SHORT COMMUNICATION

Diagnostic yield of CTPA and Wells Score utilization in pulmonary embolism assessment: Experience from a Malaysian tertiary hospital

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ABSTRACT

Introduction: Computed Tomography Pulmonary Angiography (CTPA) is the gold standard for diagnosing pulmonary embolism (PE), though concerns about overuse persist.

Materials and Methods: This study evaluated CTPA yield and Wells Score use in 361 adults at a Malaysian tertiary centre (May 2017–July 2021).

Results: PE was confirmed in 29.6% of cases, above international benchmarks. While the Wells Score was applied in 78.5% of cases, only 32.1% adhered strictly to local guidelines.

Conclusion: CTPA was not overutilized, but there is a gap between recommended clinical pathways and real-world decision-making, highlighting the need to standardize practice to improve diagnostic efficiency and support evidence-based care.

KEYWORDS:
Pulmonary embolism; Computed Tomography; Wells Score; Clinical decision rule; Diagnostic yield

INTRODUCTION

Pulmonary embolism (PE) is a potentially life-threatening condition that requires prompt and accurate diagnosis. Computed Tomography (CTPA) is widely accepted as the gold standard for diagnosing PE due to its high sensitivity, specificity, and accessibility.[1] However, its increasing use has raised concerns about overutilization, with reported diagnostic yields as low as 10% in some centres.[2] To address this, clinical decision rules such as the Wells Score, have been developed to stratify patients based on their pretest probability of PE.[3,4] These tools help determine the need for imaging, particularly when used with D-dimer testing. Despite recommendations to use the Wells Score, inconsistent adherence remains a problem, leading to unnecessary imaging and patient risk.[5] In Malaysia, limited evidence exists on real-world adherence to these tools. This study assesses the utilization of the Wells Score and the diagnostic yield of CTPA at a tertiary centre on the east coast of Malaysia.

MATERIALS AND METHODS

Study Design and Setting

This retrospective cross-sectional study was conducted at Sultan Ahmad Shah Medical Centre @ IIUM (SASMEC @ IIUM), a tertiary teaching hospital in Kuantan, Malaysia. All adult patients (≥18 years) who underwent CTPA between May 2017 and July 2021 were included. Exclusion criteria were previous PE, indeterminate imaging, or CTPA for non-PE indications.

Data Collection

Patient data were obtained from the Radiology Information System and electronic medical records. The Wells Score was retrospectively assigned based on documented symptoms, clinical signs, and risk factors. Patients were stratified into "PE likely" (score >4) and "PE unlikely" (score ≤4) groups. D-dimer results were also collected.

Statistical Analysis

Analysis was conducted using SPSS version 25 (IBM Corp., Armonk, NY). Descriptive statistics summarized demographics and outcomes. Chi-square tests assessed categorical variable associations, and binary logistic regression examined the link between Wells Score and PE diagnosis. A p-value < 0.05 was considered statistically significant.

Ethics Approval

Approval was obtained from the IIUM Research Ethics Committee (Ref: IIUM/305/20/4/1/7, 23 June 2020).

RESULTS

Demographic Characteristics

Out of 366 patients, 361 were included after exclusions. The mean age was 60 years (range 15–92), with 53.2% being female. PE was confirmed in 107 patients, resulting in a 29.6% diagnostic yield. Patient demographics, Wells score stratification, and D-dimer results are summarized in Table I.
Wells Score Stratification

Of the patients, 231 (64.0%) were classified as "PE likely," and 130 (36.0%) as "PE unlikely." Among the "PE likely" group, 33.8% had confirmed PE, compared to 27.1% in the "PE unlikely" group.

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Table I: Demographic, Wells score, and D-dimer characteristics of patients with and without pulmonary embolism (n = 361)

Variable	All patients n (%)	PE patients n (%)	Non-PE patients n (%)
Age group			
<35 years	26 (7.2)	4 (15.4)	22 (84.6)
36–64 years	169 (46.8)	51 (30.2)	118 (69.8)
>65 years	166 (46.0)	52 (31.3)	114 (68.7)
Sex			
Male	169 (46.8)	47 (27.8)	122 (72.2)
Female	192 (53.2)	60 (31.3)	132 (68.7)
Wells score group			
PE likely (>4)	231 (64.0)	78 (33.8)	153 (66.2)
PE unlikely (≤4)	130 (36.0)	29 (22.3)	101 (77.7)
D-dimer result			
Normal	42 (11.6)	14 (13.1)	28 (11.0)
Elevated	198 (54.8)	58 (54.2)	140 (55.1)
Not done	121 (33.5)	35 (32.7)	86 (33.9)

PE, pulmonary embolism.

Table II: Association between Patient Gender, PE Symptoms and Wells Criteria, With PE Result

Variable	p-Value	95 % Confidence Interval	Odd Ratio
Patient demographic			
Gender	0.475	0.538 – 1.335	0.8
PE sign and symptoms			
Shortness of breath	0.028	1.057 – 2.874	1.7
Chest pain	0.660	0.336 – 1.998	0.2
Hemoptysis	0.928	0.318 – 3.510	1.0
Wells Criteria			
Heart rate > 100 beats/min	0.180	0.466 – 1.155	0.7
Clinical sign and symptoms of DVT	0.589	0.503 – 3.349	1.3
Recent surgery or immobilization	0.278	0.809 – 2.083	1.3
History of DVT or PE	0.623	0.337 – 6.121	1.4

PE, pulmonary embolism. DVT, Deep vein thrombosis

Table III: Binary Logistic Regression for the Entire Wells Scores and Patient's Age

Variable	CTPA results		
	PE positive vs. PE negative		
	p-Value	Odd Ratio	95 % Confidence Interval
Wells Score (PE – likely)	0.038	1.149	1.008 – 1.311
Age	0.111	1.013	0.997 – 1.029

CTPA, Computed Tomography Pulmonary Angiography. PE, pulmonary embolism.

Association between Patient Gender, PE Symptoms, Wells Criteria, Wells score with PE

Variables tested for correlation with PE diagnosis include clinical signs of PE (shortness of breath, chest pain, and haemoptysis), Wells criteria (tachycardia, clinical sign and symptoms of DVT, recent surgery or immobilization, history of DVT/PE, and history of malignancy) and Wells score. However, only shortness of breath (p = 0.028) and increasing Wells score (p = 0.038, OR = 1.15, 95% CI: 1.01–1.31) showed statistically significant associations with PE diagnosis. These findings are summarized in table II.

D-dimer Testing

D-dimer testing was done in 240 patients (66.5%). Among the "PE unlikely" group, 79 (60.8%) were tested, 14 (17.7%) were positive for PE. In the "PE likely" group, 161 (69.7%) were tested despite guidelines not requiring it. Out of which 78 were PE positive (33.8%).

Adherence to Clinical Guidelines

The Wells Score was used in 78.5% of cases, but only 32.1% adhered strictly to the local guidelines, which recommend imaging only for "PE likely" or "PE unlikely" with positive D-dimer, as outlined in the Malaysian Clinical Practice Guidelines on Prevention and Treatment of Venous Thromboembolism4.

Statistical Association

Shortness of breath significantly correlated with PE diagnosis (p = 0.028). Logistic regression showed increasing Wells Score was significantly associated with PE (p = 0.038, OR = 1.15, 95% CI: 1.01–1.31). Findings are shown in table III.

DISCUSSION

Diagnostic yield is the metric used in assessing the appropriate of CTPA use. In many Western settings, yields

range between 6% and 15%. The value less than 10% is often cited as overutilization.[2,5-6] Such low yields are attributed to indiscriminate imaging, inconsistent use of clinical decision rules, and defensive medicine. In contrast, the diagnostic yield in this study was 29.6%, indicating that CTPA was appropriately utilized. This high yield is also observed in other regional studies. A study at a hospital in Kuantan, for example, reported a CTPA positivity rate of 26.5%, while other regional studies in Thailand and Singapore have also shown yields exceeding 20%.[7-8] These results suggest that, in contrast to many Western institutions, clinicians in this region are more selective when ordering CTPA, possibly due to differences in patient flow, access, or reliance on clinical judgment in resource-conscious environments.

Despite the high diagnostic yield, adherence to the guideline was suboptimal. Only 32.1% of patients followed the recommended pathway. This reliance on clinical judgment, though valid in experienced hands, introduces variability. The underuse of D-dimer in low-risk cases and overuse in high-risk cases reflects inconsistent application of the diagnostic algorithm. Nearly 40% of "PE unlikely" patients did not receive D-dimer testing, missing an opportunity to avoid imaging. Meanwhile, 70% of "PE likely" patients had unnecessary D-dimer testing. These practices may be influenced by habitual clinical behaviour, defensive medicine, or the conservative stance of the Malaysian VTE guideline regarding D-dimer use, which partly stems from historical concerns about assay sensitivity and standardisation.[4] However, D-dimer is highly sensitive for PE (sensitivity 96.2%, specificity 50%) [10] and is recommended by NICE guideline in patients with a low Wells score, with imaging reserved for those with positive results. The Pulmonary Embolism Rule-out Criteria (PERC) may also be applied in very low-risk patients to determine whether D-dimer testing is necessary.

The inconsistent application of the Wells Score and D-dimer pathway points to a gap between evidence-based recommendations and real-world clinical practice. Reliance on clinical judgement alone risks variability, inefficiency, and potential overtesting in less experienced settings. Although local cost data are unavailable, international studies have shown that inappropriate CTPA use imposes a significant financial burden. In Australia, the cost of a single CTPA is approximately AUD 530, with total costs per confirmed PE diagnosis rising up to AUD 21,800 when used in low-risk patients.[11] Conversely, Ong et al. reported a saving of AUD 61,710 after reducing 121 unnecessary CTPA scans over seven months through improved adherence to clinical prediction rules.[11]

Embedding validated decision rules into clinical workflows , such as integrating the Wells Score into electronic ordering systems or mandating documentation prior to CTPA referral could standardize decision-making, reduce unnecessary imaging, and improve resource stewardship. These interventions have been shown in other settings to increase guideline adherence and diagnostic yield without compromising patient safety.[6,9]

CONCLUSION

This study demonstrated a high diagnostic yield of CTPA for suspected pulmonary embolism, suggesting appropriate overall utilization. However, adherence to the local clinical guideline, particularly the use of Wells Score and D-dimer was suboptimal. We recommend bridging the gap between recommended practice and real-world decision-making by integrating the Wells score in electronic ordering system to further improve diagnostic efficiency, and support evidence-based care.

REFERENCES

1. Stein PD, Fowler SE, Goodman LR, et al. Multidetector computed tomography for acute pulmonary embolism. N Engl J Med 2006; 354(22): 2317-27.
2. Wiener RS, Schwartz LM, Woloshin S. When a test is too good: how CT pulmonary angiograms find pulmonary emboli that do not need to be found. BMJ 2013; 347: f3368.
3. Wells PS, Anderson DR, Rodger M, et al. Excluding pulmonary embolism at the bedside without diagnostic imaging. Ann Intern Med 2001; 135(2): 98-107.
4. Ministry of Health Malaysia. Clinical Practice Guidelines: Prevention and Treatment of Venous Thromboembolism. MOH/P/PAK/263.13(GU). 2013.
5. Adams DM, Stevens SM, Woller SC, et al. Adherence to PIOPED II investigators' recommendations for computed tomography pulmonary angiography. Am J Med 2013; 126(1): 36-42.
6. Wang RC, Bent S, Weber E, et al. The impact of clinical decision rules on computed tomography use and yield for pulmonary embolism: a systematic review and meta-analysis. Ann Emerg Med 2016; 67(6): 693-701.e3.
7. Low KP, Hassan R, Karimah H, et al. Diagnostic Yield of CT Pulmonary Angiogram in the Diagnosis of Pulmonary Embolism and Its Predictive Factors. Med J Malaysia 2023; 78(3): 285-90.
8. Vongchaiudomchoke T, Boonyasirinant T. Positive pulmonary computed tomography angiography in patients with suspected acute pulmonary embolism: Clinical prediction rules, thromboembolic risk factors, and implications for appropriate use. J Med Assoc Thai 2016; 99(1): 25-33.
9. Drescher FS, Chandrika S, Weir ID, et al. Effectiveness and acceptability of a computerized decision support system using modified Wells criteria for evaluation of suspected pulmonary embolism. Ann Emerg Med 2011; 57(6): 613-621.e1.
10. Gao H, Liu H, Li Y. Value of D-dimer levels for the diagnosis of pulmonary embolism: An analysis of 32 cases with computed tomography pulmonary angiography. Exp Ther Med. 2018; 16(2): 1554-60.
11. Chean LN, Tan C, Hiskens MI, Rattenbury M, Sundaram P, Perara J, Smith K, Kumar P. Overuse of computed tomography pulmonary angiography and low utilization of clinical prediction rules in suspected pulmonary embolism patients at a regional Australian hospital. Healthcare (Basel) 2024; 12(2): 278.