.19)	0.269[b]
41 – 60 years		14(0.32)		9(0.56)	
> 60 years		19(0.43)		4(0.25)	
Gender					
Male		19(0.43)		7(0.44)	0.969[b]
Female		25(0.57)		9(0.56)	
Ethnicity					
Malay		39(0.89)		14(0.88)	0.903[b]
Chinese		5(0.11)		2(0.13)	

a = Mean (Standard deviation)

n = Number of subjects

b = Fisher's exact test

Table 2 shows the relationship between Wells score and the CTPA results. In the 16 CTPA confirmed pulmonary embolism cases, all have a Wells score of above 2 points. Thirty of the negative pulmonary embolism cases had a Wells score of below 2 points. There is a significant relationship between Wells score and CTPA result.

Table 2 Relationship between Wells score and computed tomography pulmonary angiogram results

Wells score	**CTPA results**				***P*-value**
	No pulmonary embolism (*n* = 44)		**Pulmonary embolism (*n* = 16)**		
	n	**%**	***n***	**%**	
More than 6 points	2	3	7	12	<0.001[a]
2 to 6 points (Moderate probability)	12	20	9	15	
Less than 2 points (Low probability)	30	50	0	0	
n = Number of subjects *a* = Fisher's exact test					

The relationship between PERC score and CTPA result is shown in Table 3. In the 44 patients with negative pulmonary embolism, 5 patients fulfilled the entire PERC rule. There was no significant association between fulfilling PERC rule and a negative CTPA result seen in this study likely because of the inadequate samples size.

Table 3 Relationship between PERC score and CTPA results

Pulmonary embolism rule out criteria (PERC rule)	**CTPA results**				
	No pulmonary embolism (*n* = 44)		**Pulmonary embolism (*n* = 16)**		***P*-value**
	n	**%**	***n***	**%**	
Fulfilled all 8 criteria	5	8	0	0	0.311[a]
Did not fulfil all 8 criteria	39	65	16	27	
	n = Number of subjects *a* = Fisher's exact test				

Most of the patients with (100%) or without (91%) pulmonary embolism presented with dyspnoea. All most all of them has tachycardia and tachypnoea (Table 4).

Table 4 Symptom, physical findings, diagnostic test, comorbid and patients' outcome (*n* = 60)

	CTPA results			
	No pulmonary embolism (*n* = 44)		Pulmonary embolism (*n* = 16)	
	n	%	*n*	%
Symptoms				
Pleuritic chest pain	3	7	12	75
Substernal chest pain	5	11	10	63
Dyspnoea	40	91	16	100
Syncope	5	11	2	13
Haemoptysis	2	5	3	19
Physical findings				
Tachycardia	44	100	16	100
Tachypnic	44	100	16	100
Hypotension	0	0	5	31
Type 1 respiratory failure	38	86	16	100
Fever	24	55	8	50
Wheezing	5	11	6	38
Unilateral leg swelling	0	0	3	19
D dimer				
Positive	9	20	5	31
Negative	0	0	1	6
Not investigated	35	80	10	63
ECG changes				
Sinus tachycardia	44	100	16	100
S1Q3T3	3	7	4	25
Arterial blood gas results				
Type 1 respiratory failure	44	100	16	100
Comorbid				
Known malignancy	9	20	4	25
History of thrombosis	3	5	3	19
APLS	0	0	1	6
Outcome				
Discharge	40	91	12	75
Death	4	9	4	15

There were a total of 60 computed tomography pulmonary angiograms performed in the entire year of 2018 with 16 positive and 44 negative scans. Among the 16 positive scans, 7 (44%) had a Wells score above 6; 6 (38%) had a Wells score between 2 – 6 and 3 (18%) had a Wells score less than 2. The youngest patient was 19 years old and oldest 87 years old with a mean age of 52 years old. The ethnicity breakdown comprised of Malay (53, 88%) and Chinese (7, 12%). The patients are from medical (24, 40%) surgical (13, 22%), orthopaedic (7, 12%), obstetric (6, 10%), gynaecology (6, 10%) wards and intensive care unit (4, 6%). Out of 16 positive scans, 4 (25%) had known malignancy and 1 patient had anti-phospholipid syndrome. All 60 patients had electrographs and arterial blood gases prior to CTPA. D dimer was performed in 15 cases (25%). Among the 16 positive scan patients, 4 (25%) passed away during the same admission directly or indirectly related to pulmonary embolism.

DISCUSSION

Pulmonary embolism is a clinical condition in which the pulmonary artery or one of its branches is obstructed by a blood clot. An estimated of 600,000 cases occur in United States each year with case fatality rate of 2%[2]. Deep vein thrombosis is one of the major cause of pulmonary embolism[4, 5]. Based on the PIOPED II study, almost all of the patients with pulmonary embolism had one or more risk factors such as immobilization, travel of 4 hours or more in the past month, surgery within the last 3 months, malignancy, injury to the lower extremities and pelvis during the past 3 months, smoking, central venous instrumentation within the past 3 months, stroke, cardiac failure, history of pulmonary embolism, and chronic obstructive pulmonary disease[5, 6].

Stein PD et al. (2007) reported that pulmonary embolism can have a wide range of manifestations including shortness of breath at rest on exertion (73%), pleuritic chest pain (66%), cough (37%), orthopnoea (28%), signs and symptoms of deep vein thrombosis (44%), wheezing (21%), haemoptysis (13%) and cardiac arrythmia, syncope or presyncope and hemodynamic collapse (less than 10%)[7].

Computed tomography pulmonary angiography is the first-choice imaging modality to diagnose pulmonary embolism as it is sensitive and specific[8]. When CTPA is contraindicated for example due to a prior allergy to contrast, renal insufficiency, or the result is inconclusive, ventilation perfusion scan can be considered. Based on PIOPED study, ventilation perfusion can be interpreted into normal, low-probability PE, intermediate-probability PE, high-probability PE[8,9]. If a patient is deemed unfit, contraindicated or facilities for both CTPA and ventilation perfusion scan not available, lower limb ultrasound with Doppler may be useful. It is however non-diagnostic and has low sensitivity[9, 10].

Scoring systems has been developed to facilitate clinicians in making diagnosis of pulmonary embolism as the sign and symptoms often mimics other disease. Wells criteria includes clinical symptoms of deep vein thrombosis (3 points), other diagnoses are less likely than PE (3 points), heart rate > 100 (1.5 points), immobilization three or more days or surgery in previous four weeks (1.5 points), prior deep vein thrombosis or pulmonary embolism (1.5 points), haemoptysis (1 point), malignancy (1 point). The score obtained may classify patients into a three-tier system i.e. low risk (Wells score < 2), moderate risk (Wells score 2 – 6), high risk (Wells score > 6).

Other useful scoring system include Pulmonary Embolism Rule-out Criteria (PERC) score at which a patient who fulfilled all the criteria i.e. age < 50 years old, heart rate < 100 beats per minute, oxyhaemoglobin saturation > 95 per cent, no haemoptysis, no oestrogen use, no prior deep venous thrombosis or pulmonary embolism, no unilateral leg swelling and no surgery/ trauma requiring hospitalization within the prior four week has low risk of pulmonary embolism.

Another scoring system comparable to Wells score is Geneva criteria. It includes age more than 65 (1 point), prior deep vein thrombosis or pulmonary embolism (3 points), surgery under general anaesthesia or fracture of lower limbs (2 points), active malignancy (3 points), unilateral lower limb pain (3 points), haemoptysis (2 points), heart rate 75 – 94 (3 points), heart rate more than 95 (5 points) and tender on lower limb palpation or unilateral oedema (4 points). Patients are stratified into low risk (0 – 3), intermediate risk (4 – 10) and high risk (> 11) based on Geneva criteria. However, based on one study, it was thought that Wells score is more accurate than Geneva criteria in predicting pulmonary embolism[11].

Based on our study, by applying the pre-test Wells score which has a high negative predictive value for low risk group (NPV =

100%), all patients in this group have no pulmonary embolism. This may be a very good clinical indicator that patient in this group may not need CTPA and other differential diagnosis should be considered. PERC has a high sensitivity and positive predictive value (PPV, Sensitivity = 100%). All patients who were diagnosed with pulmonary embolism had at least fulfilled one of the PERC criteria and all patients who do fulfil any of the PERC criteria had negative findings in their CTPA.

PERC is a good clinical scoring system to exclude pulmonary embolism[12]. Result of D-dimer was not included in both wells score and PERC[13]. We found that majority of patients with suspected pulmonary embolism in our centre had no D-dimer investigated. According to Malaysia Clinical Practice Guidelines on the prevention and treatment of venous thromboembolism year 2013, there are many D-dimer assays in the market, and they all lack standardization and appropriate cut off [14]. The whole blood agglutination method for D-dimer testing often used in most Malaysian Laboratory is not sensitive in ruling out venous thromboembolism[15]. Necessity of using D-dimer in a suspected pulmonary embolism is somehow controversial as they are many different D-dimer assays available in our market which are not standardized. We suggest to study the relationship between local D-dimer assays and efficacy of applying PERC rules in our local setting in another study. A single centre cohort and small sample size were the limitations of this study.

CONCLUSION

This computed tomography pulmonary angiography annual audit report will assist clinicians in making better diagnostic decision when dealing with patients with suspected pulmonary embolism. The aims of avoiding unnecessary imaging include extra cost of hospitalization, unnecessary radiation, potential contrast induced nephropathy and allergies.

CONFLICT OF INTEREST

The authors declare that they have no competing interests in publishing this article.

ACKNOWLEDGEMENTS

We would like to thank our Director General of Health for his permission to publish this study.

REFERENCES

1. Lucassen W, Geersing GJ, Erkens PM et al. (2011). Clinical decision rules for excluding pulmonary embolism: A meta-analysis. Ann Intern Med 155 (7): 448 – 460. DOI: 10.7326/0003-4819-155-7-201110040-00007.
2. Carson JL, Kelley MA, Duff A et al. (1992). The clinical course of pulmonary embolism. N Engl J Med 326: 1240 – 1245.
3. Wells PS, Anderson DR, Bormanis J et al. (1997). Value of assessment of pretest probability of deep-vein thrombosis in clinical management. Lancet 350: 1795.
4. Moser KM, Fedullo PF, LitteJohn JK et al. (1994). Frequent asymptomatic pulmonary embolism in patients with deep venous thrombosis. JAMA 271: 223 – 235.
5. Turkstra F, Kuijer PM, van Beek EJ et al. (1997). Diagnostic utility of ultrasonography of leg veins in patients suspected of having pulmonary embolism. Ann Intern Med 12: 775 – 781.
6. Stein PD, Terrin ML, Hales CA et al. (1991). Clinical, laboratory, roentgenographic, and electrocardiographic findings in patients with acute pulmonary embolism and no pre-existing cardiac or pulmonary disease. Chest 100 (3): 598.
7. Stein PD, Beemath A, Matta F et al. (2007). Clinical characteristics of patients with acute pulmonary embolism: data from PIOPED II. Am J Med 120 (10): 871 – 879.
8. Remy-Jardin M1, Pistolesi M, Goodman LR et al. (2007). Management of suspected acute pulmonary embolism in the era of CT angiography: A statement from the Fleischner Society. Radiology 245 (2): 315.

9. PIOPED Investigators. (1990). Value of the ventilation/perfusion scan in acute pulmonary embolism. Results of the prospective investigation of pulmonary embolism diagnosis (PIOPED). JAMA 263 (20): 2753.
10. Van Rossum AB, Van Houwelingen HC, Kieft GJ et al. (1998). Prevalence of deep vein thrombosis in suspected and proven pulmonary embolism: a meta-analysis. Br J Radiol 71 (852): 1260.
11. Penaloza A, Melot C, Motte S. (2011). Comparison of the Wells score with the simplified revised Geneva score for assessing pretest probability of pulmonary embolism. Thromb Res 127 (2): 81 – 84.
12. Di Nisio M, Van EsN, Bullier HR. (2016). Deep vein thrombosis and pulmonary embolism. Lancet 388: 3060 – 3073.
13. Perrier A1, Desmarais S, Goehring C et al. (1997). D-dimer testing for suspected pulmonary embolism in outpatients Geneva University Hospital, Switzerland.
14. Malaysia Clinical Practice Guideline on the prevention and treatment of venous thromboembolism. (2013). p. 47. MOH/P/PAK/264.13(GU)
15. Adam SS, Key NS, Greenbery CS. (2009). D-dimer antigen: current concepts and future prospects. Blood 113: 2878 – 2887.