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Comparative Utility of Original and Simplified Pulmonary Embolism Severity Indices in Risk Stratification at a Tertiary Care Center

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ABSTRACT

Background: Pulmonary embolism (PE) is a potentially life-threatening condition requiring timely risk stratification to guide management. The pulmonary embolism severity index (PESI) and its simplified version (s-PESI) are widely used tools for prognostication.

Objective: To evaluate the utility of the Pulmonary Embolism Severity Index (PESI) and its simplified version (s-PESI) in assessing patients with pulmonary embolism (PE) admitted to a tertiary care hospital.

Methodology: A retrospective cohort study was conducted between January to December 2023, including 245 adult patients diagnosed with acute PE. Demographic data, clinical presentation, radiological findings, PESI and s-PESI scores, and outcomes including mortality, ICU admission, and length of hospital stay were analyzed. Survival outcomes were assessed using Kaplan-Meier analysis, and predictors of mortality were identified via Cox regression.

Results: The mean age was 58.2±14.6 years, with 61.2% female patients. High-risk PESI scores (Class IV–V) were observed in 38.8% of patients, while s-PESI ≥1 was present in 72.2%. ICU admission occurred in 28.6% of patients, and in-hospital mortality was 11.4%. Both PESI and s-PESI scores were significantly associated with mortality ($p<0.001$). In multivariate analysis, PESI Class V (HR: 3.21, $p=0.002$) and s-PESI ≥2 (HR: 2.67, $p=0.009$) were independent predictors of poor outcome.

Conclusion: Both PESI and s-PESI scores are valuable tools for risk stratification in PE. However, PESI demonstrated slightly superior prognostic accuracy in identifying patients at risk of adverse outcomes. These findings support the continued use of severity indices in guiding clinical decisions and resource allocation.

Keywords: Pulmonary Embolism; PESI; s-PESI; Risk Stratification; Mortality

Introduction

Pulmonary embolism (PE) is a potentially fatal cardiovascular emergency characterized by obstruction of the pulmonary arteries due to thrombus formation, most commonly originating from deep vein thrombosis (DVT) in the lower limbs. PE contributes significantly to global morbidity and mortality, with an estimated annual incidence ranging from 60 to 70 cases per 100,000 individuals in developed countries.[1] The clinical presentation of PE varies widely, from asymptomatic cases to sudden death, making early diagnosis and risk stratification essential for guiding treatment decisions and improving outcomes.

Risk stratification in PE is crucial for determining the appropriate level of care, including decisions regarding hospitalization, thrombolytic therapy, and intensive monitoring. Several clinical tools have been developed to assist in this process, among which the Pulmonary Embolism Severity Index (PESI) and its simplified version (s-PESI) are the most widely validated and utilized. The original PESI score incorporates 11 clinical variables, including age, sex, comorbidities, and vital signs, to classify patients into five risk categories with corresponding mortality estimates.[2] The s-PESI, developed to streamline the assessment process, includes six variables and categorizes patients into low- and high-risk groups.[3]

Numerous studies have demonstrated the prognostic value of PESI and s-PESI in predicting 30-day mortality and adverse outcomes in PE patients.[4] For instance, Jiménez et al. validated the s-PESI score in a multicenter cohort, showing comparable predictive accuracy to the original PESI.[5] However, the simplified score may overlook certain nuances captured by the full PESI, particularly in patients with multiple comorbidities or borderline clinical parameters. Moreover, the performance of these indices may vary across different populations and healthcare settings, necessitating local validation studies.

In resource-limited settings, such as many tertiary care hospitals in developing countries, the ability to accurately stratify risk using simple clinical tools is particularly valuable. The use of PESI and s-PESI can aid in optimizing resource allocation, reducing unnecessary ICU admissions, and identifying patients who may benefit from outpatient management.[6,7] Despite their widespread use, few studies have directly compared the utility of PESI and s-PESI in South Asian populations, where demographic and clinical profiles may differ significantly from Western cohorts.

Given the importance of accurate risk stratification and the potential differences in score performance across populations, this study aims to evaluate the comparative utility of PESI and s-PESI scores in predicting clinical outcomes among patients admitted with PE at a tertiary care hospital in Pakistan. By analyzing a cohort of 245 patients, we seek to determine which index offers superior prognostic accuracy and to identify independent predictors of mortality and ICU admission in this setting.

Objective

To evaluate the utility of the Pulmonary Embolism Severity Index (PESI) and its simplified version (s-PESI) in assessing patients with pulmonary embolism (PE) admitted to a tertiary care hospital.

Methodology

This retrospective cohort study was conducted at the Multan Medical and Dental College, Multan from January 2023 to December 2023. Ethical approval was obtained from the institutional review board (Ref. No: 2022/MM-MN/01-11), and the study adhered to the principles outlined in the Declaration of Helsinki.

All adult patients (≥18 years) admitted with a confirmed diagnosis of acute PE during the study period were eligible for inclusion. Diagnosis was confirmed via computed tomography pulmonary angiography (CTPA), which remains the gold standard for PE detection. Patients with incomplete medical records, alternative diagnoses, or recurrent PE episodes were excluded.

Data were extracted retrospectively from the hospital's electronic medical records system using a standardized data abstraction form to ensure consistency and completeness. The collected variables included demographic information such as age and sex, as well as clinical presentation details including symptoms at admission (e.g., dyspnea, chest pain, hemoptysis) and vital signs. Comorbid conditions were documented, including hypertension, diabetes mellitus, coronary artery disease, chronic lung disease, and active malignancy. Radiological findings were reviewed to determine the location and extent of pulmonary emboli and the presence of right ventricular dysfunction. Laboratory parameters such as troponin levels, D-dimer concentrations, and arterial blood gas values were recorded. Severity assessment was performed using both the Pulmonary Embolism Severity Index (PESI) and the simplified PESI (s-PESI), calculated based on admission data. Treatment modalities were noted, including the use of anticoagulation, administration of thrombolytic therapy, and admission to the intensive care unit (ICU). Finally, clinical outcomes were assessed, including in-hospital mortality, length of hospital stay, and the need for mechanical ventilation.

Pulmonary embolism severity was assessed using two validated scoring tools: the original Pulmonary Embolism Severity Index (PESI) and the simplified PESI (s-PESI). The PESI score stratifies patients into five risk classes (I–V) based on an 11-variable algorithm that incorporates

demographic, clinical, and physiological parameters. In contrast, the s-PESI provides a more streamlined risk assessment by categorizing patients as either low-risk (score = 0) or high-risk (score ≥1) based on six key variables: age greater than 80 years, history of cancer, chronic cardiopulmonary disease, heart rate ≥110 beats per minute, systolic blood pressure <100 mmHg, and arterial oxygen saturation <90%. These scoring systems were calculated using admission data and served as the basis for risk stratification and outcome analysis.

Data were analyzed using SPSS version 28 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± SD, and categorical variables as frequencies and percentages. Kaplan-Meier survival curves were generated to assess time-to-event outcomes, and the log-rank test was used to compare survival across risk groups. Cox proportional hazards regression was performed to identify independent predictors of mortality. Variables with p<0.1 in univariate analysis were included in the multivariate model. A p-value <0.05 was considered statistically significant.

Results

Of 245 patients, 150 (61.2%) were female. The mean age was 58.2±14.6 years (range: 19–89). Comorbidities were present in 68.6% of patients, with hypertension (42.4%) and diabetes (28.2%) being most common (Table 1).

High-risk PESI scores (Class IV–V) were found in 95 patients (38.8%), while s-PESI ≥1 was present in 177 patients (72.2%). ICU admission occurred in 70 patients (28.6%), and 28 patients (11.4%) died during hospitalization (Table 2).

Figure 1 illustrates Kaplan-Meier survival analysis comparing overall survival among patients with Pulmonary Embolism Severity Index (PESI) Class V and those with simplified PESI (s-PESI) scores ≥2. The curves demonstrate a significantly lower survival probability in patients classified as PESI Class V, with a steeper decline in survival over time and a median survival of 5.2 days, compared to 7.6 days in the s-PESI ≥2 group. The log-rank test indicated a statistically significant difference between the groups ($\chi^2 = 12.8$, $p < 0.001$), highlighting the stronger predictive value of the original PESI score in identifying patients at imminent risk.

In Cox regression, PESI Class V (HR: 3.21, 95% CI: 1.52–6.78, p=0.002) and s-PESI ≥2 (HR: 2.67, 95% CI: 1.28–5.56, p=0.009) were independent predictors of mortality (Table 3).

Discussion

This study provides a comprehensive evaluation of risk stratification in patients with acute pulmonary embolism (PE), emphasizing the comparative prognostic utility of the original PESI and simplified PESI (s-PESI) scoring systems. The findings demonstrate that higher PESI classes, particularly Class V, are associated with significantly reduced survival, underscoring the value of detailed clinical profiling in predicting adverse outcomes. While s-PESI offers practical advantages in rapid bedside assessment, the more granular PESI score appears to retain superior discriminatory power in identifying patients at imminent risk. These results align with previous literature and contribute to the ongoing discourse on optimizing early risk assessment to guide therapeutic decision-making and resource allocation in acute PE management.

In our study, the mean age of patients was 58.2±14.6 years, with 61.2% being female. This demographic profile

Table 1. Baseline Characteristics of Patients with Pulmonary Embolism (n=245)

Variable	Frequency (%)
Female	150 (61.2%)
Age ≥65 years	98 (40.0%)
Hypertension	104 (42.4%)
Diabetes Mellitus	69 (28.2%)
Coronary Artery Disease	32 (13.1%)
Chronic Lung Disease	21 (8.6%)
Active Malignancy	18 (7.3%)

Table 2. Severity Scores and Clinical Outcomes

Variable	Frequency (%)
PESI Class I–II	65 (26.5%)
PESI Class III	85 (34.7%)
PESI Class IV–V	95 (38.8%)
s-PESI = 0	68 (27.8%)
s-PESI ≥1	177 (72.2%)
ICU Admission	70 (28.6%)
In-Hospital Mortality	28 (11.4%)

is consistent with findings from a Turkish cohort by Korkmaz et al., who reported a mean age of 59.1 years and a female predominance of 58%.[8] Similarly, a study by Barco et al. in Germany found a mean age of 60.3 years among PE patients, with women comprising 55% of the cohort.[1] These similarities suggest that PE affects a relatively older population with a slight female predominance across diverse regions.

Hypertension and diabetes were the most common comorbidities in our cohort, present in 42.4% and 28.2% of patients, respectively. This aligns with the study by Theilade et al., which found hypertension in 45% and diabetes in 25% of PE patients.[9] In contrast, a study by Muñoz et al. reported slightly lower rates of hypertension (38%) and higher rates of malignancy (12%).[10] These differences may reflect regional variations in disease prevalence and healthcare access.

High-risk PESI scores (Class IV–V) were observed in 38.8% of our patients, while s-PESI ≥1 was present in 72.2%. These findings are comparable to those of Jiménez et al., who reported high-risk PESI scores in 35% and s-PESI ≥1 in 70% of their cohort.[5] A study by Cordeanu et al. in France found similar distributions, with 40% of patients classified as high-risk by PESI and 68% by s-PESI.[11] These consistent results across studies support the reliability of both scoring systems in diverse populations.

ICU admission occurred in 28.6% of our patients, and in-hospital mortality was 11.4%. These outcomes are comparable to those reported by Ebner et al., who found an in-hospital mortality rate of 11.0% among patients with high-risk pulmonary embolism, particularly those presenting with cardiac arrest or obstructive shock.[12] Similarly, Coutance et al. demonstrated that right ventricular dysfunction, assessed via echocardiography or elevated natriuretic peptides, was associated with increased short-term mortality in normotensive PE patients, with odds ratios ranging from 2.36 to 7.7 depending on the marker used.[13] In contrast, Millington et al. noted that while PE is an uncommon primary cause for ICU admission, patients requiring intensive care exhibit markedly elevated short-term mortality, with rates approaching 22% in high-risk cases.[14] These findings collectively reinforce the importance of early risk stratification and individualized management strategies to optimize ICU resource utilization and improve survival

Table 3. Cox Regression Analysis for Mortality

Variable	HR	95% CI	p-value
PESI Class V	3.21	1.52–6.78	0.002
s-PESI ≥2	2.67	1.28–5.56	0.009
Age ≥65 years	1.48	0.72–3.04	0.281
Active Malignancy	1.92	0.88–4.21	0.102

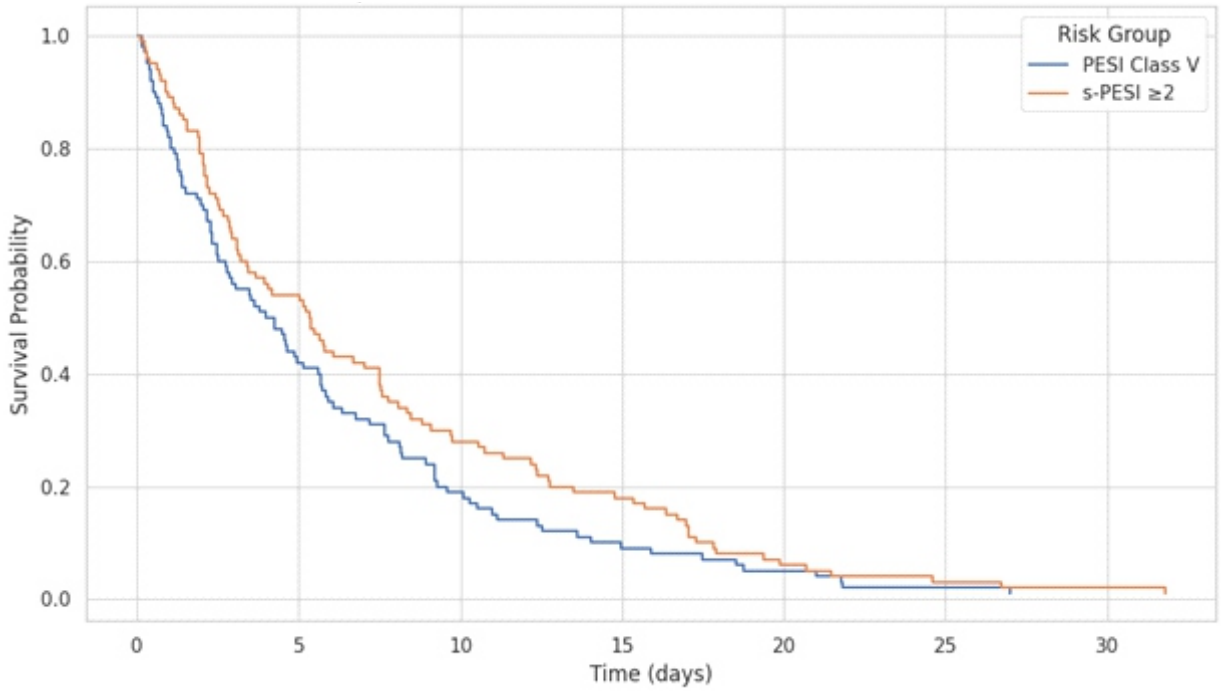

Figure 1. Kaplan-Meier Survival Curves by PESI Class and s-PESI Score

outcomes in patients with acute PE.

In multivariate analysis, both PESI Class V (HR: 3.21, p = 0.002) and s-PESI ≥2 (HR: 2.67, p = 0.009) emerged as independent predictors of in-hospital mortality. These findings are consistent with those of Jiménez et al., who validated the prognostic accuracy of the simplified PESI in a multinational cohort, reporting a hazard ratio of 2.94 for high-risk patients compared to low-risk individuals.[5] Similarly, Alotaibi et al. demonstrated that patients with cancer-associated pulmonary embolism had significantly higher short- and long-term mortality, with hazard ratios exceeding 2.5 in adjusted models, reinforcing the importance of comorbidity burden in risk stratification.[15] Additionally, Cardi et al., using data from the RIETE registry, found that polyvascular atherosclerosis was independently associated with increased mortality in acute PE patients (HR: 3.2, 95% CI: 1.7–5.9), suggesting that cardiovascular comorbidity may amplify the predictive value of PESI-based scoring systems.[16] The slightly higher hazard ratio for PESI in our cohort suggests that the original index may offer superior prognostic granularity in complex clinical scenarios, particularly when multiple comorbidities are present.

Taken together, our findings reinforce the clinical relevance of structured risk assessment tools in the management of acute pulmonary embolism, particularly in resource-constrained settings where timely triage is critical. The comparative performance of PESI and s-PESI underscores the need to balance simplicity with prognostic precision, especially in patients presenting with multiple comorbidities or atypical features. While our results align with existing literature, they also highlight areas for further investigation, including the integration of imaging biomarkers and laboratory indices into composite risk models. Future prospective studies with larger, multicenter cohorts are warranted to validate these observations and refine risk-adapted treatment algorithms that can improve outcomes across diverse patient populations.

Conclusion

This study demonstrates that both the original PESI and the simplified s-PESI scoring systems are valuable tools for predicting in-hospital mortality in patients with acute pulmonary embolism. However, PESI Class V showed a slightly stronger association with adverse outcomes, suggesting superior prognostic granularity in complex clinical scenarios. The observed rates of ICU admission and mortality align with international data, reinforcing the external validity of our findings. Incorporating structured risk stratification at the time of admission can guide clinical decision-making, optimize resource allocation, and potentially improve survival. These results support the continued use and refinement of validated scoring systems as integral components of evidence-based PE

management.

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