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ABSTRACT

Introduction
Pulmonary embolism is a major cause of cardiovascular mortality worldwide. Several risk-stratification scores have been developed and validated to assess prognosis, among which the Pulmonary Embolism Severity Index (PESI) is the most widely used.

Purpose
To evaluate the prognostic performance of the PESI score in patients with pulmonary embolism in the Democratic Republic of Congo.

Methods
We conducted a single-centre retrospective cohort study at the Diamant Ngaliema Medical Center in Kinshasa from January 2022 to December 2024. Following diagnostic confirmation by computed tomography pulmonary angiography, patients were classified into high-risk (HR) and low-risk (LR) groups according to the PESI score. The primary endpoints were in-hospital mortality and 30-day mortality. Ethical approval was obtained from the Ethics Committee of the Kinshasa School of Public Health.

Results
The mean age was 63.9 ± 16.9 years. Dyspnoea was the most common presenting symptom (79.7%). Pulmonary embolism was predominantly distal (87.5%), particularly in the low-risk group (92.1%). Mechanical ventilation was required in 17.2% of patients and occurred exclusively in the HR group (42.3% vs. 0%, $p < 0.001$). Major adverse cardiovascular events occurred in 18.8% of patients, with shock observed only in the HR group (38.5% vs. 0%, $p = 0.032$). Overall in-hospital mortality was 12.5%, with all deaths occurring in the HR group (30.8% vs. 0%, $p < 0.001$). In multivariable analysis, mechanical ventilation (adjusted OR = 4.62, 95% CI: 1.31–16.29; $p = 0.018$) and shock (adjusted OR = 3.91, 95% CI: 1.08–14.17; $p = 0.037$) were independent predictors of mortality. Thirty-day survival was significantly lower in the HR group (log-rank $p = 0.019$), with a twofold increased risk of death (HR = 2.12, 95% CI: 1.13–3.97).

Conclusion
The PESI score demonstrated good prognostic performance for mortality in pulmonary embolism. Its systematic use may improve risk stratification and clinical decision-making in resource-limited settings.

INTRODUCTION

Pulmonary embolism (PE) is a potentially life-threatening medical emergency. The literature indicates that up to 20% of patients admitted with PE die within 90 days (Lehnert et al., 2018). Its diagnosis is challenging because of the lack of specific clinical signs. To overcome this difficulty, the use of clinical probability scores is often necessary (Bula-Bula et al., 2024).

Once the diagnosis of PE is confirmed, questions regarding prognosis and management arise (Junod, 2016). The European Society of Cardiology (ESC) guidelines on the diagnosis and management of pulmonary embolism recommend stratifying patients according to their risk of in-hospital and 30-day mortality (Bounameaux et al., 2010). Initial risk stratification in PE allows for the identification of patients who require aggressive treatment and those who may be managed on an outpatient basis. It also enables personalised patient management (Torbicki et al., 2008).

Nine prognostic scores for pulmonary embolism, published between 2000 and 2014 and based on retrospective and prospective studies, have been analysed and compared. These scores aim to identify low-risk PE cases to facilitate outpatient management (Meneveau, 2015).

Among these scores, the best known and most widely used in research is the Pulmonary Embolism Severity Index (PESI). Developed in 2005 in the United States, it comprises five classes and allows for refined stratification of 30-day prognosis. Low mortality (approximately 2%) is observed in the low-risk classes (I–II), with a significant increase in the intermediate-risk class (III, 6.5%) and in the high-risk classes (IV and V, 10.4% and 24.5%, respectively) (Aujesky et al., 2005).

In sub-Saharan Africa, as in other regions of the world, the incidence of PE is high. However, intensive care units (ICUs) and critical care services are few and often under-equipped (Geandreau et al., 2025; Lokoussou et al., 2007). In addition, the medical context is frequently challenging, with limited access to imaging, the inability to ensure systematic ICU admission for all suspected PE cases, and other structural constraints. These challenges may be mitigated through the use of clinical prognostic scores.

Unfortunately, most studies validating these scores have been conducted in developed countries (Bourgos et al., 2021; Jiménez et al., 2010; Konstantinides et al., 2014; Mizuno et al., 2015; Venetz et al., 2011), and data from sub-Saharan Africa remain scarce. Moreover, constraints such as the absence of thrombolysis may affect the performance of PESI. Consequently, the use of this score in a low-income country such as the Democratic Republic of the Congo (DRC) may require local validation.

In the DRC, to the best of our knowledge, no study has yet evaluated the performance and applicability of PESI. Such a study could improve patient management by accounting for local realities, optimise the use of limited ICU resources, and enhance the quality of care while ensuring patient safety.

The objective of this study was therefore to evaluate the performance of PESI in predicting mortality related to pulmonary embolism in Kinshasa.

METHODS

Study Design, Period, and Setting

This was a retrospective, single-centre cohort study conducted in Kinshasa at the Centre Médical Diamant Ngaliema (CMDN). The study covered the period from January 2022 to December 2024.

Population and Sampling

The study population consisted of all patients hospitalised for pulmonary embolism at the selected centre. Patient recruitment was exhaustive and based on admission registers and electronic medical records. The study included all patients aged 18 years and older with a diagnosis of pulmonary embolism confirmed by computed tomography pulmonary angiography.

Given the retrospective and exploratory nature of the study, all consecutive patients meeting the inclusion criteria were included. Although no formal a priori sample size calculation was performed, the resulting sample size was considered sufficient to analyse major prognostic factors using multivariable logistic regression and survival analysis. In post hoc analysis, the observed effect sizes for the main outcomes (mortality and survival) were sufficiently large to demonstrate statistically significant differences between risk groups.

Patients whose records lacked essential variables for the study were excluded. Patients lost to follow-up after hospital discharge were included in the calculation of in-hospital mortality but excluded from the 30-day mortality analysis. Thirty-day follow-up was conducted using CMDN medical records and the electronic information system, which enabled patient tracing and outcome ascertainment.

Data were collected using a specifically designed data collection form. Patients followed for up to 30 days after diagnosis were divided into two groups according to

disease severity estimated using the PESI score, which was calculated by the principal investigator. Group 1, considered low risk (LR), included classes I (≤ 65 points) and II (66–85 points), whereas Group 2, considered high risk (HR), included classes III (86–105 points), IV (106–125 points), and V (> 125 points), according to PESI. Low mortality (approximately 2%) was observed in the low-risk classes (I–II), with a marked increase in the intermediate-risk class (III, 6.5%) and high-risk classes (IV and V, 10.4% and 24.5%, respectively).

Table 1:
Variables and Points Awarded in the PESI

Parameters	Points
Age	Age in years
Male sex	+10
Cancer	+30
Chronic heart failure	+10
Chronic respiratory disease	+10
Heart rate	+20
Systolic blood pressure	+30
Respiratory rate	+20
Temperature	+20
Altered mental status	+60
Arterial oxygen saturation	+20

bpm = beats per minute.

Variables of Interest

The variables collected included age, sex, comorbidities (cancer, heart failure, chronic lung disease, diabetes, etc.), history of thromboembolic events, circumstances of onset, heart rate, blood pressure, respiratory rate, body temperature, peripheral oxygen saturation (SpO_2), and level of consciousness.

Paraclinical variables included the location of pulmonary embolism on CT scan, signs of right ventricular dysfunction (acute pulmonary hypertension, right ventricular dilatation, paradoxical septal motion), and levels of brain natriuretic peptide (BNP) or N-terminal pro–brain natriuretic peptide (NT-proBNP).

Therapeutic variables included heparin therapy, thrombolysis, and conventional oxygen therapy delivered via nasal cannula or high-concentration mask.

Outcome variables included length of hospital stay, in-hospital mortality, 30-day mortality, and the occurrence of complications such as the need for mechanical ventilation, right ventricular dysfunction, and major adverse cardiovascular events (MACE).

Several missing variables were accounted for in the presentation and discussion of the results (echocardiography: 5 missing; thrombolysis: 64 missing; 30-day mortality: 6 missing).

The primary endpoints were in-hospital mortality and 30-day mortality. Secondary endpoints included length of hospital stay and the occurrence of complications. Patients lost to follow-up were included in the analysis of in-hospital mortality but excluded from the 30-day mortality analysis.

Statistical Analysis and Ethical Considerations

Data were entered into a Microsoft Excel 2013 database, checked for consistency, coded, and exported to Epi Info version 7 for statistical analysis.

Categorical variables were expressed as counts (n) and percentages (%), while continuous variables were presented as means ± standard deviation. Comparisons of means were performed using Student's *t* test. Proportions were compared using Pearson's chi-square test, and Fisher's exact test was applied when validity conditions were not met.

To identify factors independently associated with the primary outcomes, multivariable analyses were conducted using logistic regression (for in-hospital mortality) and Cox proportional hazards regression (for 30-day mortality), with adjustment for major confounding variables, including age, sex, presence of cancer, and right ventricular dysfunction.

Survival was estimated using the Kaplan–Meier method, and survival curves were compared using the log-rank test. A p value < 0.05 was considered statistically significant.

Patient confidentiality and anonymity were maintained in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of the School of Public Health of Kinshasa (Approval No. ESP/CE/114/2025).

RESULTS

A total of 64 patients were included in the study, of whom six were lost to follow-up after hospital discharge. The definitive diagnosis of pulmonary embolism (PE) was established in all cases by computed tomography pulmonary angiography. All patients received standard

treatment with low-molecular-weight heparin, and none underwent thrombolysis. According to CMDN hospital policy, all patients were admitted to the intensive care unit once the diagnosis was confirmed.

The mean age was 57.41 ± 15.03 years (95% CI: 59.7–68.1), with a female predominance (male-to-female ratio = 0.56). Overall in-hospital mortality was 12.5% (95% CI: 5.6–23.2). The 30-day mortality rate calculated was 13.8%. The main clinical symptoms, aetiological factors, and comorbidities are presented in Table 2.

Table 2:
Distribution of Functional Signs, Aetiological Factors, and Comorbidities

Variable	Total n/N (%) [95% CI]	LR n/N (%) (n = 38)	HR n/N (%) (n = 26)	*p*
Dyspnoea	51/64 (79.7) [68.0–88.0]	28/38 (73.7)	23/26 (88.5)	0.023
Precordial pain	12/64 (18.8) [10.4–30.1]	10/38 (26.3)	2/26 (7.7)	0.417
Tachycardia	29/64 (45.3) [32.8–58.3]	11/38 (28.9)	18/26 (69.2)	0.165
Deep vein thrombosis	4/64 (6.3) [1.7–15.2]	2/38 (5.3)	2/26 (7.7)	0.359
Hypertension	13/64 (20.3) [11.2–32.1]	8/38 (21.1)	5/26 (19.2)	0.226
Cancer	2/64 (3.1) [0.4–10.8]	0/38 (0.0)	2/26 (7.7)	0.087

DVT = deep vein thrombosis; LR = low risk; HR = high risk.

Dyspnoea was significantly more frequent in high-risk patients than in low-risk patients (88.5% vs. 73.7%; p = 0.023). No other functional sign or comorbidity differed significantly between the two groups.

Paraclinical Findings

Paraclinical parameters for low-risk and high-risk patients are summarised in Table 3.

Table 3:
Paraclinical Parameters of Patients with Pulmonary Embolism

Variable	Total n/N (%) or Mean ± SD [95% CI]	LR (n = 38)	HR (n = 26)	*p*
SpO_2 (%)	91.4 ± 6.1 [89.9–92.9]	93.0 ± 4.4	89.1 ± 7.4	0.030
Reduced creatinine clearance†	6/64 (9.4) [3.5–19.3]	2/38 (5.3)	4/26 (15.4)	0.107
Haemoglobin (g/dL)	11.4 ± 1.5 [11.0–11.7]	11.3 ± 1.2	11.4 ± 1.9	0.850
Elevated D-dimers†	63/64 (98.4) [91.6–100]	37/38 (97.4)	26/26 (100)	0.203
Elevated NT-proBNP†	10/64 (15.6) [7.8–26.9]	4/38 (10.5)	6/26 (23.1)	0.645
Proximal PE	8/64 (12.5) [5.6–23.2]	3/38 (7.9)	5/26 (19.2)	0.089
Distal PE	56/64 (87.5) [76.8–94.4]	35/38 (92.1)	21/26 (80.8)	0.080
Cardiac ultrasound performed	59/64 (92.2) [82.7–97.4]	34/38 (89.5)	25/26 (96.2)	0.178
Right ventricular dysfunction	5/64 (7.8) [2.6–17.3]	1/38 (2.6)	4/26 (15.4)	0.400

SpO_2 = peripheral oxygen saturation; PE = pulmonary embolism; RV = right ventricle.

†Creatinine clearance < 60 mL/min; D-dimer > 500 ng/mL (or age-adjusted); NT-proBNP above diagnostic threshold. Patients in the high-risk group had significantly lower oxygen saturation than those in the low-risk group (89.1% vs. 93.0%; p = 0.030).

In-Hospital Complications and Mortality

In-hospital complications and mortality outcomes are presented in Table 4.

Table 4:
In-Hospital Complications and Mortality

Variable	Total n/N (%) [95% CI]	LR (n = 38)	HR (n = 26)	*p*
Mechanical ventilation	11/64 (17.2) [9.0–28.7]	0/38 (0.0)	11/26 (42.3)	< 0.001
Shock (MACE)	10/64 (15.6) [7.8–26.9]	0/38 (0.0)	10/26 (38.5)	0.032
Bradycardia (MACE)	2/64 (3.1) [0.4–10.8]	0/38 (0.0)	2/26 (7.7)	0.052
In-hospital mortality	8/64 (12.5) [5.6–23.2]	0/38 (0.0)	8/26 (30.8)	< 0.001

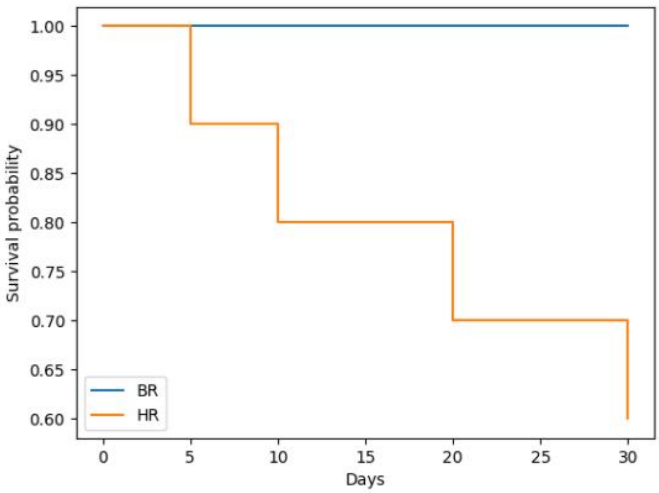
MACE = major adverse cardiovascular events; LR = low risk; HR = high risk.

High-risk patients experienced significantly higher rates of mechanical ventilation (42.3% vs. 0%; p < 0.001), shock (38.5% vs. 0%; p = 0.032), and in-hospital mortality (30.8% vs. 0%; p < 0.001). Bradycardia showed a trend towards statistical significance (p = 0.052).

Survival Analysis

Figure 1 illustrates the Kaplan–Meier survival curves for 30-day survival according to PESI risk group.

Figure 1:
The Kaplan–Meier survival curve below illustrates 30-day survival



Thirty-day survival differed significantly between groups. Patients in the high-risk group had significantly lower survival compared with those in the low-risk group (log-rank $p = 0.019$). In multivariable Cox proportional hazards regression analysis, high-risk group membership was independently associated with increased 30-day mortality (hazard ratio = 2.12; 95% CI: 1.13–3.97).

DISCUSSION

This study was conducted to evaluate the ability of the Pulmonary Embolism Severity Index (PESI) to predict in-hospital and 30-day mortality in a resource-limited setting. We found that this score was a good predictor of both mortality and morbidity in patients admitted for pulmonary embolism (PE) at the Centre Médical Diamant Ngaliema. A PESI score greater than 85, corresponding to high-risk classification, was associated with a significantly higher mortality rate.

The relatively small sample size of 64 patients may be explained by challenges related to the diagnosis of PE, including delayed hospital presentation, high healthcare costs, and limited access to diagnostic imaging in sub-Saharan Africa (Pessinaba et al., 2017).

Clinical Presentation and Baseline Characteristics

In our cohort, dyspnoea was the most common presenting symptom (79.7%), in agreement with findings reported by Hassine et al. (2023), Bakebe et al. (2017), and Tshilanda et al. (2023), as well as international data identifying dyspnoea as one of the most frequent symptoms of PE (Konstantinides et al., 2014). The high prevalence of this symptom highlights the importance of maintaining a high index of clinical suspicion, particularly in resource-limited settings where access to diagnostic imaging is often restricted (Becattini et al., 2022).

Pulmonary embolism was predominantly distal (87.5%), especially in the low-risk group (92.1%), which is consistent with observations reported by Diallo (2020) in Senegal, where distal PE accounted for 54% of cases. Although proximal PE is classically associated with greater haemodynamic severity (Konstantinides et al., 2020; Société Française d'Anesthésie et de Réanimation [SFAR], 2014), no statistically significant difference in PE localisation was observed between risk groups in our cohort ($p = 0.089$). This apparent discrepancy, despite greater clinical severity in the high-risk group, suggests that PE severity is not solely determined by thrombus location but also by factors such as age, underlying malignancy, haemodynamic instability, and individual physiological response.

Complications and Prognostic Factors

Mechanical ventilation was required in 11 patients (17.2%), exclusively in the high-risk group (42.3%), with a highly significant difference between groups ($p < 0.001$). Although this finding contrasts with results reported by Hassine et al. (2023), it is consistent with data from the RIETE registry, which reported mechanical ventilation in approximately 8% of patients hospitalised for PE (Jiménez et al., 2010). In our cohort, mechanical ventilation was strongly associated with mortality (adjusted OR = 4.62; 95% CI: 1.31–16.29; $p = 0.018$), underscoring its role as an independent marker of disease severity.

Major adverse cardiovascular events (MACE) occurred in 18.8% of patients, which is within the range reported in the literature (5.5%–17.3%) (Becattini et al., 2022; Noumegni et al., 2022). Shock, observed exclusively in the high-risk group (38.5% vs. 0%; $p = 0.032$), emerged as an independent predictor of in-hospital mortality (adjusted OR = 3.91; 95% CI: 1.08–14.17; $p = 0.037$), confirming its major prognostic significance, as previously described by Hassine et al.(2023) and Zhou et al. (2012)

Mortality and Survival Analysis

Overall in-hospital mortality was 12.5%, which is comparable to rates reported in African and international series (7%–32.6%) (Bakebe et al., 2017; Hassine et al., 2023; Mboliasa et al., 2015; Mizuno et al., 2015; Sandal et al., 2021; Taryètba et al., 2024; Thiam et al., 2025; Tshilanda et al., 2023). All deaths occurred in the high-risk group (30.8% vs. 0%; $p < 0.001$), consistent with findings reported by Chan et al. (2010).

Survival analysis demonstrated significantly lower 30-day survival in the high-risk group (log-rank $p = 0.019$), with more than a twofold increased risk of death (HR = 2.12; 95% CI: 1.13–3.97). These findings further emphasise the critical role of early risk stratification, as previously reported by Choi et al. (2009) and Sandal et al. (2021).

The absence of thrombolytic therapy at our centre, due to logistical and resource constraints, likely contributed to the high mortality observed among patients presenting with shock ($n = 10$). The literature clearly demonstrates that thrombolysis significantly improves outcomes in this high-risk subgroup (Bouzerda et al., 2017; Mamadou et al., 2024).

Practical and Organisational Implications

Our findings confirm the value of the PESI score for effective patient triage and rational allocation of limited healthcare resources in economically constrained settings. Early identification of low-risk patients may enable simplified management pathways, including reduced

need for intensive monitoring, while preserving scarce hospital and intensive care resources for the most severe cases.

However, the real-world impact of this strategy also depends on strengthening primary healthcare systems, particularly in rural areas, which often represent the first point of contact for a large proportion of the population.

Limitations

This study has several limitations. It was conducted at a single centre, and all patients with confirmed PE were admitted to the intensive care unit regardless of clinical severity. This institutional policy may have led to an overrepresentation of more severe cases and limits the generalisability of the findings to other settings.

Nevertheless, the consecutive inclusion of all eligible patients during the study period reduces the risk of internal selection bias and supports the validity of the observed associations. These results should be interpreted with caution and warrant confirmation through larger, prospective, multicentre studies.

CONCLUSION

In this single-centre retrospective cohort study, the PESI score enabled effective stratification of patients according to mortality risk. These findings support the prognostic utility of PESI in a resource-limited setting and highlight the need for future multicentre, prospective studies with larger sample sizes and consideration of contextual factors such as the availability of thrombolytic therapy.

The systematic use of PESI could facilitate early identification of high-risk patients, guide appropriate management decisions, and optimise the use of limited hospital resources—including intensive care capacity, anticoagulant therapy, and laboratory monitoring—while also accounting for the burden of infectious and non-communicable comorbidities.

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Ethical Approval: Patient confidentiality and anonymity were maintained in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of the Kinshasa School of Public Health (Approval No. ESP/CE/114/2025)..

Conflicts of Interest: None declared.

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