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Predictive Accuracy of Revised Geneva Score in the Diagnosis of Pulmonary Embolism

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ABSTRACT

***Background**: Revised Geneva score is a clinical prediction rule used in determining the pre-test probability of pulmonary embolism (PE). It has been recently introduced and is independent of the doctor's experience applying the rule. This study aimed to evaluate the predictive accuracy of revised Geneva score in the diagnostic protocol of pulmonary embolism and its role in decreasing the need for pulmonary imaging studies.*

***Materials and Methods**: In this study, we evaluated the medical records of 242 patients suspected for pulmonary embolism who underwent CT scan of the lung as part of their diagnostic protocol from October 2007 to February 2009. Six patients were excluded from the study due to their indeterminate CT scan results. The mean age of patients was 58 yrs and 62% of patients were males.*

***Results**: The overall prevalence of pulmonary embolism was 24%. By increased scoring, the clinical probability of pulmonary embolism increased as well (P=0.011). According to the classification of revised Geneva score, clinical probability of pulmonary embolism was evaluated to be low in 25% of patients, intermediate in 72% and high in 2%. Prevalence of pulmonary embolism based on the CT scan results was 7.7% ranged (0.5-14.9) in the low probability category, 22.5% ranged (15.6-29.4) in the intermediate, and 50% ranged (0.01-0.99) in the high-probability category which were comparable with the rates reported in the derivation set except for the prevalence rate for high probability patients (9%, 27.5% and 71.7%, respectively).*

The area under the ROC curve was calculated based on continuous scoring to be 0.675.

Conclusion**: Revised Geneva score had an acceptable predictive accuracy in low and intermediate-probability groups. We could not reach a conclusion regarding high probability patients due to the small number of such cases in this study.* ***(Tanaffos 2009; 8(4): 7-13)

***Key words**: Pulmonary embolism, Revised Geneva score, D-dimer*

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INTRODUCTION

Acute pulmonary embolism is among the common causes of morbidity, mortality and prolonged hospitalization. Almost half the pelvic and proximal lower extremity deep venous thromboses result in pulmonary embolism. The diagnosis of pulmonary embolism is not easy because of its non-specific signs and symptoms. The first step in the diagnosis of pulmonary embolism is to evaluate its clinical possibility in a suspected case by using different scoring methods based on patient's history, presence of underlying diseases and physical examination. Wells score is still popular but one of its main parameters is reliant on the experience of the doctor applying the rule and makes it difficult to standardize it for epidemiologic studies (1). The original Geneva score has been shown to be as accurate as the Wells Score but it has a disadvantage of requiring an arterial blood gas sample to be performed at room temperature which is not feasible in a large number of patients. More recently, the revised Geneva score has been introduced. This simplifies the scoring process and is independent of the experience of the doctor applying the rule (objectivity) (1-3). After initial evaluation of patients, the next diagnostic procedure would be selected based on the clinical probability of embolism (low, intermediate, high). The low or intermediate probability of embolism can be ruled out by the negative result of highly sensitive D-dimer test. Imaging studies are required in cases with high probability of pulmonary embolism (4-7). The imaging method of choice is spiral chest CT scan with contrast because it is fast and shows the non-vascular pulmonary structures as well. It can also help ruling out other differential diagnoses (2, 8-11).
This study aimed to evaluate the predictive accuracy of revised Geneva score in patients suspected of acute pulmonary embolism in Masih Daneshvari Hospital and its role in decreasing the need for CT scan of the lung. As a minor goal, we also evaluated the diagnostic strategy for PE in Masih Daneshvari Hospital.

MATERIALS AND METHODS

Our understudy population included suspected cases of pulmonary embolism who underwent CT scan at the Masih Daneshvari Hospital from October 2007 to February 2009. The diagnosis of pulmonary embolism was made based on positive result of spiral CT scan of the lung (Siemens, Somatom emotion) performed by single detector technique and reported by a radiologist in our center. A questionnaire was designed containing patients' demographic characteristics, parameters of revised Geneva score (Table 1), D-dimer test result and ultrasound of the lower extremities. The required data were collected from patients' medical records by a physician. If a patient did not have a positive history of thrombosis of the lower extremities, surgical operation or a malignancy in his/her medical history, he/she would not score for that parameter. Clinical symptoms of the thrombosis of lower extremities are usually included in the medical records of patients suspected for pulmonary embolism. Patients with non-diagnostic (indeterminate) CT-scan results were excluded from the study.

Table 1. Revised Geneva Score

Variable	Points
Age >65 years	1
Previous DVT or PE	3
Surgery (under general anesthesia) or	2
Active malignant condition (solid or hematologic, currently active or considered cured <1 year)	2
Unilateral lower-limb pain	3
Hemoptysis	2
Heart rate 75–94 beats/min	3
Heart rate >94 beats /min	5
Pain on lower-limp deep venous palpation and unilateral edema	4
Clinical probability	
Low	0–3 total
Intermediate	4–10 total
High	>10 total

The descriptive data were reported as mean ± SD for the quantitative variables and percentage for qualitative variables. Chi square test and Fisher's exact test were used to compare the relationship between 2 qualitative variables. T test was used for evaluation of the Geneva score and positive or negative CT scan results between the 2 groups. Predictive accuracy of Geneva score was evaluated by calculating the area under the ROC curve. P<0.05 was considered as significant. Data were analyzed using SPSS software version 16.

RESULTS

There were a total of 204 patients out of which, 6 were excluded from the study because of their non-diagnostic (indeterminate) CT-scan results. The mean age of patients was 58 yrs. Sixty-two percent of patients were males and 38% were females. Table 2 deminstrates the clinical and demographic characteristics of patients.

Table 2. Demographic and clinical characteristic of patients based on CT result

Characteristics	Patients with PE	Patients without PE	Total	p-value
Age(year)(mean± SD)	63.13±15.2	57.24±18.5	58.2±17.8	0.07
Men	71%	60%	62%	0.207
Women	29%	40%	38%	
Age>65	50%	43%	44%	0.443
Previous DVT or PE	16%	5%	7%	0.031*
Surgery or fracture within 1 mo	0%	1.9%	1.5%	>0.999
Active cancer	0%	12.5%	10%	0.016*
Unilateral lower limb pain	10.5%	4.4%	5.5%	0.227
Hemoptysis	26.3%	12.5%	15%	0.033*
Heart rate=75-94	55.3%	61.3%	60%	0.498
Heart rate>95	39.5%	29.4%	31%	0.228
Pain on lower limb palpation and unilateral edema	15.8%	5.6%	7.5%	0.044*

* Significant

The overall prevalence of pulmonary embolism was 24%. The highest score was 13 and the lowest was 1. The obtained scores were compared with CT-scan results indicating that by increasing the score, the clinical probability of pulmonary embolism raised as well (P=0.011). The scores of the 2 groups of positive and negative CT-scan results were compared with each other. The patients with positive CT scan result had a significantly higher mean score (P=0.001). Table 2 compares patients with and without PE in terms of the prevalence of various risk factors.

According to the revised Geneva score, clinical probability of pulmonary embolism was low in 25% of cases, intermediate in 72% and high in 2% of cases. Relative prevalence of PE in the 3 groups of low, intermediate and high probability was 7.7%, 22.5%, and 50%, respectively.

Area under the ROC curve was calculated for the revised Geneva score based on continuous scoring to be 0.676 (CI 95%=0.585-0.767) (Figure 1).

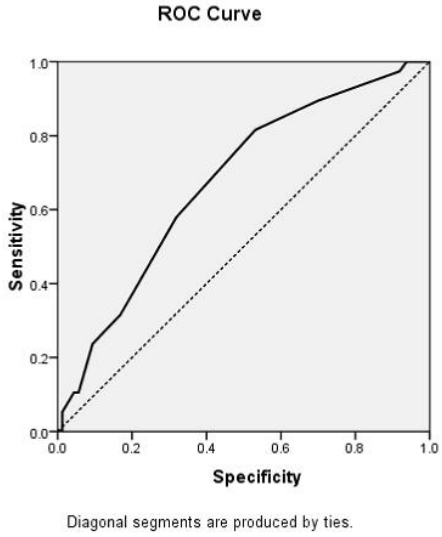

Figure 1. Receiver operating characteristic (ROC) curve of revised Geneva score [Area under the curve (AUC) = 0.676(CI95%: 0.585-0.767)]

Doppler ultrasound of the lower extremities had been performed in 28 and D-dimer test had been performed in 14 patients. Statistical analysis was not

performed in this regard due to the small number of patients.

A simplified form of revised Geneva score has recently been suggested (11). In this method, each risk factor is attributed one point and patients are categorized into different groups based on the clinical probability of PE using a 3-level scheme or a dichotomized rule.

In the dichotomized method, score of >3 is considered as having a high clinical probability and score of <3 is considered as having a low clinical probability for embolism.

Eighty four percent of our patients were categorized into PE unlikely group and 16% were categorized into the PE likely group. CT-scan result was positive in 16.3% of cases in the PE unlikely group and 34.4% of cases in the PE likely group. By increasing the score, clinical probability of PE raised as well (p=0.017). The scores of the 2 groups of positive and negative CT scan results were compared and those with positive CT scan results had a significantly higher mean score (P=0.015).

The area under the ROC curve for simplified Geneva score was 0.631 (CI 95%: 0.534-0.727) (Figure 2).

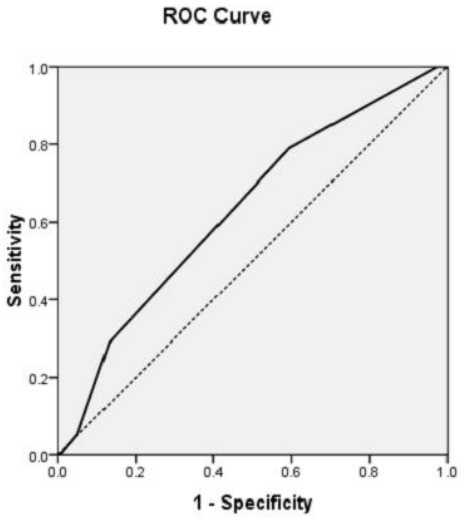

Figure 2. Receiver operating characteristic(ROC) curve of simplified revised Geneva score [Area under the curve (AUC)= 0.631(CI95%:0.534-0.727)].

Table 3 compares the relative prevalence of PE in different groups with the derivation set in the original study (2).

Prevalence of PE among the patient groups classified according to the simplified Geneva score was also in concord with that of the original study (Table 4).

Table 3. Comparison of our patients with derivation set of original study of revised Geneva score.

	Derivation set			Our study		
Risk Groups	Patients (N)	Patients with PE, (N)	Patients with confirmed PE (95% CI) %	Patients (N)	Patients with PE, (N)	Patients with confirmed PE (95% CI) %
Low	354	32	9.0(6.6-12.5)	52	4	7.7(0.5-14.9)
Intermediate	549	151	27.5(23.9-31.3)	142	32	22.5(15.6-29.4)
High	53	38	71.7(58.4-82.0)	4	2	50(0.01-0.99)
Total	956	221		198	38	

* Groups are defined according to the Geneva scores.

Table 4. Proportion of patients in two clinical probability groups of simplified revised Geneva score.

	Our study			Original study		
Risk Groups	Patients with PE (95%CI)	Patients with PE,(N)	Patients (N)	Patients with PE (95%CI)	Patients with PE, (N)	Patients (N)
PE likely	32.2% (15.8-48.6)	10	31	41.6%(36.5-46.8)	153	368
PE unlikely	16.3%(10.7-21.9)	27	166	12.5%(10.5-15.7)	88	681
Total			197			1049

DISCUSSION

The scores obtained for the low and intermediate probability groups were in accord with the results obtained in the original study which indicated the acceptable predictive accuracy of revised Geneva score in these groups of patients (according to the definition, patients with less than10% clinical probability of PE were considered as low risk, those with 10 to 60% probability were considered as intermediate and those with more than 60% probability were considered as high risk). The score for our high probability cases was not in accord with that of the original study which is probably due to the low number of high probability cases in our study (4 cases).

Area under the ROC curve in our study was equal to 0.675 which indicates the low predictive value of this score for our patients but this number is comparable with that of the original study (ROC=0.74).

Higher prevalence of hemoptysis in our patients (Table 2) compared to other studies (15% versus 4.5% in Righini (8) and colleagues study) can be due to the high number of respiratory patients especially TB patients at the Masih Daneshvari Hospital (since it is a referral center for pulmonary diseases).

Higher prevalence of active cancer in patients without PE has falsely demonstrated it as a negative risk factor (12-15). The reason might be the relatively higher referral of cases with the respiratory system cancer to the Masih Daneshvari Hospital and presence of respiratory symptoms similar to those of PE in this group of patients.

Prevalence of PE among the patient groups classified according to the simplified Geneva score was also in concord with that of the original study (Table 4).

Area under the ROC curve equal to 0.631 for the simplified Geneva score was indicative of the slight decrease in its predictive accuracy after simplifying the parameters. However, this rate was still comparable with that of Klok and his colleagues (12), study which was retrospectively performed on 1049 patients (ROC=0.68).

Most of our patients (98%) were classified into the low and intermediate-probability categories according to the revised Geneva score. By performing the D-dimer test with the ELISA method, PE could be ruled out in a large percentage of these patients and there would be no need for performing a CT scan (in a study by Ten Cate-Hoek and colleagues, using D-dimer test along with other predictive methods for PE resulted in 30% decrease in the need for performing a CT scan)(15).

In Roy et al. (13) study conducted on 1529 patients in 116 hospital emergency units in France, the diagnostic strategy of PE was inappropriate in 34% of cases. Old age, presence of an underlying cardiopulmonary disease and lack of a written diagnostic algorithm were among the main factors responsible for wrongful diagnosis. We had similar problems in the process of diagnosing PE in our patients (44% of our patients were older than 65 yrs and most of them had an underlying pulmonary disease). Since Masih Daneshvari Hospital is a referral center for cases with pulmonary diseases, a separate study may be required for finding a new clinical decision rule.

Limitations

Although the required data for calculating the revised Geneva score were obtained from the patients' medical records, none of our patients had been evaluated in terms of clinical probability in the emergency room. This can cause bios in calculating the scores. D-dimer and ultrasound of the lower extremities had been performed in only a few cases and therefore, we only focused on the result of single detector CT scan as the gold standard for the

diagnosis of PE and this was one of the limitations of this study. However, it did not cause a major problem in the course of study because the main objective was not the definite diagnosis of PE. The main goal was to detect patients in whom it is safe to withhold the anticoagulant therapy. Various studies have confirmed the safety of withholding the anticoagulant treatment in patients with negative CT scan (single detector) result for PE (3,11,14).

On the other hand, multi-detector CT scan reveals the tiny peripheral blood clots. The clinical significance of these clots is questionable and they are associated with a risk of over treatment.

As mentioned earlier, in this study CT scan was the gold standard. However, it was not performed for patients who had a low probability for PE according to the physician's judgment. Therefore, another limitation of this study was the fact that only high risk patients (based on the physician's opinion) entered this study. Further studies are required to be performed on the low probability patients so that the results can be applied to all patients suspected for PE.

CONCLUSION

Based on our study results, all patients suspected for PE (patients with dyspnea or acute chest pain)should be evaluated in the emergency room for clinical probability of PE and D-dimer test should be performed for cases with low or intermediate probability. Lung CT scan is only required in cases with positive D-dimer test or in high risk patients. Having a written diagnostic algorithm is highly advised in the hospital emergency units.

Revised Geneva score and its simplified version are among the reliable, simple and objective methods for evaluation of patients in terms of clinical probability of PE.

Evaluation of the clinical use of these methods especially in those with an underlying pulmonary disease requires prospective outcome studies. In these studies, patients in whom the probability of PE has ruled out and therefore have not received any treatment should be followed in terms of morbidity, mortality and occurrence of thromboembolic events.

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REFERENCES

1. Wells PS, Anderson DR, Rodger M, Stiell I, Dreyer JF, Barnes D, et al. 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; 135 (2): 98- 107.
2. Tapson VF. Acute pulmonary embolism. ***N Engl J Med*** 2008; 358 (10):1037-52.
3. 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; 144 (3): 165- 71.
4. van Belle A, Büller 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; 295 (2): 172- 9.
5. Di Nisio M, Squizzato A, Rutjes AW, Büller HR, Zwinderman AH, Bossuyt PM. Diagnostic accuracy of D-dimer test for exclusion of venous thromboembolism: a systematic review. ***J Thromb Haemost*** 2007; 5 (2): 296- 304.
6. van Belle A, Büller 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; 295 (2): 172- 9.

7. 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; 161 (1): 92- 7.
8. Righini M, Aujesky D, Roy PM, Cornuz J, de Moerloose P, Bounameaux H, et al. Clinical usefulness of D-dimer depending on clinical probability and cutoff value in outpatients with suspected pulmonary embolism. ***Arch Intern Med*** 2004; 164 (22): 2483- 7.
9. Kruip MJ, Söhne M, Nijkeuter M, Kwakkel-Van Erp HM, Tick LW, Halkes SJ, et al. A simple diagnostic strategy in hospitalized patients with clinically suspected pulmonary embolism. ***J Intern Med*** 2006; 260 (5): 459- 66.
10. Moores LK, Jackson WL Jr, Shorr AF, Jackson JL. Meta-analysis: outcomes in patients with suspected pulmonary embolism managed with computed tomographic pulmonary angiography. ***Ann Intern Med*** 2004; 141 (11): 866- 74.
11. Klok FA, Kruisman E, Spaan J, Nijkeuter M, Righini M, Aujesky D, et al. Comparison of the revised Geneva score with the Wells rule for assessing clinical probability of pulmonary embolism. ***J Thromb Haemost*** 2008; 6 (1): 40- 4.
12. 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; 168 (19): 2131- 6.
13. Roy PM, Meyer G, Vielle B, Le Gall C, Verschuren F, Carpentier F, et al. Appropriateness of diagnostic management and outcomes of suspected pulmonary embolism. ***Ann Intern Med*** 2006; 144 (3): 157- 64.
14. van Strijen MJ, de Monyé W, Schiereck J, Kieft GJ, Prins MH, Huisman MV, et al. Single-detector helical computed tomography as the primary diagnostic test in suspected pulmonary embolism: a multicenter clinical management study of 510 patients. ***Ann Intern Med*** 2003; 138 (4): 307- 14.
15. Ten Cate-Hoek AJ, Prins MH. Management studies using a combination of D-dimer test result and clinical probability to rule out venous thromboembolism: a systematic review. ***J Thromb Haemost*** 2005; 3 (11): 2465- 70.