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Comparison of the revised Geneva score with the Wells rule for assessing clinical probability of pulmonary embolism

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ABSTRACT

Background

The revised Geneva score, a standardized clinical decision rule in the diagnosis of pulmonary embolism (PE), was recently developed. The Wells clinical decision is widely used but lacks full standardization, as it includes subjective clinician's judgement. We have compared the performance of the revised Geneva score with the Wells rule.

Methods

In 300 consecutive patients with suspected PE, the clinical probability of PE was assessed by the Wells rule and the revised Geneva score. The predictive accuracy of both scores were compared by the area under the curve (AUC) of receiver operating characteristic (ROC) analyses.

Results

The overall prevalence of PE was 16%. The prevalences of PE in the low-, intermediate- and high-probability categories as classified by the revised Geneva score were similar to those of the original derivation set. The AUC of the revised Geneva score was not different from that of the Wells rule. After three months of follow-up, no patient classified into the low or intermediate clinical probability category by the revised Geneva score and a normal D-dimer result was subsequently diagnosed with acute venous thromboembolism.

Conclusions

This study suggests that the performance of the revised Geneva score is equivalent to that of the Wells rule. In addition, it seems safe to exclude PE in patients by the combination of a low or intermediate clinical probability by the revised Geneva score and a normal D-dimer concentration.

INTRODUCTION

Current diagnostic work-up of patients with suspected acute pulmonary embolism (PE) usually starts with the assessment of clinical pretest probability using clinical prediction rules, and plasma D-dimer measurement.[1,2] Indeed, recent studies have demonstrated the safety of rejecting the diagnosis of PE by the combination of a low clinical probability and a normal quantitative D-dimer test result, thereby decreasing the need for further diagnostic radiological imaging in up to 30% of patients.[3]

The best validated and therefore most widely used clinical decision rules are the Wells rule (Table 1) and the Geneva score.[1,2] However, both scores have limitations. The Wells rule includes the physician's judgement of whether an alternative diagnosis is more likely than PE.[1] This criterion, which carries a major weight in the score, is subjective and cannot be standardized. Moreover, it has been suggested that the predictive value of the Wells rule is derived primarily from its subjective component.[4] The Geneva score, based on 13 entirely objective variables, requires a blood gas analysis while breathing room air and has only been evaluated for patients in the emergency ward.[2] Both scores appeared to have a comparable predictive value for PE.

The revised Geneva score is a simple score based entirely on clinical variables and is independent from physicians' implicit judgement (Table 1).[5] The prevalence of PE obtained using the revised Geneva score in the original derivation cohort was comparable to that obtained using the original Geneva score and the Wells rule, i.e. 9.0% in the low clinical probability group,

Table 1. The Wells rule and revised Geneva score.

Wells rule[1]		Revised Geneva score[5]	
Items	**Score**	**Items**	**Score**
Clinical signs of DVT	3	Age >65 years	1
Alternative diagnosis less likely than PE	3	Previous DVT or PE	3
Previous PE or DVT	1.5	Surgery or fracture within 1 month	2
Heart rate >100 beats/min	1.5	Active malignancy	2
Surgery or immobilization within 4 weeks	1.5	Unilateral lower limb pain	3
Hemoptysis	1	Hemoptysis	2
Active malignancy	1	Heart rate 74-94 beats/min	3
		Heart rate ≥95 beats/min	5
		Pain on lower limb deep vein palpation and unilateral edema	4
Clinical probability		**Clinical probability**	
Low	<2	Low	0–3
Intermediate	2–6	Intermediate	4–10
High	>6	High	≥11
PE unlikely	≤4		
PE likely	>4		

PE=pulmonary embolism, DVT=deep vein thrombosis.

27.5% in the intermediate clinical probability group and 71.7% in the high clinical probability group. However, this rule has not yet been evaluated by large clinical outcome studies. There-fore, we assessed the revised Geneva score in a convenience sample from a prospective cohort study on the safety of the use of multi-detector row computed tomography (CT) in suspected PE.[6] Furthermore, we compared its performance to that of the Wells rule, which had been routinely assessed in all patients.

METHODS

Patients
The clinical probability of PE was prospectively assessed using the Wells rule in consecutive patients with suspected PE referred to our hospital as part of a large diagnostic study.[6] In contrast to the original publication of the Wells rule that categorized patients in 3 groups of increasing risk for PE, the Christopher study used a dichotomized version of this prediction rule. In all patients with a Wells rule indicating PE unlikely (score of 4 points or less), a quantitative D-dimer test was performed. When the result of this test was within normal ranges, PE was considered to be excluded and patients were left untreated. To establish the final diagnosis of PE, spiral CT-scanning was performed in all remaining patients, i.e. if PE was considered likely (Wells rule greater than 4 points) or in cases of an abnormal quantitative D-dimer test result. All patients were followed for three months to evaluate the recurrence of venous thrombo-embolism (VTE).[6]

Assessment of the revised Geneva score
The revised Geneva score comprises four variables not included in the Wells rule: 1) age over 65 years, 2) unilateral lower limb pain, 3) heart rate 75–94 beats per minute or more than 94 beats per minute and 4) pain on lower limb deep venous palpation and unilateral edema (Table 1). These items were abstracted from the patient charts after masking the final diagnosis. Values for each item were scored on the day of inclusion. In cases of inaccessibility of patient's files or absence of relevant data, patients were excluded.

Data analysis
Frequencies of PE obtained with the revised Geneva score and original 3-level Wells rule were compared with those of the original Geneva score dataset by comparing the corresponding confidence intervals.[5] The accuracy of the revised Geneva and Wells rule scores was com-pared by the area under the curve (AUC) in receiver operating characteristic (ROC) analyses.[7] Results from the clinical rule and D-dimer tests were then combined and related to the clinical outcome. In particular, the VTE recurrence rate of patients with a low or intermediate clinical probability as calculated using the revised Geneva score and a normal D-dimer result were

studied. Statistical analyses were performed using SPSS software (SPSS for windows 12.0.1, Inc. 1989–2003, Chicago, IL, USA).

RESULTS

Patients

The study included 300 patients with suspected PE. Medical records of all subjects were obtained and studied. There were no missing data, so the revised Geneva score could be calculated for all patients. Included patients were 47 ±16 years old at the time of diagnosis; 60% were female and 96% were outpatients. The overall incidence of PE was 16%. According to the revised Geneva score, 157 patients (52%) had low clinical probability, 136 (45%) inter-mediate clinical probability and 7 (2.3%) high clinical probability (Table 2). The incidence of PE was 8.3% (95% confidence interval [CI] 4.0–13), 23% (95% CI 16–30) and 71% (95% CI 35–99.9) respectively for the three probability groups. These frequencies were well comparable to those in the derivation and validation set of le Gal as well as in the Wells rule calculated in the Leiden population (Table 2).[5,6]

Table 2. Proportion of patients classified by, and predictive accuracy of the revised Geneva score in the original derivation and validation set compared to the results of the revised Geneva score and Wells rule in the Leiden study population.

	Derivation set le Gal[5]				Validation set le Gal[5]				Validation set Leiden				Wells in Leiden			
Clinical probability	Patients		Patients with PE		Patients		Patients with PE		Patients		Patients with PE		Patients		Patients with PE	
	n	%	%	95% CI	n	%	%	95% CI	n	%	%	95% CI	n	%	%	95% CI
Low	354	37	9.0	6.6-13	229	31	7.9	5.0-12	157	52	8.3	4.0-13	133	44	4.5	1.7-9.6
Intermediate	549	57	28	24-31	463	62	29	25-33	136	45	23	16-30	154	51	23	16-30
High	53	6	72	58-82	57	8	74	61-83	7	2.3	71	35-99.9	13	3.4	62	32-86

CI=confidence interval, n=number.

Performance of the revised Geneva score

We compared the AUC of the ROC analysis for the revised Geneva score and Wells rule (Figure 1A and B). The AUC of the continuous prediction rules between the Wells rule (0.79; 95% CI 0.72–0.87) and the revised Geneva score (0.73; 95% CI 0.65–0.81) were comparable (difference 0.06, 95% CI -0.03-0.09). The AUC of the categorized rules was 0.72 (95% CI 0.65–0.80) for the Wells rule and 0.67 (95% CI 0.59–0.76) for the revised Geneva score. These AUCs were not sig-nificantly different as well (difference 0.05, 95% CI -0.04-0.13).

In total, 134 (45%) patients were classified differently using the Wells rule and the revised Geneva score (Table 3, κ=0.16). In almost all patients (97%), this disagreement was due to the decision
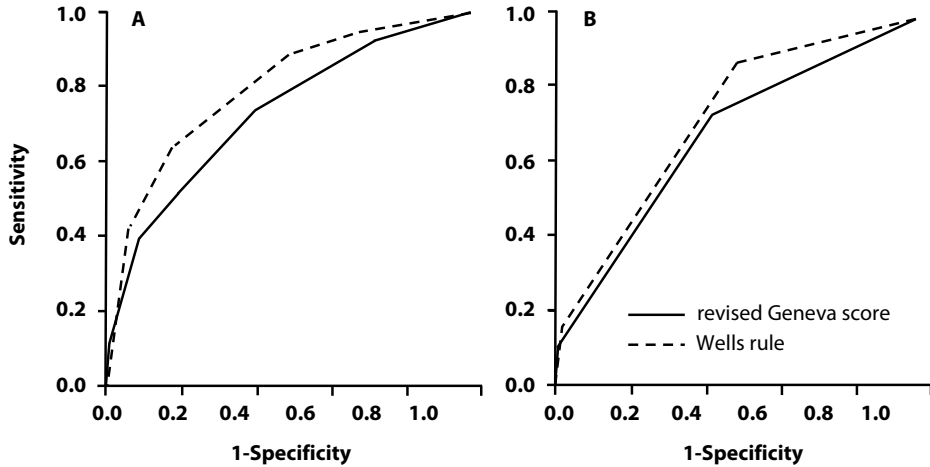
Figures 1A and 1B. Receiver operating characteristic curves of the continuous (A) and categorized (B) outcome of the revised Geneva score and Wells rule.

of awarding or not awarding 3 points for the item 'alternative diagnosis less likely than PE' in the Wells rule. Extreme disagreement, defined as patients classified into the low clinical probability group by one score and into the high clinical probability category by the other score, did not occur. In patients with CT-proven PE, 20 patients were categorized differently by the two rules: the Wells rule classified 15 patients into a higher clinical probability category than the revised Geneva score; in 5 patients it was the other way around. Among patients with a higher Wells rule classification, the CT-scan indicated central embolus location in four, segmental location in eight, and subsegmental embolus in three. Among cases of higher classification by the revised Geneva score, one patient had central emboli and four patients had segmental emboli. There was no difference between these two groups (p=0.5).

Table 3. (dis-) Similarities in clinical probability between the Wells rule and revised Geneva score in individual patients from our study population.

revised Geneva score	Wells rule		
	Low	Intermediate	High
Low	85	48	0
Intermediate	72	78	4
High	0	10	3

D-dimer testing was performed in all patients (233) with a Wells rule of 4 points or less. After three months of follow-up, no patient with a low (0/98; 95% CI 0.0–2.7) or intermediate (0/34; 95% CI 0.0–7.4) clinical probability score by the revised Geneva score and a normal D-dimer result at inclusion was subsequently diagnosed with VTE.

DISCUSSION

Our study confirms the good performance of the revised Geneva score. This conclusion is based on 4 observations. First, the predictive accuracy of the revised Geneva score in our study population was comparable to that of the original derivation and validation set of the score. Second, the comparison of the AUCs of the ROC analyses, a validated instrument for weighing the discrimination ability of a statistical method for predictive purposes, showed the equivalence of the revised Geneva score and Wells rule in our study population.[8] Third, our data suggest that the combination of a low or intermediate clinical probability by the revised Geneva score with a normal D-dimer result can safely rule out the diagnosis of PE. Fourth, cases of disagreement between the Wells rule and the revised Geneva score were not explained by embolus location. Therefore, neither score tended to overestimate clinical probability in cases of subsegmental PE.

There are several additional points. First, the observed kappa statistic of 0.16 suggests great difference in individual classification of individual patients by the revised Geneva score and Wells rule. Explanations for this are the different criteria on which both scores are based and the subjective item of the Wells rule. We found that 97% of the cases in which individual patients were classified differently could be explained by this subjective item. Although implicit clinical judgement may improve the accuracy of a prediction rule, as was shown using the original Geneva score, and the subjective item of the Wells rule has been shown to be of high predictive value for PE in comparison to other items, the Wells rule did not perform better than the completely objective revised Geneva score.[9,10] Second, although the patients were prospectively followed, the revised Geneva score was assessed retrospectively. Nonetheless, inclusion bias was not present since we included consecutive patients and their medical charts were abstracted by researchers blinded to the final diagnosis. Third, D-dimer measurements were only performed in patients classified as PE unlikely according to the Wells rule. Therefore, D-dimer results were available for only 80% (233/293) of all patients classified into the low or intermediate clinical probability groups by the revised Geneva score.

In summary, this study suggests that the performance of the revised Geneva score is equivalent to that of the Wells rule in a cohort largely dominated by outpatients. It seems safe to withhold oral anticoagulation therapy in patients with suspected PE, a low or intermediate clinical probability by the revised Geneva score and a normal D-dimer level. Prospective clinical outcome studies with larger numbers of patients are needed to confirm these latter findings.

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