

Review of the the Pulmonary Embolism Severity Index (PESI) Calculator

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Abstract

The Pulmonary Embolism Severity Index (PESI) is a risk stratification tool that has been externally validated to determine the mortality and outcome of patients with newly diagnosed PE.

I. HOW TO USE

When to Use

The Pulmonary Embolism Severity Index (PESI) is a risk stratification tool that has been externally validated to determine the mortality and outcome of patients with newly diagnosed PE.

Pearls / Pitfalls

1. PESI determines risk of mortality and severity of complications
2. PESI does not take into account laboratory data
3. PESI does not take into account CTPA imaging results/RV dysfunction findings
4. Should always be used within the appropriate clinical context

Why Use

The PESI is designed to risk stratify patients who have been diagnosed with a PE to determine the severity of their disease. This can help physicians make decisions on the management of those patients who could potentially be treated as outpatients, as well as raise concern for those who are determined to be high-risk and could benefit from higher levels of care.

II. NEXT STEPS

Advice

Social determinants of health should be taken into account before considering outpatient management (including access to anticoagulants and prompt follow-up

care for further workup and management, typically within 7 days).

Given low mortality of low risk PE, outpatient management would save significant healthcare costs over hospitalization (~5000 EUR per avoided admission per Ghazvinian et al, 2020).

The non-inferiority trial showed successful and safe outpatient management of Class I and II patients.

Management

If the patient is considered very low (≤ 65) or low risk (66-85) by the PESI score.

1. Patient has an overall low risk of mortality or severe morbidity.
2. Consider outpatient management of PE if clinically appropriate and social factors allow for it.

If the patient is considered intermediate (86-105), high risk (106-125) or very high risk (>125) by the PESI.

1. Patient has an overall high risk of mortality and severe morbidity.
2. Consider higher levels of care (e.g., ICU) for those with higher scores.

Critical Actions

1. Renal failure or patients with other significant comorbidities should be considered separately as these patients were not included in the validation study
2. CTPA measured parameters can be superior to PESI in 30d mortality
3. PESI poorly predicts morbidity/mortality in intermediate risk groups

4. pro-BNP levels, RV function and presents of thrombus in R heart to determine high/low risk assessment

III. EVIDENCE

Evidence Appraisal

The primary evaluation was designed to develop a prediction rule which classifies patients already diagnosed with pulmonary embolism on risk of mortality and morbidity.

- Short-term mortality is cited to range from 2-95% based on severity of PE (submassive vs. cardiorespiratory arrest).
- Patients were retrospectively identified from a healthcare database of inpatients >18 years old with a primary or secondary diagnosis of PE (plus a diagnosis of PE related complication, i.e., arrest, shock, pulmonary hypertension) from 2000-2002.
- 15,531 patients from 186 hospitals were identified, with 10,354 (67%) randomly selected for derivation and 5,177 (33%) held for internal validation. The authors derived 11 criteria with regression analysis based on a main outcome of 30-day mortality.
- Criteria: male sex, cancer, CHF, lung disease, pulse ≥ 110 , SBP < 100 , RR ≥ 30 , temp $< 36^\circ\text{C}$, ams, and $\text{O}_2 \text{ SAT} < 90 \text{ mmHg}$.
- Created 5 classes:
 - Class I - Scores ≤ 65 indicate very low risk.
 - Class II - Scores of 66-85 indicate low risk.
 - Class III - Scores of 86-105 indicate intermediate risk.
 - Class IV - Scores of 106-125 indicate high risk.
 - Class V - Scores > 125 indicate very high risk.
- Externally validated in 221 ED patients in Switzerland and France, confirmed with CT scan and followed up for mortality and complications.
- 30-day mortality rate for the derivation was 9.2% and for the internal validation was 9.5%. The external validation has a 30-day mortality rate of 2.7% but is complicated by a lower prevalence of comorbidities.
 - Derivation mortality risk for level: I) 1.1%, II) 3.1%, III) 6.5%, IV) 10.4%, V) 24.5%.
 - Internal validation mortality risk for level: I) 1.6%, II) 3.5%, III) 7.1%, IV) 11.4%, V) 23.9%.
 - External validation mortality risk for level: I) 0%, II) 1.7%, III) 3.2%, IV) 4%, V) 10.0%.
- Nonfatal cardiogenic shock or cardiorespiratory arrest occurred in less than 1.3% (derivation) of Class II, and less than 1.0% (internal validation) of Class I.

Derivation study:

Citation	Aujesky D, Obrosky DS, Stone RA, Auble TE, Perrier A, Cornuz J, Roy PM, Fine MJ. Derivation and validation of a prognostic model for pulmonary embolism. <i>Am J Respir Crit Care Med</i> . 2005 Oct 15;172(8):1041-6. doi: 10.1164/rccm.200506-862OC. Epub 2005 Jul 14. PMID: 16020800; PMCID: PMC2718410.
Type of study	Observational cohort study
Funding source	Supported by a grant from the National Heart, Lung, and Blood Institute (1 R21 HL075521-01A1). D.A. was supported by the Swiss Foundation in Medicine and Biology and the Swiss Medical Association, and the Clinical Epidemiology Center, University of Lausanne. M.J.F. was supported in part by a career development award (K24 AI001769) from the National Institute of Allergy and Infectious Diseases.
Number of patients	• 15,531 patients discharged from inpatient settings in Pennsylvania who had been diagnosed with PE ◦ From these patients, 10,354 were randomly selected for tool derivation and the other 5,177 for internal validation • Additional 221 inpatients prospectively diagnosed with PE from three in Switzerland and France for external validation
Inclusion criteria	• Hospitalized patients, 18y or older • Diagnosed with PE • Primary diagnosis of PE based on ICD-9 code OR secondary diagnosis of PE along with a primary diagnosis representing a complication or treatment of PE, such as: 1. Respiratory failure 2. Cardiogenic shock 3. Cardiac arrest 4. Secondary pulmonary hypertension 5. Syncope 6. Thrombolysis 7. Intubation/mechanical ventilation External validation Cohort: 1. Inpatients prospectively diagnosed with PE using CTA
Exclusion criteria	External validation Cohort: 1. Unable to get CTA 2. Severely ill patients unable to be diagnosed by CTA
Study endpoints and findings	The following eleven patient characteristics independently associated with 30-day mortality stratified patients with PE into five severity classes. A yes or no answer used except for patient's age and sex. 1. Age (number in years) 2. Sex (male or female) 3. History of cancer 4. History of heart failure 5. History of chronic lung disease 6. Heart rate < 100 7. Systolic BP $< 100 \text{ mmHg}$ 8. Respiratory rate ≥ 30 9. Temperature $< 36^\circ\text{C}/96.8^\circ\text{F}$ 10. Altered mental status (disorientation, lethargy, stupor or coma) 11. Oxygen saturation $< 90\%$ Patients were divided into the following five severity classes: 1. 0 – 1.6% in class I 2. 1.7 – 3.5% in class II 3. 3.2 – 7.1% in class III 4. 4.0 – 11.4% in class IV 5. 10 – 24.5% in class V The overall 30-day mortality rate for the derivation was 9.2% and for the internal validation was 9.5%. The external validation had a 30-day mortality rate of 2.7% but was confounded by a lower prevalence of comorbidities.

	- Derivation mortality risk for level: I) 1.1%, II) 3.1%, III) 6.5%, IV) 10.4%, V) 24.5%. - Internal validation mortality risk for level: I) 1.6%, II) 3.5%, III) 7.1%, IV) 11.4%, V) 23.9%. - External validation mortality risk for level: I) 0%, II) 1.7%, III) 3.2%, IV) 4%, V) 10.0%.
Strengths	- First derivation of a practical bedside prediction rule stratifying risk in patient diagnosed with PE - Internally and externally validated - Large sample size - Clinically relevant outcome - Uses easily accessible clinical variables
Criticisms	- Only hospitalized patients included - Patients in the externally validated group were overall healthier, with less comorbidities. Fewer severely ill patients presented compared to the derivation study. - Certain patient comorbidities not considered

Validation Study:

Citation	Donzé J, Le Gal G, Fine MJ, et al. Prospective validation of the Pulmonary Embolism Severity Index. A clinical prognostic model for pulmonary embolism. <i>Thromb Haemost.</i> 2008;100(5):943-948. doi:10.1160/th08-05-0285
Type of study	Prospective cohort study
Funding source	n/a
Number of patients	357
Inclusion criteria	- Confirmed diagnosis of acute PE - Adult patients >18y - Consecutive enrollment to participating European hospitals - PESI variables available
Exclusion criteria	- Unable to confirm PE - Unable to obtain all required PESI calculation variables - Pregnant patients - Patients unable to be present for 90-day follow up
Study endpoints and findings	Validate the PESI in a European cohort. Prospectively validated the PESI in patients with PE diagnosis between six emergency departments in three European countries. The PESI reliably identified patients at low-risk PE who could benefit from outpatient treatment.
Strengths	- Prospective study - Several different emergency departments - Objectively confirmed PE
Criticisms	- Limited power due to small sample size - Limited data for higher risk PESI classifications - Only EU hospitals - Focused only on mortality - No funding disclosure - Excluded patients unable to follow up at 90-day mark

Validation Study:

Citation	Perrier A, Roy PM, Aujesky D, et al. Validation of the Pulmonary Embolism Severity Index (PESI) in a European cohort of patients with pulmonary embolism. <i>Eur Heart J.</i> 2008;29(15):1905-1910.
Type of study	Prospective multicenter validation cohort study
Funding source	n/a
Number of patients	357
Inclusion criteria	- Adults >18y - Objectively confirmed PE on imaging (CTA, VP scan, Pulmonary angiography) - Able to calculate PESI
Exclusion criteria	- No confirmed PE - Missing PESI variables - Were not part of the prospectively enrolled eligible patient cohort
Study endpoints and findings	To externally validate the PESI score to predict mortality in patients with acute PE across many European centers.
Strengths	90-day all-cause mortality end point - Objectively confirmed PE on imaging - Prospective design
Criticisms	- Limited power due to small sample size - Geographic limitation - Focused on mortality only, no other negative outcomes - Observational - Unable to determine funding source

Validation Study:

Citation	Bumroongkit C, Limsukon A, Liwsrisakun C, et al. Validation of the Pulmonary Embolism Severity Index Risk Classification and the 2019 European Society of Cardiology Risk Stratification in the Southeast Asian Population with Acute Pulmonary Embolism. <i>J Atheroscler Thromb.</i> 2023;30(11):1601-1611. doi:10.5551/jat.64094
Type of study	Retrospective cross-sectional cohort study
Funding source	n/a
Number of patients	696
Inclusion criteria	- Patients aged >15 - ICD-10 codes consistent with acute PE - Acute PE confirmed with imaging - Complete data to calculate necessary PESI and sPESI variables
Exclusion criteria	- Non-Asian ethnicity - Repeated admissions - No imaging confirmation of PE - Incorrect diagnosis code - Chronic PE instead of acute - Missing data to calculate risk stratification score
Study endpoints and findings	30-day all-cause mortality risk increased with higher PESI risk classes. PESI classification showed ~6-fold increased risk of 30-day mortality in high risk vs low risk groups.

Strengths	1. Large sample size over 10-year period 2. Used confirmatory imaging 3. Assessed 30-day all-cause mortality 4. Risk regression and ROC analysis 5. One of only a few studies to assess this population
Criticisms	1. Single tertiary center in Thailand 2. Retrospective design 3. Missing data exclusion 4. No standardized treatment protocol 5. Limited external validation

Clinical Practice Guidelines

Citation	Creager, M, Barnes, G, Giri, J. et al. 2026 AHA/ACC/ACCP/ACEP/CHEST/SCAI/SHM/SIR/SVM/SVN Guideline for the Evaluation and Management of Acute Pulmonary Embolism in Adults: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. JACC. null2026, 0 (0) . https://doi.org/10.1016/j.jacc.2025.11.005
Type of study	Comprehensive literature search from February 2024 to October 2024 to identify clinical studies, reviews, and other evidence conducted on human subjects that were published in English from MEDLINE (through PubMed), EMBASE, the Cochrane Library, Agency for Healthcare Research and Quality, and other selected databases relevant to this guidelines.
Funding source	n/a
Number of patients	n/a
Inclusion criteria	Studies pertaining to: Adults >18y with confirmed, acute PE; randomized controlled trials, observational cohort studies, meta analyses and systemic reviews; studies using diagnostic tools (D dimer, CTA, etc), risk stratification tools, treatments for acute PE.
Exclusion criteria	Studies pertaining to: pediatric population, not specific to acute PE
Study endpoints and findings	Five "Acute Pulmonary Embolism Clinical Categories" and subcategories were created that provide a framework designed to define the severity of an acute PE, improve diagnostic accuracy, and guide therapeutic decision-making across the acute and early post acute phases of care. The guidelines given recommendations regarding anticoagulation initiation, risk factors that should be considered during evaluation, and stress the importance of Pulmonary Embolism Response Teams (PERTs).
Strengths	Systemic review of many studies, multidisciplinary medical panel used for review, highest level of clinical guidance used in practice
Criticisms	Dependent on existing studies, expert consensus which can be limited, not all recommendations are high level (specifically for new treatments)

Systematic Reviews/Meta-analyses:

Citation	Elias A, Mallett S, Daooud-Elias M, Poggi JN, Clarke M. Prognostic models in acute pulmonary embolism: a systematic review and meta-analysis. <i>BMJ Open</i> . 2016;6(4):e010324. Published 2016 Apr 29. doi:10.1136/bmjopen-2015-010324
Type of study	Systematic review and meta-analysis
Funding source	n/a
Number of patients	71 studies included, ~44,298 patients
Inclusion criteria	Studies that: 1. Developed, validated, updated or assessed the impact of a prognostic model for acute symptomatic PE

	2. Included models combining at least two prognostic variables (clinical, biological, or imaging) for predicting outcomes such as all cause death, PE related death, VTE recurrence up to 3 months. 3. Hospital based studies
Exclusion criteria	Studies that did not: 1. Assess a prognostic model 2. Assess acute or symptomatic patients 3. Occur within hospital settings 4. Have a full text document with original outcomes 5. Report all relevant outcomes 6. Use humans
Study endpoints and findings	Identified that PESI and sPESI were the most widely validated models and generally effective at identifying low risk patients
Strengths	1. Comprehensive methodology 2. Clear eligibility criteria and prognostic quality criteria 3. Subgroup and sensitivity analysis 4. Clinically meaningful results indicating absolute risk 5. Provided guidance on limitations
Criticisms	1. Heterogeneity among included studies, many were retrospective 2. Several studies lacked data elements 3. Incorporated studies up to 7/2014, no later data included

Formula

Addition of the selected points

1. Age - + ____
2. Sex - F(0) M(+10)
3. History of cancer – No (0) Yes (+30)
4. History of heart failure – No (0) Yes (+10)
5. History of chronic lung disease – No (0) Yes (+10)
6. Heart rate ≥ 110 – No (0) Yes (+20)
7. sBP ≤ 100 mmHg – No (0) Yes (+30)
8. Respiratory rate ≥ 30 – No (0) Yes (+20)
9. Temperature $<36^{\circ}\text{C}$ / 96.8°F – No (0) Yes (+20)
10. AMS – No (0) Yes (+60)
11. O2 saturation $<90\%$ – No (0) Yes (+20)

Facts & Figures

Score interpretation. 5 classes:

- Class I - Scores ≤ 65 indicate very low risk.
- Class II - Scores of 66-85 indicate low risk.
- Class III - Scores of 86-105 indicate intermediate risk.
- Class IV - Scores of 106-125 indicate high risk.
- Class V - Scores >125 indicate very high risk.

Literature

Derivation

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dation of a prognostic model for pulmonary embolism. *Am J Respir Crit Care Med*. 2005 Oct 15;172(8):1041-6. doi: 10.1164/rccm.200506-862OC. Epub 2005 Jul 14. PMID: 16020800; PMCID: PMC2718410.

Validation

Donzé J, Le Gal G, Fine MJ, et al. Prospective validation of the Pulmonary Embolism Severity Index. A clinical prognostic model for pulmonary embolism. *Thromb Haemost*. 2008;100(5):943-948. doi:10.1160/th08-05-0285

Additional validation studies

Perrier A, Roy PM, Aujesky D, et al. Validation of the Pulmonary Embolism Severity Index (PESI) in a European cohort of patients with pulmonary embolism. *Eur Heart J*. 2008;29(15):1905-1910.

Bumroongkit C, Limsukon A, Liwsrisakun C, et al. Validation of the Pulmonary Embolism Severity Index Risk Classification and the 2019 European Society of Cardiology Risk Stratification in the Southeast Asian

Population with Acute Pulmonary Embolism. *J Atheroscler Thromb*. 2023;30(11):1601-1611. doi:10.5551/jat.64094

Elias A, Mallett S, Daoud-Elias M, Poggi JN, Clarke M. Prognostic models in acute pulmonary embolism: a systematic review and meta-analysis. *BMJ Open*. 2016;6(4):e010324. Published 2016 Apr 29. doi:10.1136/bmjopen-2015-010324

Additional Citations

Ghazvinian, Raein & Elf, Johan & Gotts, Anders & Löfvendahl, Sofie & Holst, Jan. (2020). Outpatient treatment in low-risk pulmonary embolism patients receiving direct acting oral anticoagulants is associated with cost savings.. 10.21203/rs.3.rs-16558/v1.

Creager MA, Barnes GD, Giri J, et al. 2026 AHA/ACC/ACCP/ACEP/CHEST/SCAI/SHM/SIR/SVM/SVN Guideline for the Evaluation and Management of Acute Pulmonary Embolism in Adults. *JACC*. Published online Feb. 19, 2026. doi: 10.1016/j.jacc.2025.11.005