The Utility of Modified Wells Score as a Pre-Test Risk Stratification Tool in Suspected Cases of Pulmonary Embolism Undergoing Computed Tomography Pulmonary Angiogram

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ABSTRACT

Objectives: To assess the validity of pre-test evaluation of patients with Modified Wells score at our facility to improve diagnostic yield of CT pulmonary angiography for pulmonary embolism.

Study Design: Prospective longitudinal study.

Place and Duration: Department of Computed Tomography, Armed Forces Institute of Radiology & Imaging, Pak Emirates Military Hospital, Rawalpindi Pakistan, from Feb to Jul 2019.

Methodology: After approval from the Ethical Review Board, 60 patients with clinical suspicion of pulmonary embolism were selected. Modified Wells score was calculated for each patient, and a senior consultant reviewed their CT Pulmonary Angiograms.

Results: Sixty patients were assessed from February to July 2019. Pulmonary embolism was diagnosed in 21(35%) patients; 22(37%) patients were unremarkable, while alternate diagnosis was provided for 17(28%) patients. Modified Wells score was 66.6% sensitive and 74.3% specific for diagnosis of pulmonary embolism, with a positive predictive value of 58.3% and a negative predictive value of 80.5%.

Conclusion: Modified Wells score carries a good negative predictive value for ruling out pulmonary embolism. Hospitals must devise their departmental protocol utilizing risk stratification tools, lab tests and other safer imaging alternatives, where applicable.

Keywords: Computed tomography, Diagnostic yield, Modified Wells score, Pulmonary angiography, Pulmonary embolism.

INTRODUCTION

Pulmonary embolism (PE) is a dreaded medical condition occurring primarily as a complication of deep vein thrombosis; about 2.60 to 12.82% of the high-risk Pakistani population gets affected by this condition.[1] Every year, around 360,000 Americans are diagnosed with it.[2] while 100,000–200,000 annual deaths are attributable to it.[3]

Various imaging modalities are being utilized for the diagnosis of PE, like chest X-ray, ventilation-perfusion scan, computed tomography pulmonary angiography (CTPA), catheter pulmonary angiogram and very recently, Magnetic Resonance pulmonary angiogram, but the use of CTPA remains the most popular.[4,5]

Nevertheless, an unjustified scan exposes the patient to a radiation dose of 10-20 mSv-equivalent to 750 chest X-rays.[6] It risks the development of contrast-induced nephropathy and can be of more harm than good in pregnant or lactating females and adolescents. Moreover, in a third-world country like ours, the expense of an unnecessary investigation is also a major cause of concern.[7,8]

The non-specificity of the symptoms, for example, shortness of breath and chest pain, especially in the high-risk patient group, does not make the physician's decision any easier. Therefore, because of this dilemma, several studies have proposed using a structured diagnostic algorithm using various scoring systems and lab tests, which can increase the diagnostic yields of CTPA.[9,10]

Modified Wells score (MWS) is one of the widely used pre-test clinical evaluation systems that renders the probability of pulmonary embolism as "likely or unlikely". Hence, this study was devised to investigate whether pre-test evaluation with Wells score could be applied at our facility to improve the yield of CTPA for pulmonary embolism.

METHODOLOGY

The prospective longitudinal study was carried out from February 2019 to July 2019 after getting approval from the Ethical Review Board Committee, Armed Forces Institute of Radiological Imaging, Rawalpindi (*ERB Approval Certificate # 0022*).

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Inclusion Criteria: Patients of either gender, aged 18 and above, with suspicion of PE based on clinical findings of chest pain and dyspnea who underwent CTPA were included.

Exclusion Criteria: Patients with co-existing hemodynamic disorders, previous/chronic history of PE & history of contrast reactions were excluded from the study.

A carefully designed proforma including patient demographics, risk factors for PE and components of Modified Wells score were filled out by the radiology resident at the CT console before the scan by inquiring about pertinent details from patients themselves and reviewing referring physician's notes. MWS was then calculated for each patient. Patients were categorized as "likely" to have PE if MWS was equal to or more than 4.5, while those with scores equal to or less than four were considered "unlikely" to have PE. All CTPA evaluations were performed using 128-detector CT equipment (Siemens 128 slice Somatom Definition AS, Germany), and intravenous contrast material was administered using a CT automated injector. In preparation for CTPA evaluation, after gaining intravenous access, 35mL of non-ionic contrast material (Omnipaque) was administered at a rate of 4.5 mL/sec. Initially, a bolus dose of 10ml contrast was given, followed by 25 ml of remaining contrast after 1 minute. Patients were asked to hold their breath during the evaluation.

Images were obtained through the apex of the lungs up to the diaphragm level with section thicknesses of 0.50 and 1.00mm. Variable dose parameters automated by the CT scan machine were used according to the patient's weight (CT maximum range: kVp=150, mA=600). CTPA was performed in a single breath-hold. Data was compiled, and images were viewed on the Vitrea workstation, including multi-formatted images. The presence of PE on CTPA images was defined according to the established criteria (pulmonary arterial luminal filling defect on at least two consecutive axial images, associated with a crescent or ring of contrast enhancement surrounding partial filling defects).[11] Potential confounding artefacts were excluded (respiratory or cardiogenic motion artefact, crossing un-opacified pulmonary veins, bronchial wall thickening, and peribronchial lymph nodes) by careful analysis of anatomy and adjacent lung parenchyma on both soft tissue and corres-ponding lung windows.

Statistical Package for Social Sciences (SPSS) version 23.0 was used for the data analysis. Quantitative variables were expressed as Mean±SD and qualitative variables were expressed as frequency and percentages. Diagnostic parameters were calculated using a 2x2 table. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were determined by using the standard formulae. Chi-square test was applied to explore the inferential statistics. The *p*-value of ≤0.05 was considered statistically significant.

RESULTS

Of the 60 patients who underwent CTPA upon suspicion of PE, 49(82%) were males, while 11(18%) were females, with a mean age of about 46±19 years. PE was diagnosed in 21 (35%) cases, 22(37%) were unremarkable studies, and an alternate diagnosis was provided for 17(28%) patients (Figure).
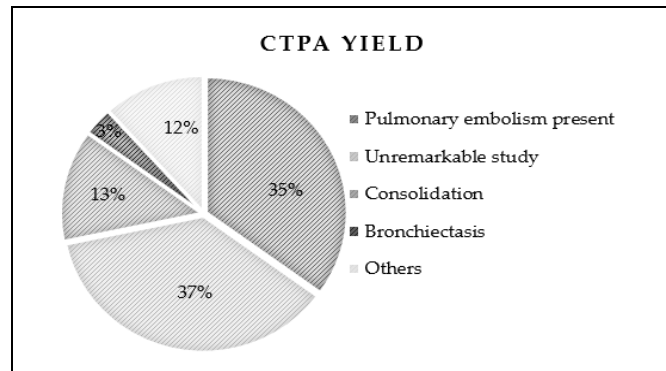

Figure: Percentages of various findings on Computed Tomography Pulmonary Angiography

Out of 21 patients who were diagnosed with PE, 14(66.6%) had MWS ≥ 4.5 and 7(33.3%) patients had MWS ≤4 (Table-I). MWS was found to be 66.6% (n=14) sensitive and 74.3% (n=29) specific for diagnosing pulmonary embolism with a positive predictive value of 58.3%, a negative predictive value of 80.5% and a diagnostic accuracy of 71.6% (Table-II).

Table–I: Relationship of Modified Wells score (Two Tier Model) with Computed Tomography Pulmonary Angiography findings of Pulmonary Embolism (n=60)

	Computed Tomography Pulmonary Angiography Findings	
	Pulmonary Embolism Present	Pulmonary Embolism not Present
Modified Wells score		
More than 4.5	14(66.6%)	10(25.6%)
Less than 4	07(33.3%)	29(74.3%)

The majority of the patients undergoing CTPA had presented with shortness of breath (85%), chest

pain (43%), history of stay at high altitudes (33%) and pulse rate greater than 100 beats per minute (27%) (Table-III).

a previous study as 36.76%[11] in 2019 and is towards the higher side of that recommended by the Royal College of Radiologists (UK), i.e., 15.4-37.4%.[12] A

Table–III: Predisposing factors in patients referred with suspicion of Pulmonary Embolism (n=60)

Variables	Shortness of breath	Chest pain	High altitude	Deep venous thrombosis	Pulse rate > 100bpm	Cardiomegaly	Smoking	Previous history of PE	Hemoptysis	Immobilization	History of surgery	Ischemic heart disease	Malignancy
Number of Patients n(%)	51 (85%)	26 (43%)	20 (33%)	15 (25%)	16 (27%)	15 (25%)	15 (25%)	14 (23%)	13 (22%)	13 (22%)	12 (20%)	3 (5%)	3 (5%)

However, apart from a pulse rate greater than 100 beats per minute (*p-value* <0.001), no significant association was found between signs and symptoms of PE/components of MWS and diagnosis of CTPA (Table-IV).

Table–IV: Associaion of Computed Tomography Pulmonary Angiography findings with components of Modified Wells score (n=60)

	Computed Tomography Pulmonary Angiography		*p-value*
	Pulmonary Embolism Present	Pulmonary Embolism not Present	
Deep Vein Thrombosis			
Yes	08	07	0.088
No	13	32	
Pulse Rate			
>100 beats per minute	15	01	<0.001
<100 beats per minute	06	38	
Immobilization			
Yes	06	07	0.349
No	15	32	
History of Surgery			
Yes	05	07	0.596
No	16	32	
Previous History of Pulmonary Embolism			
Yes	04	10	0.572
No	17	29	
Hemoptysis			
Yes	06	07	0.349
No	15	32	
Malignancy			
Yes	0	03	0.199
No	21	36	

DISCUSSION

In our study, 35% of patients with clinically suspected PE were found to have characteristic CTPA findings. This figure is very similar to that reported in

previous study reported CTPA yields as low as 5.4%.[13] It accredited the low numbers to the wide availability of CT facilities in the US compared to those from Europe and to follow proper guidelines. 37% of CTPAs ordered at our facility were unremarkable, while an alternate diagnosis of consolidations and bronchiectasis was made in 16 % of cases.

In a study from China, Chien *et al*. compared the use of unenhanced multi-detector CT findings in acute central PE with that of CTPA and found it to be 96.9% sensitive to pick embolism-more than that of MWS.[14] Hence, as an extension of our study, we urge investigators to look for more evidence.

Unfortunately, like PE, limited latest prevalence studies regarding DVT are available from Pakistan, and our study highlights the need for more locally based research on this topic. Older literature has shown that half of the patients diagnosed with PE were found to have signs and symptoms of DVT.[15, 16] Therefore, in a symptomatic patient, a duplex lower limb ultrasound with evidence of DVT, especially with prior history, should be enough to formulate a PE diagnosis and initiate treatment .[17, 18]

In our study, MWS was found to have a low sensitivity of 66.6% but a considerable specificity and negative predictive value of 74.3% and 80.5%, respectively. A previous reported similar figures, with an even higher negative predictive value of 91.1%, [19] which could imply that a low MWS could safely dismiss the role of CTPA.

Moreover, VQ perfusion scans have negative predictive values almost equal to that of CTPA **(20)** but five times lesser radiation dose..[12] Similarly, a combination of MWS and D dimer levels reported a sensitivity of 93.8% for diagnosing PE.[11] Therefore, in light of such convincing figures, we suggest the

development of detailed intra-departmental diagnostic protocols for PE, keeping in mind the available facilities and patient population catered for at each hospital.

LIMITATIONS OF STUDY

There were various limitations linked to our study. The sample size was relatively small. Three marks in MWS are attributable to "diagnosis other than PE unlikely". There was no communication bet-ween the referring physician and radiologist besides the provided clinical notes. Hence, each patient was considered to have been sent with a high suspicion of PE and given a score of three in this regard unani-mously. We also were unable to retrieve the D dimer levels of most patients. Therefore, we could not investigate the correlation of D dimer and MWS in combination with CTPA findings.

CONCLUSION

Modified Wells score has a good negative predictive value for ruling out pulmonary embolism, and when combined with laboratory tests and clinical decision-making, can lead to further increased sensitivity. Depending on the facilities available, each hospital must devise its depart-mental protocol utilizing pre-test risk stratification tools, laboratory investigations and other safer alternatives such as nuclear scans in low-risk patients or duplex lower limb ultrasounds in those with previous history of DVT.

Conflict of Interest: None.

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

UN: & HN: Conception, study design, drafting the manuscript, approval of the final version to be published.

ZIM: & MB: Data acquisition, data analysis, data inter-pretation, critical review, approval of the final version to be published.

ZA: & ARP: Critical review, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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