

Updated - Wells' Criteria for Pulmonary Embolism

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Abstract

The Wells' Criteria for Pulmonary Embolism is a validated clinical tool that helps stratify patients for risk of pulmonary embolism based on pre-test probability. It objectifies pretest probability through a weighted scoring system which can help guide decisions about diagnostic testing and imaging. It is an evidence-based risk assessment tool for patients in whom PE is suspected.

I. HOW TO USE

When to Use

The Wells' Criteria risk stratifies patients for pulmonary embolism (PE) and provides an estimated pre-test probability in patients where PE is suspected. The physician can then choose what further testing is required for diagnosing a PE (i.e. d-dimer, V/Q scan or CT angiogram).

Pearls / Pitfalls

The Wells' Criteria risk stratifies patients for pulmonary embolism (PE), and has been validated in both inpatient and emergency department settings. Its score is often used in conjunction with d-dimer testing to evaluate for PE.

There must first be a clinical suspicion for PE in the patient (this should not be applied to all patients with chest pain or shortness of breath, for example).

Wells' criteria can be used with either 3 tiers (low, moderate, high) or 2 tiers (unlikely, likely). We recommend the two tier model as this is supported by [ACEP's 2018 Acute Venous Thromboembolic Disease / VTE policy](#). (See Next Steps). Wells' criteria is often criticized for having a "subjective" criterion in it ("PE #1 diagnosis or equally likely")

Wells' criteria is not meant to diagnose PE but to guide workup by predicting pre-test probability of PE and appropriate testing to rule out the diagnosis.

Consider using alternative pathways if Wells' score is not appropriate for your patient such as [YEARS crite-](#)

[riahttps://www.mdcalc.com/calc/4067/years-algorithm-for-pulmonary-embolism-pe](https://www.mdcalc.com/calc/4067/years-algorithm-for-pulmonary-embolism-pe) for pregnant patients

Why to Use

The Wells' Score has been validated multiple times in multiple clinical settings. Physicians have a low threshold to test for PE. The score is simple to use and provides clear cutoffs for the predicted probability of PE. The score aids in potentially reducing further testing including radiologic imaging in low-risk PE patients.

II. NEXT STEPS

Advice

Some advocate using the Wells' score over clinician gestalt to predict who is low-risk and then applying the PERC rule to stop workup for PE.

As with all clinical decision aids, the physician must first have a suspicion of the diagnosis before attempting to apply Wells' criteria.

The original intent of this tool was to determine who was low risk enough to rule out testing with a d-dimer.

Age adjusted d-dimer cutoffs have been validated for use in patients over 50 years in low risk patients (rGeneva "not high" or Wells' low). If using the appropriate d-dimer assay we recommend calculating the age adjusted d-dimer cutoff of: Age (years) x 10 µg/L = cutoff (for patients > 50 years) as per the ACP¹ guidelines and ACEP² policy.

While both two and three tier models are accepted, guidelines appear to favor the two tier model which uti-

lizes only the high sensitivity d-dimer and more conservative risk stratification; “intermediate” risk patients are thought to be still too high risk to be evaluated without further risk stratification.

Management

Based on ACP guidelines¹ and ACEP Clinical Policy²

Three Tier Model

1. Patient is determined to be low risk (<2 points: 1.3% incidence PE): consider d-dimer testing to rule out Pulmonary embolism. Alternatively consider a rule-out criteria such as PERC.
 - If the d-dimer is below the threshold, PE is ruled out.
 - If the d-dimer is above the threshold (≥ 500 ng/ml or age adjusted), the next step is confirmatory imaging like CTA or V/Q scan.
2. Patient is determined to be at moderate risk (score 2-6 points, 16.2% incidence of PE): the recommendation is high sensitivity d-dimer testing or CTA.
 - If the d-dimer is below the threshold, PE is ruled out.
 - If the d-dimer is above the threshold (≥ 500 ng/ml or age adjusted), the next step is confirmatory imaging like CTA or V/Q scan.
3. Patient is determined to be high risk (score >6 points: 37.5% incidence of PE): move directly to confirmatory imaging like CTA. D-dimer testing is not recommended.

Two Tier Model

1. Patient risk is determined to be “PE Unlikely” (0-4 points, 12.1% incidence of PE): consider high sensitivity d-dimer testing.
 - If the d-dimer is below the threshold, PE is ruled out.
 - If the d-dimer is above the threshold (≥ 500 ng/ml or age adjusted), the next step is confirmatory imaging like CTA or V/Q scan.
2. Patient risk is determined to be “PE Likely” (>4 points, 37.1% incidence of PE): move directly to confirmatory imaging like CTA.

Critical Actions

Given the next generation d-dimer has high sensitivity but low specificity (approx 50%), patients who are considered high risk should be ruled out with CTA.

Never delay resuscitative efforts for diagnostic testing, especially in the unstable patient.

History and physical exams should always be performed prior to diagnostic testing.

III. EVIDENCE

The original Wells study was performed on cohorts where prevalence of PE was high: approximately 30%. Two further emergency department studies validated this tool with a 9.5%-12% PE prevalence.

The largest study demonstrated risk stratification with:

- Low score of 0-1 having a 1.3% prevalence.
- Moderate score of 2-6 having a 16.2% prevalence.
- High score of >6 having a 37.5% prevalence.

The Christopher study divided the Wells scoring system into 2 categories:

- A score of 4 or less was defined as “PE unlikely” and tested with a d-dimer.
- A score of 5 or more was defined as “PE likely” and went straight to CTA

Overall incidence of PE was 12.1% in the “unlikely” group vs. 37.1% in the “likely” group.

If dimer was negative no further testing was performed.

If dimer was positive the patient went to CTA.

20.4% of all patients who went to CTA had a diagnosis of PE. In the “PE unlikely” group, those with a negative dimer and discharged to home had an incidence of missed PE on 3 month follow up of 0.5%.

Derivation study

Wells PS, Anderson DR, Rodger M, Stiell I, Dreyer JF, Barnes D, Forgie M, Kovacs G, Ward J, Kovacs MJ. Excluding pulmonary embolism at the bedside without diagnostic imaging: management of patients with suspected pulmonary embolism presenting to the emergency department by using a simple clinical model and d-dimer. *Ann Intern Med.* 2001 Jul 17;135(2):98-107. PubMed PMID: 11453709.

The original Wells study was a prospective cohort investigation conducted in a real-world emergency department (ED) setting. It was funded by the Canadian Institutes of Health Research (CIHR) along with several other Canadian academic and health agencies. The cohort consisted of 930 consecutive adult patients who presented to the ED with clinical suspicion of pulmonary embolism (PE). Patients were excluded if they were already receiving anticoagulation, were unable to undergo the required diagnostic testing, or had contraindications to follow-up.

The primary endpoint was the rate of venous thromboembolism (VTE) during a 3-month follow-up among patients classified as low risk who also had a negative D-dimer test and therefore did not undergo imaging. Among 437 such low-risk patients with a negative D-dimer, only 3 (0.7%) developed VTE during follow-up. Based on this low event rate, the authors concluded that

PE can be safely excluded without imaging in low-risk patients who have a negative D-dimer.

Key strengths of the study included being the first derivation of a practical bedside prediction rule, its prospective and multicenter design, and the use of clinically meaningful outcomes with systematic follow-up. However, several criticisms were noted: the prediction rule required external validation before broad implementation; the criterion “PE more likely than alternative diagnosis” introduced an element of subjective judgment; and the D-dimer assays used across sites were heterogeneous and not fully standardized.

Validation study

Wolf SJ, McCubbin TR, Feldhaus KM, Faragher JP, Adcock DM. Prospective validation of Wells Criteria in the evaluation of patients with suspected pulmonary embolism. *Ann Emerg Med*. 2004 Nov;44(5):503-10. doi: 10.1016/j.annemergmed.2004.04.002. PMID: 15520710.

This Wolf Study was a prospective observational study evaluating the Wells Criteria for pulmonary embolism (PE). It was supported in part by a Medicare grant from the 2001 Kaiser Permanente/Exempla Saint Joseph Hospital Research Fund. Of 176 patients who presented during study shifts, 134 were prospectively enrolled and followed for three months.

All patients presenting during a study shift who were referred for imaging for suspected PE after the emergency provider had completed a history, physical examination, chest radiograph, and ECG were considered eligible. Patients were excluded if they declined participation, were missed, or did not meet eligibility criteria. Additional exclusions included being non-English speaking, recently very obese (over approximately 350 lb), having a known genetic clotting disorder, being younger than 18 or older than 85 years, being critically ill or unable to consent, or having a recently known elevated or normal D-dimer result.

The study found that the Wells Criteria demonstrated moderate to substantial interrater reliability, supporting its use by emergency medicine providers as an objective method to determine pre-test probability when considering PE in a patient. This reliability allows clinicians to reproducibly stratify patients with suspected PE into low, moderate, or high-risk categories.

Key strengths included providing evidence that the Wells score can be applied consistently between different raters, reinforcing its role as a practical risk-stratification tool for suspected PE. However, the study had important limitations: the overall sample size was relatively small, and the population was restricted to patients already undergoing imaging for PE, which may limit generalizability to all ED patients with suspected PE.

Additional Studies

The Christopher Study was a prospective cohort study evaluating a diagnostic algorithm consisting of sequential application of a clinical decision rule, D-dimer testing, and CT within 24 hours of presentation.¹ Additionally, there was a prospective study which evaluated and ruled out pulmonary embolism using a D-dimer test. This also confirmed the safety of a 2-tiels Wells + age-adjusted D-dimer strategy.²

Further Meta- analyses

Meta-analysis including 11 studies and found Wells score to be more effective than revised Geneva score in finding PE.³

This study compared multiple CPRs—Wells, Geneva, PERC—in primary care and ED settings and it found Wells to be well-validated with high safety when combined with D-dimer testing. Established strong evidence supporting outpatient use of Wells score.⁴

Impact Analysis

There was an Impact analysis done as well: After implementing a clinical flowchart incorporating Wells score, PERC rule and D-dimer, imaging rate dropped from 14.5 to 8.6 per 1,000 ED presentations, a ~40% reduction.⁵

Diagnosis rates remained unchanged and no cases of missed pulmonary embolism attributable to the flow-chart were identified.

Clinical Practice Guidelines

ACEP VTE assessment guidelines promote use of Wells score along with other CDRs for PE risk stratification.

Current clinical policies from major medical organizations—including ACEP, CHEST, ESC/ERS, NICE, ACR, and ASH—demonstrate a strong consensus on the use of validated clinical decision rules (CDRs) for pulmonary embolism (PE) risk stratification. These guidelines emphasize the integration of pretest probability, primarily via the two-level Wells score, with the Pulmonary Embolism Rule-out Criteria (PERC) to identify low-risk patients. For individuals with low or intermediate clinical probability, the use of standard, age-adjusted, or adapted D-dimer testing provides a high-confidence rule-out strategy. Specifically, multiple societies endorse that imaging can be safely omitted in patients with a Wells score and a negative D-dimer. Collectively, these evidence-based strategies support a tiered diagnostic approach that reduces unnecessary imaging and radiation exposure while maintaining diagnostic safety.

Formula

Addition of the selected points:

Facts & Figures

Score interpretation:

Score	Risk Category
Three-Tier Model	
0 - 1	Low Risk
2 - 6	Moderate Risk
>6	High Risk
Two Tier Model	
≤4	PE Unlikely (with d-dimer)
≥5	PE Likely (with CTA)

Literature

Original/Primary

<http://www.ncbi.nlm.nih.gov/pubmed/11453709>

Wells PS, Anderson DR, Rodger M, Stiell I, Dreyer JF, Barnes D, Forgie M, Kovacs G, Ward J, Kovacs MJ. Excluding pulmonary embolism at the bedside without diagnostic imaging: management of patients with suspected pulmonary embolism presenting to the emergency department by using a simple clinical model and d-dimer. *Ann Intern Med.* 2001 Jul 17;135(2):98-107. PubMed PMID: 11453709.

Validation

<http://www.ncbi.nlm.nih.gov/pubmed/15520710>

Wolf SJ, McCubbin TR, Feldhaus KM, Faragher JP, Adcock DM. Prospective validation of Wells Criteria in the evaluation of patients with suspected pulmonary em-

bolism. *Ann Emerg Med.* 2004 Nov;44(5):503-10. PubMed PMID: 15520710.

Other

<http://www.ncbi.nlm.nih.gov/pubmed/16403929>

van Belle A, Buller HR, Huisman MV, et al. Effectiveness of managing suspected pulmonary embolism using an algorithm combining clinical probability, D-dimer testing, and computed tomography. *JAMA : the journal of the American Medical Association.* Jan 11 2006;295(2):172-179

ACP Guidelines for PE evaluation

Raja AS, Greenberg JO, Qaseem A, Denberg TD, Fitterman N, Schuur JD; Clinical Guidelines Committee of the American College of Physicians. Evaluation of Patients With Suspected Acute Pulmonary Embolism: Best Practice Advice From the Clinical Guidelines Committee of the American College of Physicians. *Ann Intern Med.* 2015 Nov 3;163(9):701-11. doi: 10.7326/M14-1772. Epub 2015 Sep 29. PMID: 26414967.

ACEP policy for Suspected Acute Venous Thromboembolic Disease

American College of Emergency Physicians Clinical Policies Subcommittee (Writing Committee) on Thromboembolic Disease;; Wolf SJ, Hahn SA, Nentwich LM, Raja AS, Silvers SM, Brown MD. Clinical Policy: Critical Issues in the Evaluation and Management of Adult Patients Presenting to the Emergency Department With Suspected Acute Venous Thromboembolic Disease. *Ann Emerg Med.* 2018 May;71(5):e59-e109. doi: 10.1016/j.annemergmed.2018.03.006. PMID: 29681319.

REFERENCES

1. Writing Group for the Christopher Study Investigators*. Effectiveness of Managing Suspected Pulmonary Embolism Using an Algorithm Combining Clinical Probability, D-Dimer Testing, and Computed Tomography. *JAMA*. 2006;295(2):172-179. doi:[10.1001/jama.295.2.172](https://doi.org/10.1001/jama.295.2.172)
2. Kearon C, de Wit K, Parpia S, et al. Diagnosis of Pulmonary Embolism with d-Dimer Adjusted to Clinical Probability. *N Engl J Med*. 2019;381(22):2125-2134. doi:[10.1056/NEJMoa1909159](https://doi.org/10.1056/NEJMoa1909159). PMID:31774957
3. Shen JH, Chen HL, Chen JR, et al. Comparison of the Wells score with the revised Geneva score for assessing suspected pulmonary embolism: a systematic review and meta-analysis. *J Thromb Thrombolysis*. 2016;41:482-492. doi:[10.1007/s11239-015-1250-2](https://doi.org/10.1007/s11239-015-1250-2)
4. Etemadi A, Hosseini M, Rafiee H, et al. Comparative diagnostic accuracy of pre-test clinical probability scores for the risk stratification of patients with suspected pulmonary embolism: a systematic review and Bayesian network meta-analysis. *BMC Pulm Med*. 2025;25:162. doi:[10.1186/s12890-025-03637-6](https://doi.org/10.1186/s12890-025-03637-6)
5. Buntine P, Thien F, Stewart J, et al. Effect of a clinical flowchart incorporating Wells score, PERC rule and age-adjusted D-dimer on pulmonary embolism diagnosis, scan rates and diagnostic yield. *Emerg Med Australas*. 2019;31(2):216-224. doi:[10.1111/1742-6723.13125](https://doi.org/10.1111/1742-6723.13125). PMID:30008186