



The Analysis Study of Comparison Clinical Scoring System in Pulmonary Embolism: A Comprehensive Systematic Review

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ABSTRACT

Background: Pulmonary embolism is a significant diagnostic challenge in emergency departments due to its life-threatening nature and non-specific symptoms. Diagnostic systems like CTPA have been developed to address these challenges, but their limitations and radiation exposure raise concerns about patient safety. Comparing clinical scoring systems for pulmonary embolism can enhance diagnosis yield and optimize resource allocation. **Methods:** This systematic review adhered to PRISMA 2020 guidelines, focusing exclusively on full-text articles published in English between 2014 and 2024. Editorials and review articles without a DOI were excluded to ensure the utilization of high-quality sources. A literature review was conducted utilizing reputable databases including ScienceDirect, PubMed, and SagePub to identify relevant studies. **Result:** The initial database search identified nearly 200 publications pertinent to the topic. After a thorough three-stage screening process, eight studies were chosen that satisfied the established inclusion criteria for detailed analysis. The studies underwent a thorough critical evaluation, facilitating a detailed examination of the comparison clinical scoring system in pulmonary embolism. This targeted methodology guaranteed that the analysis utilized robust evidence closely aligned with the study's aims. **Conclusion:** Pulmonary embolism diagnosis accuracy has been significantly improved by integrating clinical scoring systems with D-Dimer testing and PERC. Combinations like WS + PERC and RGS + PERC achieved near-perfect sensitivity, reducing failure rates. However, trade-offs exist between sensitivity and specificity, necessitating further research.

Keywords: clinical scoring system, pulmonary embolism, sensitivity, specificity

INTRODUCTION

Pulmonary embolism (PE) is a critical diagnosis in emergency departments (EDs) due to its life-threatening nature and non-specific symptomatology, including chest pain and dyspnea. These symptoms overlap with various other conditions, complicating the diagnostic process, particularly given the extensive list of predisposing risk factors.^{1,2} This diagnostic challenge underscores the importance of accurate and timely evaluation to prevent adverse outcomes. PE ranks as the third leading cause of death among cardiovascular diseases, following myocardial infarction and stroke, with approximately 300,000 deaths annually in Europe alone.³ Alarming, the mortality rate remains high, reaching 15% within the first three months and 20% within the first year after diagnosis.¹

Imaging, particularly computed tomography and pulmonary angiography (CTPA), has become the cornerstone for diagnosing PE, and it is often driven

by a clinician's suspicion. CTPA is favored for its high sensitivity and specificity and its availability in most hospitals. However, this diagnostic tool is not without limitations. The associated radiation exposure and the use of iodinated contrast medium raise significant concerns regarding patient safety.⁴ Over the past two decades, the use of CTPA has surged, correlating with an increase in diagnosed PE cases. Despite this trend, mortality rates have shown no significant change, prompting questions about diagnostic efficiency and the optimal use of imaging resources. Furthermore, the diagnostic yield of CTPA varies geographically, with the U.S. targeting a value of 10% or higher, while Europe aims for 20–30%.^{5,6}

To address these challenges, several Clinical Decision Support Systems (CDSS) have been developed to assist clinicians in assessing the probability of PE and ruling it out without relying on CTPA. Notable examples include the Wells score (2001),⁷ the PERC rule (2004),⁸ the Revised Geneva score (2006),⁹

and the YEARS criteria (2017)¹⁰. These tools aim to reduce unnecessary CTPA utilization, thereby minimizing radiation exposure, reducing the use of contrast medium, and alleviating ED overcrowding while lowering costs. By improving the diagnostic process, CDSS can enhance PE diagnosis yield and optimize resource allocation. This study investigates the comparison of clinical scoring systems for pulmonary embolism, providing insights into their effectiveness and potential to transform PE management.

METHODS

Protocol

This study adhered strictly to the PRISMA 2020 guidelines, ensuring a methodologically precise and high-quality research process. By following these comprehensive protocols, the review was conducted with transparency, reproducibility, and scientific rigor at its core. Critical procedures, including extensive literature searches, accurate data extraction, and meticulous synthesis of findings, were carefully

implemented to minimize bias. This rigorous methodology enhances the study's credibility and reliability, providing a solid foundation for advancing evidence-based research.

Criteria for Eligibility

This study aims to evaluate and compare clinical scoring systems in pulmonary embolism (PE) by systematically reviewing and synthesizing data from a diverse range of studies. The research seeks to uncover patterns and emerging trends in the existing literature, providing insights to develop more effective diagnostic approaches and patient care strategies. The ultimate goal is to enhance the understanding of clinical scoring systems in PE and contribute to improved clinical outcomes for affected patients.

To ensure analytical rigor, the study applied strict inclusion and exclusion criteria. Peer-reviewed articles published in English between 2013 and 2024 were included, with each study's authenticity verified through DOI validation. Non-research materials, such as reviews, editorials, and duplicate entries, were

excluded to maintain a focused and high-quality dataset. This meticulous selection process ensures that the analysis is grounded in reliable and relevant sources, strengthening the validity of the findings.

By employing a systematic and comprehensive methodology, the study ensures that its conclusions are supported by robust and credible evidence. The anticipated findings aim to advance the understanding and application of clinical scoring systems in PE diagnosis and management. Ultimately, the research aspires to drive improvements in patient care and contribute to better health outcomes for individuals with pulmonary embolism.

Search Strategy

A well-defined search strategy was implemented to identify relevant studies for this systematic review, focusing on the keywords "pulmonary embolism," "clinical scoring system," and "comparison." The search was conducted across three major academic databases—PubMed, SagePub, and ScienceDirect—ensuring a comprehensive and in-

depth exploration of the topic. This systematic approach enabled the identification of diverse, high-quality sources, forming a robust evidence base for analysis and enhancing the reliability and validity of the review's findings.

Data retrieval

The authors conducted a meticulous preliminary review of each article, systematically assessing titles and abstracts to evaluate their relevance before proceeding to an in-depth analysis. Only studies that aligned with the research objectives and satisfied the predetermined inclusion criteria were selected for detailed examination. This structured and methodical approach facilitated the identification of consistent and meaningful patterns across the literature, ensuring a focus on studies directly pertinent to the research question.

To ensure uniformity and enhance the comparability of findings, only full-text articles published in English were included in the analysis. A rigorous screening process was applied to confirm that

all selected studies adhered to the established inclusion criteria and effectively addressed the study's objectives. Articles that did not meet these standards were excluded, ensuring that the final dataset was precise, high-quality, and closely aligned with the research focus.

The evaluation process incorporated a comprehensive assessment of multiple factors, including study titles, authorship, publication dates, research locations, and methodologies. This thorough consideration ensured the inclusion of only the most relevant and reliable studies. By employing a systematic and robust selection process, the authors enhanced the credibility and rigor of the findings, providing a solid foundation for drawing reliable and actionable conclusions.

Quality Assessment and Data Synthesis

The authors implemented a meticulous initial screening process, carefully evaluating the titles and abstracts of each article to identify studies relevant for further analysis. Only articles that met the predefined

relevance and quality criteria were advanced to a comprehensive, in-depth review. This rigorous and systematic approach prioritized the inclusion of studies that were both high-quality and directly aligned with the research objectives. By refining the selection process in this manner, the authors ensured that the final dataset consisted of contextually significant and methodologically robust studies. This approach not only enhanced the focus and precision of the analysis but also strengthened the overall quality, relevance, and scientific rigor of the review.

Table 1. Search Strategy

Database	Search Strategy	Hits
Pubmed	<i>("pulmonary embolism" AND "clinical scoring system")</i>	5
Science Direct	<i>("pulmonary embolism" AND "clinical scoring system" AND "comparison")</i>	182
Sagepub	<i>("pulmonary embolism" AND "clinical scoring system" AND "comparison")</i>	16



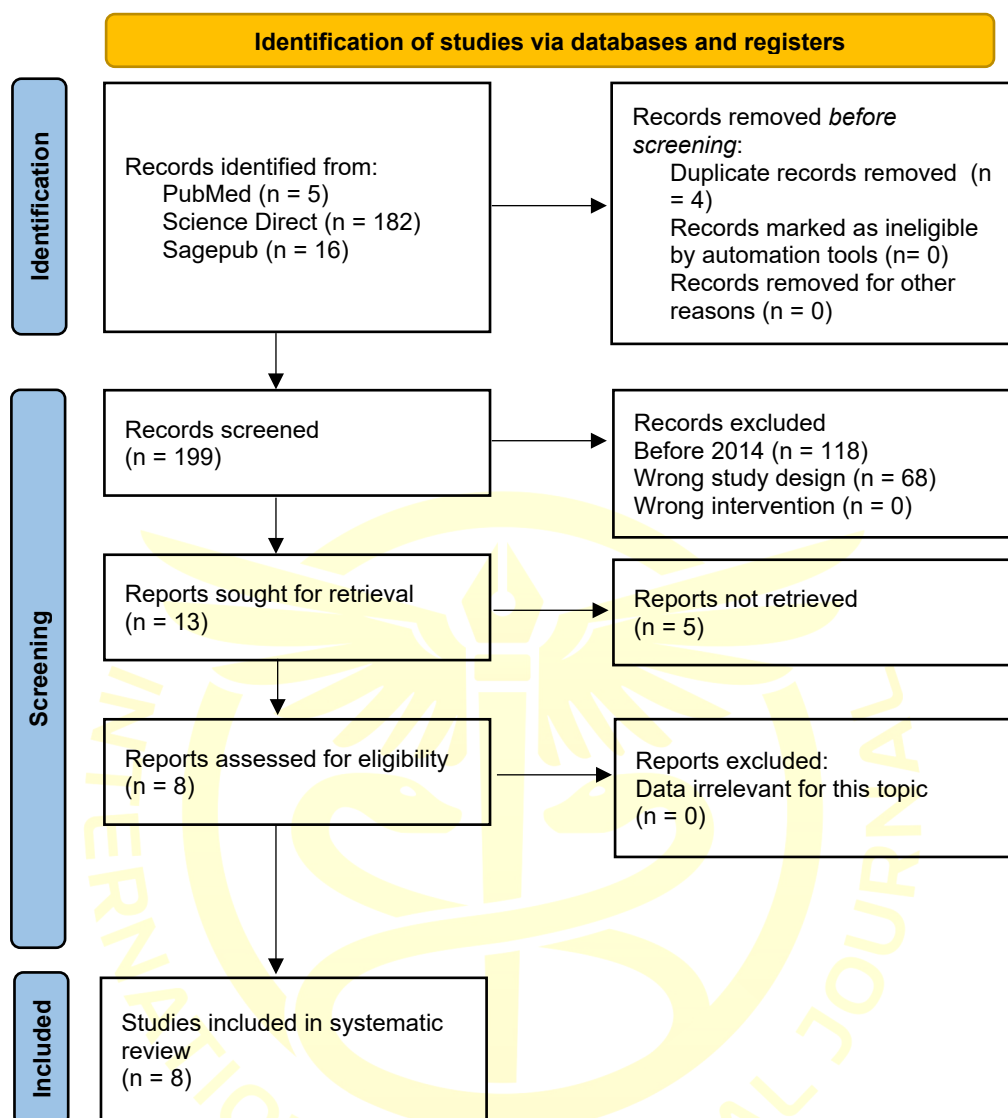


Figure 1. Article search flow chart

Table 2. Critical appraisal of Study

Parameters	(Guo et al., 2015)	(Barnes et al., 2020)	(Coelho et al., 2020)	(Medson et al., 2022)	(Gogulakrishnan et al., 2023)	(Tang et al., 2023)	Fayia d et al., 2024)	(Tang et al., 2024)
1. Bias related to temporal precedence Is it clear in the study what is the “cause” and what is the “effect” (ie, there is no confusion about which variable comes first)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Bias related to selection and allocation Was there a control group?	No	No	No	No	No	No	No	No
3. Bias related to confounding factors Were participants included in any comparisons similar?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
4. Bias related to administration of intervention/exposure Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	No.	Yes.
5. Bias related to assessment, detection, and measurement of the outcome Were there multiple measurements of the outcome, both pre and post the intervention/exposure? Were the outcomes of participants included in any comparisons measured in the same way? Were outcomes measured in a reliable	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No No No	No Yes Yes

way?

6. Bias related to participant retention

Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
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7. Statistical conclusion validity

Was appropriate statistical analysis used?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
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RESULT

The investigation commenced with a systematic search of reputable academic databases, including ScienceDirect, PubMed, and SagePub, to identify studies relevant to the review. A rigorous three-stage screening process was implemented to filter and select the most pertinent studies, ultimately refining the selection to eight papers that met the predefined inclusion criteria. These studies underwent comprehensive analysis, with critical topics carefully extracted for detailed examination. To ensure clarity and facilitate effective presentation, the findings are succinctly summarized in Table 3, providing a well-organized and concise overview of the analyzed data.

Table 3. The literature included in this study

Author	Origin	Method	Sample	Result
Guo et al. ¹¹ (2015)	China	Retrospective Study	360 participants	A study found that 28.6% of cases diagnosed with PE were aged 65+, with 65.8% positive predictive values and 32.4% negative predictive values in elderly patients. The negative predictive values were 93.7%, 100%, and 100% in the elderly.

Barnes et al.¹² (2020)	USA	Cohort	416 participants	A study of 416 patients with acute pulmonary embolism found that 7-day mortality varied among low-risk and highest-risk groups, with modest discrimination for 7-day mortality and slightly lower discrimination for 30-day mortality, according to risk stratification tools.
Coelho et al.¹³ (2020)	France	Prospective study	1757 participants	The prevalence of PE was 11.3%, with significant differences in prevalence among patients aged ≥ 65 . The AUC for WS and RGS for patients aged ≥ 65 was 0.632 and 0.610, respectively, but the difference was not statistically significant ($p = .441$).
Medson et al.¹⁴ (2022)	Sweden	Retrospective Study	1566 participants	Out of 1566 CTPA patients, 17% were positive for PE. The diagnosis yield from five decision groups was 15%, with a PERC rule of 18%, Wells score of 19%, revised Geneva score of 26%, and YEARS criteria of 18%.
Gogulakrishnan et al.¹⁵ (2023)	India	Prospective Study	65 patients	The study involved 65 patients with suspected PE, with a majority being male. PE was present in 23 (35.4%) patients, with a significant difference. The Wells score, simplified Wells score, revised Geneva score, and simplified revised Geneva score were used to assess PE severity. The results were not statistically significant.

Tang et al.¹⁶ (2023)	China	Retrospective Study	685 participa nts	PECSS identified seven clinical predictors strongly associated with pulmonary embolism, including anhelation, abnormal blood pressure, age > 65 years, and high levels of pro-BNP, CRP, and UA. Patients can be safely ruled out if $PECSS \leq 4$, or if $4 < PECSS \leq 6$ and D-Dimer ≤ 2.5 mg/L.
Fayiad et al.¹⁷ (2024)	Egypt	Cross sectional study	50 participa nts	The YEARS score accurately predicted PE in 80% of 50 patients, with a 90% sensitivity and 65% specificity. Patients with zero YEARS score and D-dimer ≥ 1000 ng/ml or ≥ 1 YEARS score and D-dimer ≥ 500 ng/ml were likely to have PE. This reduces CTPA overuse in PE diagnosis.
Tang et al.¹⁸ (2024)	China	Retrospective Study	3437 participa nts	The study involved 3437 patients with PE, with 698 diagnosed. Integrating PERC or D-D with WS or RGS significantly decreased failure rates and increased sensitivity. However, using WS or RGS alone increased specificity and AUC. Overall, all screening approaches performed better among PE patients with respiratory distress compared to those without.

DISCUSSION

The study demonstrated that integrating clinical scoring systems with complementary diagnostic tools significantly improved the accuracy of pulmonary embolism (PE) diagnosis across all severity grades. Specifically, combining the Wells Score (WS) or Revised Geneva Score (RGS) with D-Dimer (D-D) testing or the Pulmonary Embolism Rule-out Criteria (PERC) yielded remarkable results. Notably, the combinations of WS + PERC and RGS + PERC reduced the rate of undiagnosed PE cases to below 1%, achieving near-perfect sensitivity.¹⁸ This substantial enhancement in diagnostic accuracy underscores the potential of integrative approaches in managing PE. However, the study also highlighted a critical trade-off: these combinations exhibited considerably lower specificity compared to using WS or RGS alone. Interestingly, WS + D-D and RGS + D-D achieved a more balanced performance, offering improved sensitivity while maintaining moderate specificity.¹⁹ These findings reinforce the utility of

incorporating tools like D-Dimer and PERC into traditional scoring systems to enhance diagnostic precision, particularly in conditions as critical as PE.^{16,18}

A critical metric in evaluating diagnostic efficacy is the failure rate, defined as the proportion of missed PE cases among all suspected cases.²⁰ By integrating PERC with WS or RGS, the study observed significant reductions in failure rates, especially among patients presenting with respiratory distress. This aligns with PERC's primary purpose of safely ruling out PE in low-risk cases.^{16,21} Moreover, while WS and RGS alone exhibited moderate concordance in stratifying patients into risk categories, combining them with PERC led to a more unified and accurate classification system.¹⁴ Notably, RGS + PERC achieved a zero failure rate in patients with main pulmonary artery PE who did not exhibit respiratory distress, positioning it as a potentially superior diagnostic tool for atypical and severe PE presentations.¹⁸

Despite its advantages, integrating PERC into diagnostic

strategies came at the cost of reduced specificity, a common trade-off in achieving higher sensitivity. Increased sensitivity often leads to more false positives, which can impact specificity metrics.²² This phenomenon was reflected in the lower area under the curve (AUC) values for WS + PERC and RGS + PERC, indicating diminished discriminative power.²³ However, in clinical settings—particularly emergency and community environments—predictive values hold greater practical relevance than AUC metrics. The integrative approaches demonstrated high negative predictive values (NPVs), emphasizing their reliability in ruling out PE when test results are negative. Conversely, their low positive predictive values (PPVs) suggest limited effectiveness in confirming a PE diagnosis based on a positive result.^{24,25}

These findings suggest that integrating clinical scoring systems such as WS and RGS with PERC or D-Dimer can substantially improve diagnostic outcomes for PE, particularly in complex or high-risk

cases. The trade-offs between sensitivity and specificity necessitate thoughtful consideration by clinicians, who must balance the risks of false negatives against the implications of false positives. RGS + PERC, in particular, shows great promise in diagnosing severe and atypical PE cases, offering a pathway for enhancing patient outcomes in critical scenarios. Future research should aim to refine these integrative approaches, assess their utility across diverse populations, and explore strategies to mitigate specificity limitations, ultimately advancing the management of PE in varied clinical contexts.

CONCLUSION

In conclusion, integrating clinical scoring systems with complementary tools such as D-Dimer testing and PERC has significantly enhanced the diagnostic accuracy for pulmonary embolism (PE), particularly in high-risk and complex cases. While combinations like WS + PERC and RGS + PERC achieved near-perfect sensitivity and reduced failure rates, they also

highlighted the trade-offs between sensitivity and specificity inherent in such strategies. Notably, the RGS + PERC combination demonstrated exceptional potential for diagnosing severe and atypical PE presentations, offering a promising tool for improving patient outcomes. Moving forward, further research is essential to refine these integrative methods, address specificity limitations, and validate their efficacy across diverse clinical settings and patient populations.

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