

Combination of the Simplified Modified Geneva and Wells Clinical Prediction Scoring promise a good performance in pulmonary embolism diagnosis

Gökhan Çoraplı¹, Ayşe Füsün Topçu²

¹ Department of Chest Diseases, Yüksekova State Hospital, Turkey

² Department of Chest Diseases, Medicine Faculty of Dicle University, Turkey

ORCID ID of the author(s)

GÇ: 0000-0002-3992-840X
AFT: 0000-0001-7570-2339

Corresponding Author

Gökhan Çoraplı
İpekyolu üzeri İnanlı Köyü mevki, Yüksekova Devlet Hastanesi, Yüksekova, Hakkari, Turkey
E-mail: gcorapli02@gmail.com

Ethics Committee Approval

Ethics committee approval was obtained from Dicle University Medical School (approval code: 18.05.2018/337).

All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest

No conflict of interest was declared by the authors.

Financial Disclosure

The authors declared that this study has received no financial support.

Published

2021 August 28

Copyright © 2021 The Author(s)

Published by JOSAM

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License 4.0 (CC BY-NC-ND 4.0) where it is permissible to download, share, remix, transform, and build upon the work provided it is properly cited. The work cannot be used commercially without permission from the journal.



Abstract

Background/Aim: Pulmonary thromboembolism (PTE) has high mortality and morbidity, is difficult to diagnose, and is generally preventable. Clinical scoring is used for early diagnosis. Two of these often-used scoring systems include the Wells and Simplified Modified Geneva scoring systems. We aimed to comparatively determine the values of the Wells and the Simplified Modified Geneva scoring systems in showing PTE.

Methods: This prospective cohort study included 195 patients who underwent computerized tomography pulmonary angiography (CTPA) with suspected PTE between May 2018 and November 2018. The Wells and Simplified Modified Geneva scores of the patients were calculated. Wells Clinical Scoring results were grouped as having a weak/strong probability of PTE, while those of the Modified Geneva clinical scoring were categorized as possible/unlikely PTE. The analyses were performed with the SPSS package 21.0 program.

Results: One hundred and nine (55.9%) patients presented to the emergency department and eighty-six (44.1%) patients visited the outpatient clinic for chest diseases. Of all cases, 83 (42.6%) were male and 112 (57.4%) were female. The mean age was 57.16 (18.62) years. Forty-one (21%) patients had PTE. The sensitivity and specificity of Wells Clinical Scoring for PTE were 87.8% and 83.8%, respectively, while those of the Simplified Modified Geneva Clinical Scoring were 82.9% and 53.3%, respectively. The chi-square analysis for two clinical scorings revealed a *p*-value of 0.001. The negative predictive values of Wells and Simplified Modified Geneva Scores were 96.2% and 92.1%, respectively. The positive predictive value was the highest in the emergency department (80% and 39.4%, respectively). When the two clinical scores were used together, the negative and positive predictive values were 95.6% and 61.1%, respectively.

Conclusion: We found that Wells Clinical Scoring is superior to the Simplified Modified Geneva Score in terms of sensitivity and specificity. The use of these two clinical scores in the outpatient clinic was more useful in excluding PT, while in the emergency department, their combination was more effective in diagnosing it.

Keywords: Pulmonary thromboembolism, Computed tomography pulmonary angiography, Wells Clinical Scoring, Simplified Modified Geneva Score

Introduction

Pulmonary thromboembolism (PTE) has high mortality and morbidity, is challenging to diagnose, and is generally preventable [1]. PTE ranks third among the causes of cardiovascular death after myocardial infarction and cerebrovascular events [2]. Although clinical symptoms and findings vary according to the size and localization of the embolism, infarction development, the age of the patient, whether it is recurrent, comorbidities, and the patient's cardiopulmonary reserve also significantly affect mortality [3]. Whereas the mortality of PTE is approximately 25-30% in untreated cases, it decreases to 2-8% among treated patients [4]. The first stage in the diagnosis of PTE is clinical suspicion about the disease. The algorithm to be followed for diagnosis is determined, necessary examinations are requested and a decrease in mortality can be achieved by immediately starting the treatment.

Clinical findings and laboratory data are not sufficient to diagnose or exclude PTE. For this reason, clinical classifications are needed to help and guide in deciding the cases requiring further examination. Today, the most widely accepted clinical probability classifications are the Wells and Modified Geneva classifications [5], both of which also have simplified forms. Since the clinical probability classifications are determined by objective data, they are used more in emergency services [6]. Widespread use of clinical risk scorings in daily practice will provide great benefits in preventing unnecessary expensive, invasive, and time-consuming tests. The pulmonary embolism guide recommended using the clinical risk scorings by combining them with serum D-Dimer levels for excluding PTE.

In this study, we aimed to comparatively determine the diagnostic values of Wells and Simplified Modified Geneva scorings and their combination in patients with a PTE pre-diagnosis who visited the emergency department and chest diseases outpatient clinics.

Materials and methods

This prospective study was approved by Dicle University Non-Interventional Ethics Committee (approval code: 18.05.2018/337). All participants were informed about the study verbally and in writing and signed informed consent forms.

Patient selection

A total of 195 patients, who visited the emergency service and chest diseases outpatient clinic ambulatorily between May 2018 – November 2018, who were suspected of PTE and whose computed tomography pulmonary angiography (CTPA) scans were performed were included in this study. PTE was diagnosed by CTPA, which was reported as positive or negative for pulmonary embolism. These patients were prospectively evaluated with the Wells (Canadian) and the Simplified Modified Geneva pulmonary thromboembolic scorings.

Computerized tomography pulmonary angiography

Computed tomography pulmonary angiography examinations were performed with the CT device with 64 detectors (Brilliance CT device, Philips Medical Systems, Cleveland, Ohio). Before the scanning began, venous access was established in all patients through an 18-20 G catheter from the

forearm. For pulmonary CTPA examination, 100 mL of non-ionic contrast agent was injected through the antecubital vein at 4 mL/sec with an automatic injector. From the moment the contrast agent density in pulmonary truncus reached the threshold value, sections were filmed with a delay of 18.5 seconds.

Clinical scorings

Patients' Wells (Canadian) and Simplified Modified Geneva scores were calculated for PTE. Wells Clinical Scoring results were grouped as weak/strong probability of PTE, while those of the Modified Geneva clinical scoring were categorized as possible/unlikely PTE [7, 8].

Statistical analysis

Analyses were performed with the SPSS 21 package program. If the data showed normal distribution, they were shown as mean (standard deviation). Descriptive data were presented as a ratio. Categorical data were compared by the Pearson's chi-square test. The sensitivity and specificity of the scoring systems were determined for PTE. Power analysis was performed for sample size estimation, based on a similar study. The sample size required for an effect size of 0.258, an alpha of 0.05, and a power of 0.95 at a 95% confidence interval was 195. Results were statistically significant when P -value ≤ 0.05 .

Results

One hundred and ninety-five patients with CTPAs performed for suspicion of a pulmonary embolism were included in this study. CTPA results were interpreted as positive or negative for pulmonary embolism. All patients were prospectively evaluated with Wells (Canadian) and Simplified Modified Geneva pulmonary thromboembolic scoring.

Among all patients, 86 patients (44.1%) had visited the chest diseases department, and 109 (55.9%) had presented to the emergency service ambulatorily. There were 112 (57.4%) females and 83 (42.6%) males. The overall mean age was 57.16 (18.62) years (range: 17-91).

The CTPAs were negative and positive for a pulmonary embolism in 154 (79%) and 41 (21%) patients, respectively, yielding a PTE prevalence of 21%. The results of 10 (11.6 %) of 86 patients who visited the outpatient clinic, and 31 of 109 patients (28.4 %) who presented to the emergency service were positive for PTE.

According to Wells Clinical Scoring, 134 patients (68.7%) had a weak probability of PTE, among which 129 were CTPA-negative and 5 were CTPA-positive, and 61 (31.3%) had a strong probability of PTE (Table 1), of which 25 were CTPA-negative, and 36 were CTPA-positive. This test's sensitivity and specificity were 87.8% and 83.8%, respectively. The chi-square analysis revealed $p=0.001$, based on which the Wells Clinical Scoring system was considered significant for PTE (Table 1).

Table 1: The relationship between Clinical scorings and CTPA results

		Negative CTPA n (%)	Positive CTPA n (%)	P-value	Sensitivity	Specificity	PPV	NPV
Wells Clinical Scoring	Weak probability	129 (96.3%)	5 (3.7%)	0.001	87.8%	83.8%	59%	96.3%
	Strong probability	25 (41%)	36 (59%)					
Simplified Modified Geneva Clinical Scoring	Not probable	82 (92.1%)	7 (7.9%)	0.001	82.9%	53.3%	32%	92.1%
	Probable	72 (67.9%)	34(32.1%)					

CTPA: Computerized Tomography Pulmonary Angiography

The Simplified Modified Geneva Clinical Scoring results of 106 patients (54.4%) were interpreted as probable, of which 72 and 34 were CTPA-negative and -positive, respectively, and those of 89 (45.6%), as not probable in terms of PTE diagnosis, among which 82 were CTPA-negative, and 7, CTPA-positive (Table 1). This scoring system’s sensitivity and specificity were 82.9% and 53.3%, respectively, with a p-value of 0.001 in the Chi-square test, making its results significant for PTE.

The negative predictive values of the Wells and Simplified Modified Geneva Scorings were at their highest in the outpatient clinic (96.7%, and 95.7%, respectively) (Table 2), while their positive predictive values were at their highest in the emergency service (80%, and 39.4%, respectively) (Table 2).

Table 2: Effectiveness of Wells clinical score and Simplified Modified Geneva Scoring according to the place of use

		Negative CTPA n (%)	Positive CTPA n (%)
WCS evaluation in polyclinic	Weak probability	58 (96.7%)	2 (3.3%)
	Strong probability	18 (69.2%)	8 (30.8%)
WCS evaluation in emergency service	Weak probability	71 (95.9%)	3 (4.1%)
	Strong probability	7 (20.0%)	28 (80.0%)
SMGCS evaluation Scoring in polyclinic	Not probable	44 (95.7%)	2 (4.3%)
	Probable	32 (80.0%)	8 (20.0%)
SMGCS evaluation in emergency service	Not probable	38 (88.4%)	5 (11.6%)
	Probable	40 (60.6%)	26 (39.4%)

CTPA: Computerized Tomography Pulmonary Angiography, WCS: Wells Clinical Scoring, SMGCS: Simplified Modified Geneva Clinical Scoring

The two scores’ combined use revealed a low probability in 82 patients, of which 78 (95.1%) were CTPA-negative, and a high probability in 54 patients, of which 33 (61.1%) were CTPA-positive. The negative and positive predictive values of the combined use of two scoring systems were 95.1% and 61.1%, respectively (Table 3).

Table 3: Effectiveness of Wells and Simplified Modified Geneva Scorings in combination

			Negative CTPA n (%)	Positive CTPA n (%)	Sensitivity	Specificity	PPV	NPV
Not Probable in SMGS	WCS	Weak probability	78 (95.1%)	4 (4.9%)	9.8%	50.6%	32.7%	95.1%
		Strong probability	4 (57.1%)	3 (42.9%)	7.3%	2.5%	42.8%	79.7%
Probable in SMGS	WCS	Weak probability	51 (98.1%)	1 (1.9%)	2.4%	33.2%	1.9%	72%
		Strong probability	21 (38.9%)	33 (61.1%)	80.5%	13.7%	61.1%	94.3%

CTPA: Computed tomography pulmonary angiography, WCS: Wells Clinical Scoring, SMGS: Simplified Modified Geneva Scoring

Discussion

The early diagnosis and treatment of PTE, which has a high mortality rate, is essential. The diagnosis of PTE starts with a suspicion. Difficulties are experienced in PTE diagnosis because PTE symptoms and findings are not specific, and not all centers have access to advanced diagnostic modalities. One of the most important steps of the diagnostic algorithm in PTE diagnosis is to determine the clinical probability and proceed to the next phase. Researchers tried developing clinical probability scoring systems with several parameters to be used in predicting PTE with many resulting clinical probability scores.

Our study aimed to comparatively assess the value of two clinical probability scoring methods used in PTE diagnosis, the Wells and Simplified Modified Geneva Clinical scoring. A prospective study conducted in the Netherlands between July 2008-November 2009 in 7 hospitals on 807 patients with

suspicion of acute PTE examined four clinical scoring systems and reported that acute PTE prevalence was 23% [9]. Wells and Simplified Modified Geneva scores were previously compared in a study that revealed the PTE prevalence as 19% [10]. The clinical probability of PTE was prospectively evaluated by Wells Clinical Scoring and retrospectively evaluated with the revised Geneva Score on 300 consecutive patients, and PTE prevalence was 16% [11]. In a cross-sectional study, PTE was detected in 55 of the 598 patients (9%) who underwent CTPA due to PTE suspicion [12]. In our study, the PTE prevalence among patients with a clinical suspicion was 21%, comparable to other studies. Performing CTPA in all patients with PTE suspicion exposes many patients without PTE to radiation. This can be prevented by the combined use of clinical scoring and D-dimer levels.

In a prospective study conducted by Wells and his friends, PTE was detected only in 7.8% of the cases with a Wells clinical score of ≤ 4 (weak probability), and not detected in 92.2% [13].

In a prospective study performed on 3306 patients in 12 centers in the Netherlands between 2002-2004, Wells Clinical Scoring results were dichotomized and trichotomized. The sensitivity and specificity of the dichotomized Wells clinical scoring were 71%, and 41%, respectively. Accordingly, the dichotomized scoring was more effective than the trichotomized scoring in clinical practice [14].

In a prospective study conducted with 339 patients with clinical suspicion of PTE, the Wells and Simplified Modified Geneva Scores were compared. There were 104 patients with a strong probability of PTE according to Wells, of which 46 were diagnosed with PTE, and 235 patients with a weak probability of PTE, of which 19 were diagnosed with it. The sensitivity and specificity of Wells Clinical Scoring were 70% and 78%, respectively. The same patients were evaluated with the Simplified Modified Geneva Score, and of 115 patients with probable and 224 patients with not probable PTE, 43 and 22 patients, respectively, were diagnosed with PTE. The sensitivity and specificity of the dichotomized Simplified Modified Geneva Scoring system were 66% and 72%, respectively. Both clinical scores were significant, and Wells Clinical Scoring surpassed Simplified Modified Geneva Score in terms of sensitivity and specificity [10].

In a prospective study including 613 patients in Argentina, the sensitivity and specificity of the dichotomized Wells Clinical Scoring were 65% and 81%, respectively [15]. In a PTE study conducted with 922 patients, PTE was diagnosed in 95 of the 722 patients, who were considered to have a weak probability of PTE according to Wells Clinical Scoring; and it was diagnosed in 112 of the 200 patients with a strong probability. In this study, the sensitivity and specificity of Wells Clinical Scoring were 54% and 87%, respectively [16].

In a meta-analysis conducted on 7268 patients suspected of embolism, the sensitivity and specificity of Wells Clinical Scoring were 53% and 79%, respectively [17]. The effectiveness of the Simplified Modified Geneva Score was examined in research conducted on 1049 patients by combining two prospective studies. Its sensitivity and specificity were 61% and 71%, respectively, proving significant for PTE [11].

In our study, the sensitivity and specificity of Wells Clinical Scoring were 87.8% and 83.8%, respectively, while those of the Simplified Modified Geneva Clinical Scoring system were 82.9% and 53.3%, respectively. Both results were comparable to those in the literature, and both clinical scoring systems were significant. Wells clinical scoring was stronger than the simplified modified Geneva score in terms of both sensitivity and specificity. Using these two clinical scores separately was more useful in excluding embolism in the outpatient clinic, while it was better in making a pre-diagnosis in the emergency service. Their combinational use was more effective in excluding PTE. Since the Simplified Modified Geneva Scoring is easy to remember because the same points are given to each item, it can be an alternative to Wells clinical scoring.

Conclusion

Our results prove the effectiveness of Wells and Simplified Modified Geneva Scores in showing PTE, and the risk scoring systems should be well examined before performing invasive tests on patients for diagnostic purposes. The Wells Score is more effective than the Simplified Modified Geneva Score in the diagnosis of PTE.

References

- Sandler DA, Martin JF. Autopsy proven pulmonary embolism in hospital patients: are we detecting enough deep vein thrombosis. *J R Soc Med.* 1989 Apr;82(4):203-5. doi: 10.1177/014107688908200407.
- Heit JA. The epidemiology of venous thromboembolism in the community. *Arterioscler Thromb Vasc Biol.* 2008 Mar;28(3):370-2. doi: 10.1161/ATVBAHA.108.162545.
- Cohen AT, Dobromirski M, Gurwith MM. Managing pulmonary embolism from presentation to extended treatment. *Thromb Res.* 2014 Feb;133(2):139-48. doi: 10.1016/j.thromres.2013.09.040.
- Nijkeuter M, Söhne M, Tick LW, Kamphuisen PW, Kramer MH, Laterveer L, et al. The natural course of hemodynamically stable pulmonary embolism: Clinical outcome and risk factors in a large prospective cohort study. *Chest.* 2007 Feb;131(2):517-23. doi: 10.1378/chest.05-2799.
- Konstantinides SV, Torbicki A, Agnelli G, Danchin N, Fitzmaurice D, Galiè N, et al. 2014 ESC guidelines on the diagnosis and management of acute pulmonary embolism. *Eur Heart J.* 2014 Nov 14;35(43):3033-69. doi: 10.1093/eurheartj/ehu283.
- Wicki J, Perneger TV, Junod AF, Bounameaux H, Perrier A. Assessing clinical probability of pulmonary embolism in the emergency ward: a simple score. *Arch Intern Med.* 2001 Jan 8;161(1):92-7. doi: 10.1001/archinte.161.1.92.
- Ceriani E, Combescure C, Le Gal G, Nendaz M, Perneger T, Bounameaux H, et al. Clinical prediction rules for pulmonary embolism: a systematic review and meta-analysis. *J Thromb Haemost.* 2010 May;8(5):957-70. doi: 10.1111/j.1538-7836.2010.03801.x.
- Le Gal G, Righini M, Roy PM, Sanchez O, Aujesky D, Bounameaux H, et al. Prediction of pulmonary embolism in the emergency department: the revised Geneva score. *Ann Intern Med.* 2006 Feb 7;144(3):165-71. doi: 10.7326/0003-4819-144-3-200602070-00004.
- Douma RA, Mos IC, Erkens PM, Nizet TA, Durian MF, Hovens MM, et al. Performance of 4 clinical decision rules in the diagnostic management of acute pulmonary embolism: a prospective cohort study. *Ann Intern Med.* 2011 Jun 7;154(11):709-18. doi: 10.7326/0003-4819-154-11-201106070-00002.
- Penalzoza A, Melot C, Motte S. Comparison of the Wells score with the simplified revised Geneva score for assessing pretest probability of pulmonary embolism. *Thromb Res.* 2011 Feb;127(2):81-4. doi: 10.1016/j.thromres.2010.10.026.
- Klok FA, Mos IC, Nijkeuter M, Righini M, Perrier A, Le Gal G, et al. Simplification of the revised Geneva score for assessing clinical probability of pulmonary embolism. *Arch Intern Med.* 2008 Oct 27;168(19):2131-6. doi: 10.1001/archinte.168.19.2131.
- Hall WB, Truitt SG, Scheunemann LP, Shah SA, Rivera MP, Parker LA, et al. The prevalence of clinically relevant incidental findings on chest computed tomographic angiograms ordered to diagnose pulmonary embolism. *Arch Intern Med.* 2009 Nov 23;169(21):1961-5. doi: 10.1001/archinternmed.2009.360.
- Wells PS, Anderson DR, Rodger M, Ginsberg JS, Kearon C, Gent M, et al. Derivation of a simple clinical model to categorize patients probability of pulmonary embolism: increasing the models utility with the SimpliRED D-dimer. *Thromb Haemost.* 2000 Mar;83(3):416-20.
- van Belle A, Buller HR, Huisman MV, Huisman PM, Kaasjager K, Kamphuisen PW, et al. Effectiveness of managing suspected pulmonary embolism using an algorithm combining clinical probability, D-dimer testing, and computed tomography. *JAMA.* 2006 Jan 11;295(2):172-9. doi: 10.1001/jama.295.2.172.
- Posadas-Martínez ML, Vázquez FJ, Giunta DH, Waisman GD, de Quirós FG, Gándara E. Performance of the Wells score in patients with suspected pulmonary embolism during hospitalization: a delayed-type cross sectional study in a community hospital. *Thromb Res.* 2014 Feb;133(2):177-81. doi: 10.1016/j.thromres.2013.11.018.
- Righini M, Le Gal G, Perrier A, Bounameaux H. Clinical probability assessment of pulmonary embolism by the Wells' score: is the easiest the best. *J Thromb Haemost.* 2006 Mar;4(3):702-4. doi: 10.1111/j.1538-7836.2006.01797.x.
- van Es N, Kraaijpoel N, Klok FA, Huisman MV, Den Exter PL, Mos IC, et al. The original and simplified Wells rules and age-adjusted D-dimer testing to rule out pulmonary embolism: an individual patient data meta-analysis. *J Thromb Haemost.* 2017 04;15(4):678-84. doi: 10.1111/jth.13630.