

ORIGINAL ARTICLE

USE OF COMPUTED TOMOGRAPHIC PULMONARY ANGIOGRAPHY FOR THE DIAGNOSIS OF PULMONARY EMBOLISM; ARE WE OVERDOING IT?

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Background: Computed tomographic pulmonary angiography (CTPA) is a gold standard test for the diagnosis of pulmonary embolism (PE), but is reported to be over prescribed. We performed this study to determine over prescription of CTPAs at a District General Hospital (DGH) in the United Kingdom. Our secondary aim was to establish a cause of its over-prescription. **Methods:** We retrospectively reviewed clinical data of all patients who underwent CTPAs during January 2011 to July 2013. Collected data included CTPA findings, clinical probability score, D-dimer results, chest x-ray (CXR) findings and patient's demographic data. A calculation of overall clinical probability (including initial and post CTPA values) and its cross analysis with D-dimer, CTPA and CXR findings was made. **Results:** Pulmonary embolism was positive in 5 (11.6%) cases. An Initial probability score was available in 16 (37.20%), and a D-dimer result was available in 33 (76.7%). Chest X-ray (CXR) was abnormal in 8 (18.6%). A coupling of total probability score with D-dimer results (CPPD) identified 10 (22.2%) potential over prescriptions. A further analysis of CPPD with CXR revealed a definite over prescription of 8 (18.6%), whereas it increased the number of an overall possible over prescription to 14 (32.6%). **Conclusion:** The CTPAs are being over prescribed and the main reasons behind it are poor utilization of probability scoring systems, D-dimer rule and lack of interpretation of alternative diagnosis on CXRs.

Keywords: Pulmonary Embolism, Tomography, X-Ray Computed, Probability, fibrin fragment D, Prescriptions

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INTRODUCTION

Pulmonary embolism is a potentially fatal condition and has been a diagnostic dilemma. The main diagnostic challenges in patients with suspected pulmonary embolism remains the accurate diagnosis of around 25% patients who require anticoagulation therapy from the other 75% patients who do not require it.^{1,2} Different strategies have been adapted to help in diagnosing this condition. Among these are D-dimers, Doppler venography, Ventilation perfusion imaging, pulmonary angiography and CTPA.^{3,4}

CTPA is now being used as a gold standard diagnostic test for PE, replacing conventional pulmonary angiography.⁴ Its easy availability and high sensitivity has increased its use as a first line investigational tool. This approach has raised certain concerns among some quarters because of its potential hazards.⁵⁻⁸ These include radiation exposure, contrast nephropathy, and a clinical challenge of interpreting significance of small sub-segmental pulmonary embolism.⁵⁻⁸ These hazards can be minimized by limiting its use, which can be achieved by using established clinical probability scoring systems (either Geneva or Wells) and D-dimer results.⁹⁻¹² However, some questions have been raised about compliance with effective utility of coupled approach of clinical decision rule and D-dimers to identify low risk patient

who can be safely ruled out of PE without using CTPA.^{13,14}

We suspected an over-prescription of CTPAs in our hospital. So, we performed this retrospective study in a District General Hospital in United Kingdom with the primary aim to determine over-prescription of CTPA by utilizing this well established clinical decision rule and D-dimers couplet. Our secondary aim was to identify any other reasons for this over-prescription.

MATERIAL AND METHODS

In this cross sectional Study, CTPAs performed during January 2011 to July 2013 at a secondary care hospital in the United Kingdom were retrospectively analysed. All patients who underwent CTPA during this period were included in the study. Demographic data including age and sex, was collected for all of the patients. Reported CTPA findings of PE and other diagnoses were documented. An overall probability category was calculated by two ways: either looking at pre-test assignment of probability category (either Well's or Modified Geneva) by requesting physician, or a post-CTPA Well's probability category assignment for the purpose of this study. This post-test probability category was assigned based on information about patient's characteristics in those patients where first option was not available. A note of

D-dimer results was made to cross analyse it, along with probability category, to CTPA findings. The CXR findings where available were noted as normal or abnormal. An electronic database system was used to collect all of this data.

All of the collected data was then entered into SPSS-20. Frequencies of PE positive and negative CTPA scans were calculated. Percentages of different diagnoses among PE negative CTPAs were also calculated. Frequencies of utilization of pre-CTPA probability scoring systems were also calculated and divided into utilization and non-utilization group. An overall Probability category was devised after calculating post-test probability category in the remaining patients. An analysis of utility of D-dimer was also noted and the available D-dimer results were crossed analysed with CTPA findings after coupling it with probability category. Because of non-availability of D-dimers in some patients an additional analysis of CXR findings was done by dividing it into normal and abnormal findings and then cross analysing it with CTPA findings of patients with different probability categories and D-dimer positivity.

RESULTS

A total of 43 patients underwent CTPAs during this period of 18 months. Mean age was 55.53±20.89. There were 30 (70%) women with two of them being pregnant. Main findings of demographics, probability categorization, D-dimer use, CXR findings and CTPA findings are summarized in Table-1. Pulmonary embolism was diagnosed in 5 (11.6%). A probability category was documented in 16 (37.2%). The overall probability categories, after calculation of post-test probability in rest of the 27 (62.8%), the final probability score included: 24 (55.8%) of low probability, 16 (37.2%) of moderate probability and 2 (4.6%) of high probability patients. No probability categorization was possible in one (2.3%) patient. A D-dimer test was positive in 32 (74.4%) and negative in one (2.3%); whereas it was not done in 10 (23.3%) cases. A CXR examination was found abnormal in 8 (18.8%).

In order to look at overuse of CTPA and to calculate percentages of patient which could have avoided this test in this cohort of CTPAs, a Coupling of D-dimers and clinical probability categories (CPDD) (Table 4) was compared with CTPA results. It depicted that all PEs were positive in either of the high probability 1 (2.3%) or moderate probability with positive D-dimers 4 (9.3%). Keeping in mind the fact that patients in low or moderate probability should only undergo CTPA if they are positive for D-dimers, we suspected a possible over-prescription of CTPA in 5 (11.6%) of low probability and 4 (9.3%) of moderate

probability patients who did not have D-dimer tests done, which could well have been negative. (Table 2)

On Further analysis of this CPDD against CXR abnormalities, it revealed that there is a definite over-prescription of CTPA in 8(18.6%) patients who had an alternative diagnosis available on CXR, thus did not need further CTPAs. (Table-3).

Table-1: Summary of patients demographics, probability categories, D-dimers and CXR results (n=43)

Characteristic	Number	Percentage
Gender:		
Male	13	30.2
Female	30	69.8
Pregnant	2	
Non-pregnant	28	
Pre-Test probability score (Revised Geneva or Well's)		
Low probability	6	
Moderate probability	9	
High Probability	1	
Post-Test Calculated Probability (Well's)		
Low probability	18	
Moderate probability	8	
High probability	1	
Not Possible*	1	
Final probability scores (Pre-test+Post-test probability)		
Low Probability	24	55.8
Moderate Probability	16	37.2
High Probability	2	4.6
D-Dimer results		
Positive	32	74.4
Negative	1	2.3
Not done	10	23.3
Chest X-ray Findings		
Normal	33	76.7
Abnormal	8	18.6
Not done	2	4.6
CTPA Findings		
Pulmonary Embolism	5	11.6
Normal	22	51.2
Other diagnosis	16	37.2

*data insufficient to categorize in any probability group.

Table-2: Results of CTPA in relation to the Clinical probability and D-dimers results.

CTPA Results	D-Dimers results		
	Positive	Negative	Not Done
Pulmonary Embolism (n=5)			
Low Probability	0	0	0
Moderate probability	4	0	0
High Probability	0	0	1
other diagnosis* (n=16)			
Low Probability	9	0	2
Moderate probability	1	1	3
High Probability	0	0	0
Normal CTPA (n=22)			
Low Probability	10	0	3
Moderate probability	6	0	1
High Probability	1	0	0
Un-classified	1	0	0

Depicts 43 patients for their typical diagnosis and patient's resultant final clinical probability score along with D-dimers findings. *Other diagnosis includes: Pneumonia (n=8), Lung Cancer (n=3), Pneumothorax (n=1), Bronchiectasis (n=1), Effusion (n=1), pelural plaques (n=1)

Table-3: Admission Chest X-ray Findings and its correlation with clinical probability category and D-dimer results

CXR results*	D-Dimer results		
	Positive	Negative	Not done
Normal (n=33)			
Low	15	0	2
Moderate	10	0	3
High	1	0	1
Non-classified	1	0	1
Abnormal (n=8)			
Low	4	0	2
Moderate	0	1	1
High	0	0	0
Non-classified	0	0	0
Not Done (n=2)			
Low	0	0	1
Moderate	1	0	0
High	0	0	0
Non-classified	0	0	0

*A total of 41 patients had a chest x-ray. 2 of the patients who did not have chest x-ray belonged to 1 low and one moderate risk category.

Patient with moderate probability was diagnosed as PE on CTPA while one in low category had a normal CTPA. All of these findings were confirmed on subsequent CTPAs.

DISCUSSION

Our study has shown that CTPA were over-prescribed in at least 18.3% patients in our hospital. The reasons behind its over-prescription were multifactorial including a poor utility of clinical probability scoring system and D-dimer assay (CPDD) to rule out low probability patients, and an inability to keep an overall picture of the patient in mind. Quite a few of the CTPAs were requested without any D-dimer results despite patients being in low or moderate probability category. The most important reason behind this approach appears to be an inability to initially categorize patients into any probability category. Another important issue, which was highlighted in this study, was an inability of requesting physician to interpret abnormal CXR findings prior to CTPA requests. This could be either due to an inability of junior doctors to pick up these findings on CXRs or being not able to chase these X-ray reports altogether.

These findings mean that we have been over utilizing our CT scanner facility. This overuse took the toll in the form of wastage of crucial CT scanner time, as well as, an already limited, monetary and human resources. In addition, it has also subjected patients to risk of exposure to harmful effects of radiations and contrast agents.

Studies have shown that there is always some tendency among physicians to over prescribe CTPA. However, causes of over prescription of CTPA are different in different settings. O'Connor C *et al*¹³ in Ireland reported that Modified Well's score (WMS) was not being utilized in pregnant patients to rule out low risk patients. She found that MWS has 100% negative predictive value to rule out pulmonary embolism.

Similarly, Ng BJ *et al*.¹⁴ in Australia, has reported a 29.7% non-compliance with clinical pathway of Well's score and D-dimers results, resulting in an over prescription of CTPA in these patients. We have found similar trend in our patients as well. However, an additional factor of over-prescription of CTPA in our study, which was unique from other studies, was a lack of interpretation of CXR findings of alternative diagnosis prior to CTPA requests.

The findings of this study have important clinical implications. Different studies suggested that use of probability clinical rule and D-dimers is associated with decrease in number of unnecessary CTPA prescriptions and low risk patients can be excluded of pulmonary embolism by this clinical decision rule and D-dimers assay.⁹⁻¹² Our study does support this notion that over prescription of CTPA was done due to lack of proper utility of probability scoring system and D-dimer assays. Hence, if proper utility of probability scoring system and D-dimer clinical rule, along with a prompt interpretation of alternative findings on the CXR is ensured, most of the unnecessary CTPAs can be prevented. It does suggest that some more robust arrangements should be made to develop a system which should encourage clinicians to use probability scoring system and D-dimer clinical rule to confidently rule out pulmonary embolism in low risk patients. It also stresses on importance of encouraging doctors to promptly interpret CXR findings in an effective and timely manner. Ideally, no CTPA should be requested without seeing a CXR.

These goals can be achieved by making a probability scoring system and D-dimer test results documentation, an integral part of CTPA- test requests. Also a further education of doctors regarding importance of utility of clinical rule and prompt interpretation of CXR will help in achieving these goals. Also, another check on this over prescription could be an additional effort from radiologists to check and report CXR prior to CTPA scanning.

Limitations of our study include its smaller sample size, retrospective design and relatively shorter duration of time, which could mean that these practices may only be common during the study duration and its findings may not be generalizable. This study has included a full spectra of doctors at our hospital and there has not been any major changes in medical staffing prior to or during this period. Also, because of limitations of its design, it was not possible to definitely identify major causes of underutilization of Clinical decision rule or of lack of interpretation of CXR.

CONCLUSION

The CTPAs are being over prescribed and the main reasons behind their over prescription are poor utility of probability scoring systems and poor CXR

interpretations. A mandatory clinical decision rule as a part of CTPA requests and a prompt interpretation of CXRs will solve this issue.

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