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Original Research Article

Diagnostic Accuracy of Wells Score and PERC Score to Predict Pulmonary Embolism in Suspected Cases

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Abstract: *Pulmonary embolism (PE) is a potentially life-threatening condition requiring prompt and accurate diagnosis. Clinical decision rules such as the Wells score and the Pulmonary Embolism Rule-out Criteria (PERC) are widely used to estimate pretest probability and reduce unnecessary imaging. However, their diagnostic performance remains variable across populations.* ***Objective:*** *To determine the diagnostic accuracy of the Wells score and PERC criteria in predicting pulmonary embolism, using computed tomography pulmonary angiography (CTPA) as the gold standard, in suspected cases.* ***Methods:*** *This validation study was conducted at the Pulmonology Unit of Fauji Foundation Hospital, Rawalpindi. One hundred ninety-eight patients presenting with clinical suspicion of PE were enrolled consecutively between 18 October 2024 and 19 February 2025. In all patients, the senior registrar on duty calculated the Wells and PERC scores before CTPA was performed. The final diagnosis of PE was confirmed through CTPA. Statistical analysis included calculation of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy (DA).* ***Results:*** *The mean age of the participants was 56 ± 8 years. The Wells score demonstrated a sensitivity of 62.4%, specificity of 63.0%, PPV of 70.9%, NPV of 53.7%, and DA of 62.6%. The PERC criteria showed a higher sensitivity of 75.2%, but a lower specificity of 38.2%, with PPV at 63.8%, NPV at 51.7%, and DA at 60%.* ***Conclusion:*** *The Wells and PERC scores exhibited limited diagnostic accuracy in predicting pulmonary embolism compared to CTPA. These clinical assessment tools, therefore, cannot reliably exclude PE or sufficiently reduce the need for confirmatory imaging in the pulmonary emergency setting.*

Keywords: Pulmonary Embolism, Wells Score, PERC Score, Diagnostic Accuracy

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Introduction

Pulmonary thromboembolism, widely known as pulmonary embolism (PE), is a severe medical condition caused by the blockage of the pulmonary artery or its branches. This occurs when emboli, which may originate from the venous system or the right side of the heart, travel to the lungs. Such an obstruction disrupts normal blood flow in the lungs and negatively affects respiratory function, potentially leading to life-threatening complications (1). The estimated incidence of PE ranges from 60 to 75 cases per 100,000 people each year, emphasizing its status as a significant cardiovascular issue (2). Despite improvements in medical treatment, PE remains a perilous condition, often resulting in severe dysfunction of the right heart and posing a considerable risk of death. Reports indicate that the 30-day all-cause mortality rate for PE hovers around 13%, highlighting the critical need for prompt diagnosis and intervention (3). However, diagnosing PE can be particularly challenging due to the nonspecific symptoms that often mimic those of other medical issues. Common symptoms such as shortness of breath (dyspnea), chest pain, cough, and fever are prevalent among patients with PE. Unfortunately, these signs can also indicate other conditions, including pneumonia, myocardial infarction, or chronic obstructive pulmonary disease (COPD). This overlap in symptoms can lead to delays in appropriate treatment, underscoring the importance of maintaining a high level of clinical suspicion and employing advanced diagnostic methods to identify and address this potentially deadly condition accurately (4, 5).

Computed tomography pulmonary angiography (CTPA) is the preferred diagnostic tool in emergency departments (EDs) when there are no contraindications. Despite its increased application leading to a higher detection rate of pulmonary embolism (PE), the overall mortality associated with PE remains unchanged (6, 7). Additionally, there has been a rise in incidences of allergic reactions and nephrotoxicity linked to the use of contrast agents. In recent years, substantial research efforts have focused on creating non-invasive and cost-efficient methods for diagnosing PE, given the high costs and invasive nature of traditional angiography (8, 9).

Established in 1997, the Wells score is a clinical tool for assessing the likelihood of pulmonary embolism (PE) by evaluating symptoms, medical history, and risk factors, categorizing patients as low, moderate, or high risk. While useful, its subjective nature and the necessity for further testing have led to the creation of supplementary tools.[8] In 2004, Kline et al. introduced the Pulmonary Embolism Rule-out Criteria (PERC), which allows low-risk patients to rule out PE without extensive testing. PERC comprises eight criteria: age, heart rate, and oxygen saturation. If all criteria are met, the risk of PE is deemed low, minimizing unnecessary diagnostic procedures and associated costs (9).

This study aimed to determine the diagnostic accuracy of the Wells score and PERC criteria in predicting pulmonary embolism (PE), taking CTPA as the gold standard in suspected cases.

Methodology

In this validation study, we included 198 patients who presented in the pulmonology unit of Fauji Foundation Hospital Rawalpindi, presenting with suspicion of PE (patients presenting with chest pain, dyspnea, tachycardia, an elevated jugular venous pressure, a gallop rhythm, and a widely split second heart sound). While previously diagnosed cases of PE were excluded. The study population was collected from 18 October 2024 to 19 February 2025. Informed consent was obtained from each study patient.

Data regarding the patient's age and gender were collected for each patient. In all patients, the Wells and PERC score was calculated by the senior registrar on duty.

After that, all patients were referred to the Department of Radiology for confirmation of the diagnosis of PE using CTPA. The final diagnosis of PE was based on the reporting of a consultant radiologist of the hospital. SPSS v25 was used to calculate the diagnostic accuracy of Wells and PERC score (by formulating a 2×2 table), taking CT scan reporting as the gold standard.

Results

The mean age of patients was 56±8 years. Out of 198, 92 (46.5%) patients were male. The diagnostic accuracy of the Wells Score for pulmonary embolism (PE) was evaluated. Among these patients, 103 tested positive for PE on the Wells Score, and 73 were confirmed on CTPA. Conversely, 95 patients tested negative on the Wells Score; 44 had confirmed PE on CTPA, while 51 did not. This leads to a sensitivity of 62.4%, indicating the test's ability to identify those with the disease correctly. The specificity is 63.0%, reflecting the test's accuracy in identifying those without the disease. The positive predictive value (PPV) is 70.9%, while the negative predictive value (NPV) is 53.7%. Overall, this study's diagnostic accuracy (DA) of the Wells Score is 62.6% (Table 1).

The diagnostic accuracy of the PERC score is represented in Table 2. Among 138 patients identified as "positive" for the PERC score, 88 patients had a positive finding of PE on CT pulmonary angiography (CTPA), while 50 did not. Conversely, among 60 patients positive on the PERC score, 29 patients tested positive for PE. In contrast, 31 tested negative. The sensitivity of the PERC score was calculated at 75.2%, indicating a good ability to identify patients with the condition correctly. However, the specificity was lower at 38.2%, revealing many false positives among those with a negative result. The positive predictive value (PPV) was 63.8%, while the negative predictive value (NPV) stood at 51.7%. Overall, the PERC score's diagnostic accuracy (DA) was determined to be 60% (Table 2).

Table 1. Diagnostic Accuracy of the Wells Score

PE on Wells	PE on CTPA		Total
	Yes	No	
Yes	73	30	103
No	44	51	95
Total	117	81	198
Sensitivity = 62.4% Specificity= 63.0% PPV= 70.9% NPV= 53.7% DA= 62.6%			

Table 2. Diagnostic Accuracy of PERC Score

PERC Score	PE on CTPA		Total
	Yes	No	
Yes	88	50	138
No	29	31	60
Total	117	81	198
Sensitivity= 75.2% Specificity= 38.2% PPV= 63.8% NPV= 51.7% DA= 60%			

Discussion

Effectively managing patients suspected of having pulmonary embolism (PE) remains a significant challenge across various healthcare settings, including emergency departments, intensive care units, and internal medicine or surgical wards. The urgency of such cases often compels clinicians to adopt a systematic approach that considers the patient's clinical presentation and history and integrates a range of diagnostic tools. Currently, healthcare professionals utilize a combination of diagnostic methods to confirm or rule out the presence of PE. This typically begins with a thorough clinical assessment that may include evaluating risk factors such as recent surgery, immobilization, or a history of thrombosis. Based on this preliminary evaluation, probability assessment tests, like the Wells score or the PERC, are conducted to gauge the likelihood of a PE diagnosis (10, 11).

In the present study, we found that the Wells and PERC scores have average diagnostic values for diagnosing PE.

Similar results are reported in previous studies. Kabalak et al. conducted a study on the diagnostic accuracy of the Wells and PERC scores for predicting PE in suspected cases, taking CTPA as the gold standard. On CTPA, PE was diagnosed in 62.6% of patients. On the Wells score, PE was diagnosed in 59.8% of patients; on the PERC score, PE was diagnosed in 81.5%. The Wells score (≥4) was 59.8% sensitive, 63.9% specific, with positive predictive value (PPV) of 73.5% and negative predictive value (NPV) of 48.7%, While the PERC score (≥1) was 82.3%, 19.6% specific, PPV of 63.1% and NPV of 40%.(12).

A study by Girardi et al. on the diagnostic accuracy of the Wells score in predicting PE reported that the Wells score is 40% sensitive, 87% specific, with a PPV of 59% and an NPV of 77%. The authors reported PE in 30.4% of patients (13).

Another study by Kline et al. reported that the PERC score is 98.2% sensitive and 34.7% specific in diagnosing PE (13).

Research conducted by Dachs and colleagues indicated that the PERC rule demonstrated a sensitivity of 100% and a specificity of just 24.6% for effectively ruling out pulmonary embolism (PE) in an emergency department. Their findings suggested that implementing the PERC rule could lead to a 23% reduction in unnecessary CTPA evaluations in emergency departments (14).

In a separate study conducted in Turkey, the PERC score achieved a sensitivity of 98% but had a significantly lower specificity of 7%. Notably, this study included a sample of 125 patients, out of which only five were classified as PERC negative.[15] Aligning with the outcomes of these studies, the current investigation revealed a sensitivity of 75.2% and a specificity of 38.2% for the PERC test. These results indicate that while the PERC rule shows some utility, it should not be regarded as a highly

reliable scoring system for ruling out PE in emergency department scenarios.

Conclusion

Our findings indicate that the Wells and PERC scores lack sufficient sensitivity and specificity for the accurate diagnosis of PE. As a result, these assessments are inadequate for reducing unnecessary radiologic examinations in a pulmonary emergency department.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-JGSVF-24)
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Conflict of interest

The authors declared the absence of a conflict of interest.

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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