

The patterns of ordering Computed Tomography Pulmonary Angiogram (CTPA) for diagnosis of pulmonary embolism (PE) in a rural health setting

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Abstract

Background: Pulmonary embolism (PE) is a life-threatening condition with overall mortality of up to 20 % when left untreated. CTPA is the preferred investigation for diagnosis of PE for patients with normal kidney function. Several studies showed this test is being over employed without using available predictive tools i.e. Wells score, Modified Geneva score & D-Dimer

Methodology: A retrospective review of patients' records who had CTPA for suspected pulmonary embolism from the period of 1st March 2015 to 28th Feb 2016. Patient's demographics and components of different scoring system were obtained by manual review of patient's electronic records.

Result: A total of 249 CTPAs were done during this study period. In term of patient demographics, median age was 63 years and 48.6 % of patients were females. PE was diagnosed in 34 (13.7%) patients. Only 196 (76.6%) patients had a CXR as an initial investigation. Acute kidney injury was noted in 23 (14.0%) patients post CTPA.

Revised Geneva score was calculated for all patients who had CTP for PE, only 10 (4 %) patients had a high probability on Revised Geneva score (score >11). Wells score could not be accurately calculated due to the retrospective nature of the study.

Conclusion: The diagnostic yield of CTPA with a positive result for pulmonary embolism was 13.7%, which is below the recommended standards by the Royal College of Radiology (UK) (15.4% to 37.4%). Also, these findings were noted to be inferior compared with a similar study done in an Australian hospital. These findings may be attributed to the poor utilization of risk assessment tools (Geneva, Wells and D-Dimer) and not performing simple chest X-ray prior to CTPA. A protocol to request CTPAs is needed which is suited to the regional settings to avoid unnecessary CTPAs and its complications.

Introduction

Pulmonary embolism (PE) is a potentially fatal condition if left untreated. The annual crude incidence rate of PE in Australian was estimated to be 0.31 per 1000 in a community setting [1]. The 1-year case-fatality rate for PE is approximately 23% [2]. Efficient clinical evaluation and diagnostic testing is necessary to avoid delays in initiating therapy, which in turn reduces morbidity and mortality from PE [3]. Pulmonary angiography is the historical criterion standard for the diagnosis of PE, which has now been largely replaced by less invasive alternatives. CTPA is the investigation of choice for diagnosis of PE but requires the use of potentially nephrotoxic contrast agents and radiation [4,5]. Alternatively, as a result V/Q scans are commonly considered in patients with renal impairment, pregnant women and in young patients due to the lower dose of radiation [6]. Over the last decade, there has been a significant increase in CTPA use for diagnosis of PE [7]. Inappropriate CTPA use is associated with increases in health care expenditure and risks causing unnecessary harm for patient such as contrast-induced nephropathy and hypersensitivity reactions [8].

The positive rate of CTPA for PE can be as low as 7% but this rate can be increased to more than 30% with use of pre-test risk assessment tools [9-11]. Commonly applied stratifying tools are the Wells score and the revised Geneva score [12]. Depending on the risk factors for

pulmonary embolism, patients are categorized into three groups: low (Geneva score 0-3, Wells score 0-1), intermediate (Geneva score 4-10, Wells score 2-6) or high (Geneva score ≥ 11 , Wells score ≥ 7) [13].

The D-Dimer value is a very useful marker in low/intermediate probability groups and its use has been validated in several studies [12]. In the general population, the combination of D-Dimer testing and clinical assessment tools miss less than 2% of PEs [14].

Objectives of the study

The objectives of this audit are:

- 1) To evaluate the appropriate use of CTPA (overuse/underuse) and the rate of positive results of CTPA for PE in a regional health setting.
- 2) To check the degree of adherence to an existing algorithm for using CTPA for PE.
- 3) To estimate the rate of contrast induced nephropathy.

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Setting

Goulburn Valley Health is a rural hospital located 200km northeast of Melbourne that provides care for a catchment population of approximately 120,000 people from the City of Greater Shepparton extending to southern New South Wales. The Medical imaging provides variety of services including CT scans and nuclear medicine.

Methodology

We performed a retrospective review of patients' records who had CTPA for suspected pulmonary embolism from the 1st March 2015 to the 28th Feb 2016. Patients demographics and components of different scoring system were obtained by manual review of patient's electronic records. Patients' individual baseline creatinine values were identified along with their serum creatinine within 72 hours after the CTPA. We defined contrast-induced nephropathy as renal function impairment within 48-72 hours of contrast administration and was measured as a 25% increase in serum creatinine from baseline. Our study was reviewed and approved by the human research ethics committee at Goulburn Valley Health.

Result

We have a total of 249 CTPAs the study period. a 48.6% of patients were females with median age was 63 (IQR =25) years. Only 34 (13.7%) CTPAs were positive for PE. The most common risk factor for PE in our cohort was immobilization or surgery within 4 weeks (19.2%). In term of symptoms, the most common symptom was shortness of breath (70.7%) followed by chest pain (52.2 %) (Table 1).

In regard to the use of the PE risk assessment tools, only 79 (31.7%) patients had D-Dimer and 191 (76.7 %) chest x-ray as the primary imaging. 56 out of 191 patients (29.3%) had findings in their chest x-ray adequate to explain their symptoms but treating doctors opted to proceed with CTPA .We used the modified Geneva score to stratify patients according to PE risk , 76 (30.5%) patients had low risk ,163 (65.5%) patients had medium risk and 10 (4.0%) patients had high risk for PE .The rate of positive CTPA for PE was linearly proportional to the modified Geneva score (Figure 1). 247 (99.2 %) patients had renal function test pre-CTPA and 164 (65.9%) had follow up renal function test .23 out of these 164 (14.0%) patients had acute kidney injury.

Discussion

CTPA is the investigation of choice for diagnosis of PE. The diagnostic yield of CTPA with positive results is only 13.7 % which is lower compared to the recommended standard by the Royal College of Radiology UK (15.4 -37.4%).

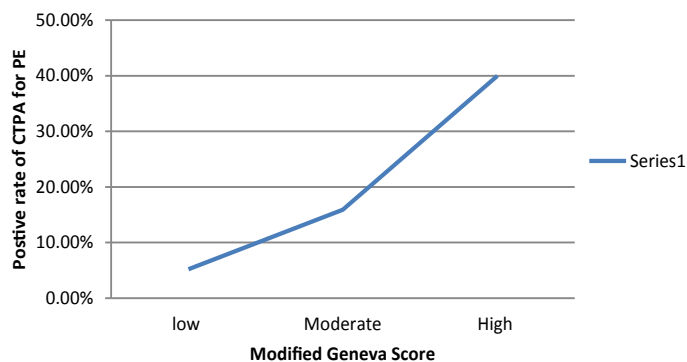


Figure 1. Relationship between Modified Geneva Score and positive rate of CTPA.

Table 1. Patients characteristics and common risk factors, signs and symptoms.

Characteristics: n=249	
Age (yr): mean (IQR)	63 (25)
Sex: female (%)	48.6
Risk Factors	
Active Malignancy (%)	17.3
Immobilization or surgery in the previous 4 weeks (%)	19.2
Previously diagnosed with DVT or PE (%)	13.2
Signs and Symptoms	
Hemoptysis (%)	2.8
Shortness of breath (%)	70.7
Chest pain (%)	52.2
Signs and symptoms of DVT (%)	11.2
Tachycardia (%)	31.3

The role of clinical assessment tools and D-Dimer for excluding PE in well validated in medical literature and helps in minimizing unnecessary use of CTPA [15]. Furthermore, the introduction of the age adjusted d-dimer has been shown to be more accurate than standard testing and has the potential to reduce the number of unnecessary CTPAs [16]. However, this test is poorly utilized in our institution with less than 32% of patients had D- Dimer.

Only 76.6% had chest x-rays and around 30% of this group had findings in their chest x-ray adequate to explain patients' symptoms. However, in all occasions, treating doctors opted to proceed with CTPA. We could not calculate Well score due to the retrospective nature of this study, however, when we calculated the modified Geneva score, we found less than 5% of patients -who had CTPA -had high probability score which indicates that majority of these scans were unnecessary.

Easy accessibility to CT is a well-known factor associated with overuse of CTPA [17] and we believe that this is the case in our institution. Another factor that might be associated with overuse of CTPA in regional health settings is the lack of senior decision makers especially after business hours. Also, using CTPA to increase chance of finding alternative diagnosis which is unacceptable stander medical practice and should be avoided [18].

Patients undergoing CTPA are at risk of contrast-induced nephropathy and radiation exposure. In our cohort, only 164 (65.9%) patients had follow up renal function tests and we found 23 (14%) of them had a degree of acute kidney injury. The rate of contrast-induced nephropathy in our study is almost similar to positive rate of CTPA for PE which is similar to previous studies findings [19-22].

In summary, this audit had proven that poor utilization of pre-test risk assessment tool d resulted unnecessary use of CTPA that caused harm for some patients. To minimize this problem, we strongly recommend introducing educational interventions such as seminars as well as devising algorithms targeting clinicians who request imaging without compromising patient safety [23,24]. Guidelines such as these are beneficial to clinicians as they aid in overcoming defensive practice and fear of missing the diagnosis [19].

Conclusion

We have proven that CTPA has been overused at GVH with the low positive rate of PE. Implementation of algorithm-based clinical guidelines and validated pre-test assessment tools will guide the rational use of CTPA. We would recommend carrying out educational interventions directed to medical staff involved with requesting CTPAs. Finally, follow-up audit to monitor the compliance with these recommendations is essential.

Declaration

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2. The authors declare no conflict of interest in preparing this article.

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