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Predictive value of the Wells score combined with D-dimer level in identifying acute pulmonary embolism in patients with coronary heart disease with chest pain

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Acute pulmonary embolism (APE) is a challenging condition with frequently missed or delayed diagnosis, and thus may be fatal. In emergency patients with a history of coronary heart disease, the electrocardiogram (ECG) results are often not specific, and APE is difficult to diagnose. Consequently, the patients tend to be diagnosed with acute coronary syndrome (ACS), and either undergo reexamination with myocardial enzyme observations in the emergency department, or are admitted to the hospital for coronary angiography. The 2008 European Society of Cardiology (ESC) guidelines on the diagnosis and management of acute pulmonary embolism stated that the clinical risk assessment of APE should be based on the Wells score.[1] However, despite this official recommendation, the Wells score is not widely used in emergency medicine, especially for patients with coronary heart disease and concomitant APE. The present study analyzed the predictive value of the Wells score combined with the D-dimer level in identifying APE in patients with coronary heart disease.

Our retrospective study was conducted in accordance with the *Declaration of Helsinki*. We included 247 consecutive patients with a history of coronary heart disease who presented to the emergency department of Beijing Anzhen Hospital for chest pain and were suspected as acute pulmonary thromboembolism and subjected to computed tomography pulmonary angiogram (CTPA) examination from May 1, 2008 to July 31, 2016. Based on the CTPA results, the patients were divided into the group with APE and coronary heart disease ($n = 104$) and the group with coronary heart disease alone ($n = 143$). We collected retrospectively the medical records of all patients, and routine blood counts. All data were analyzed using SPSS 22.0 statistical software (IBM Corp, Armonk, NY, USA). Categorical variables were presented as numbers and percentages and analyzed with Chi-square test. Continuous variables with normal distribution were expressed as mean ± standard deviation and analyzed with Student's *t* test and those with skewed distribution were presented as median (Q_1, Q_3) and analyzed with Mann-Whitney *U* test. Univariate and multivariate logistic regression were used to analyze the factors associated with APE in patients with coronary heart disease. Receiver operating characteristic (ROC) curves were drawn, and comparisons of area under the curve (AUC) were made using the *Z* test. $P < 0.05$ was considered statistically significant.

Of the patients with coronary heart disease and suspected APE included in the present study, 42.1% (104/247) actually had APE. The average age of the patients with coronary heart disease and APE was lower than those with coronary heart disease alone (61 ± 5 years *vs.* 66 ± 12 years, $t = 7.485$, $P = 0.002$). The group with coronary heart disease and concomitant APE had a significantly different mean systolic blood pressure (118.3 ± 22.4 mmHg *vs.* 125.9 ± 20.4 mmHg, $t = 8.562$, $P = 0.006$), diastolic blood pressure (71.8 ± 12.8 mmHg *vs.* 75.4 ± 12.3 mmHg, $t = 10.25$, $P = 0.028$), heart rate (100.9 ± 18.5 beats/minute *vs.* 91.5 ± 15.6 beats/minute, $t = 23.47$, $P < 0.001$), percentage of unilateral lower limb swelling (51.0% [53/104] *vs.* 17.5% [25/143], $\chi^2 = 31.23$, $P < 0.001$), deep venous thrombosis (DVT; 19.2% [20/104] *vs.* 7.0% [10/143], $\chi^2 = 8.451$, $P = 0.004$), Wells score (5.2 ± 1.3 *vs.* 3.5 ± 1.2, $t = 3.016$, $P = 0.048$) and shock (16.3% [17/104] *vs.* 6.3% [9/143], $\chi^2 = 6.460$, $P = 0.011$) compared with the patients with coronary heart disease alone. The two groups did not differ significantly regarding mean body mass index, smoking history, history

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Table 1: Univariate and multivariate analysis of risk factors for APE in patients with coronary heart disease.

Variables	Univariate analysis			Multivariate analysis		
	B	OR (95% CI)	*P*	*B*	OR (95% CI)	*P*
Unilateral lower limb swelling (yes *vs.* no)	−1.697	7.364 (2.675–16.348)	0.014	−1.478	5.634 (1.257–13.463)	0.037
DVT (yes *vs.* no)	−2.486	1.732 (0.598–13.162)	0.000	−2.692	1.657 (0.338–12.850)	<0.001
Tachycardia (yes *vs.* no)	−1.348	1.024 (0.869–9.376)	0.008	−1.058	1.194 (0.569–8.846)	0.043
Age (≥60 *vs.*<60 years)	0.022	1.022 (0.994–1.050)	0.125			
Shock (yes *vs.* no)	0.264	0.768 (0.168–3.516)	0.734			
SBP (<100 *vs.*≥100 mmHg)	0.004	1.004 (0.983–1.025)	0.157			
SIQIIITIII (yes *vs.* no)	−0.333	0.717 (0.312–1.646)	0.432			
D sign (yes *vs.* no)	0.057	1.120 (0.897–1.397)	0.318			
Pulmonary arterial widening (yes *vs.* no)	0.048	0.034 (0.782–1.072)	1.084			

APE: Acute pulmonary embolism; CI: Confidence interval; DVT: Deep venous thrombosis; OR: Odds ratio; SBP: Systolic blood pressure; SIQIIITIII: S wave deepening in lead I, Q wave deepening in lead III and T wave inversion in lead III.

of diabetes mellitus, chronic obstructive pulmonary disease, and hyperlipidemia, B natriuretic peptide, troponin I, uric acid and Wells score (all $P > 0.05$). There was a borderline significant difference between the coronary heart disease and concomitant APE group and the coronary heart disease-alone group in the D-dimer level (2148 [1121, 3503] ng/ml *vs.* 1771 [885, 1896] ng/ml, $Z = 2.309$, $P = 0.051$]. The echocardiogram results of the group with coronary heart disease and concomitant APE showed significantly higher incidences of the D sign (7.7% [8/104] *vs.* 1.4% [2/143], $\chi^2 = 6.227$, $P = 0.013$) and pulmonary arterial widening (4.8% [5/104] *vs.* 0.7% [1/143], $\chi^2 = 4.490$, $P = 0.034$). The ECG results showed that the group with coronary heart disease and concomitant APE had significantly greater incidences of sinus tachycardia (69.2% [72/104] *vs.* 39.2% [56/143], $\chi^2 = 24.02$, $P < 0.001$) and SIQIIITIII pattern (40.4% [42/104] *vs.* 22.4% [32/143], $\chi^2 = 9.304$, $P = 0.002$) than the group with coronary heart disease alone.

Both univariate and multivariate logistic analysis indicated that the independent risk factors for APE in patients with coronary heart disease were unilateral lower limb swelling, tachycardia, and deep vein thrombosis [Table 1].

For predicting the occurrence of APE in patients with coronary heart disease, the D-dimer level had a sensitivity of 88.46% and specificity of 83.22%, the Youden index (YI) was 0.717 and the cutoff value was 1090 ng/ml. The Wells score had a sensitivity of 75.96% and specificity of 70.63%, the YI was 0.466 and the cutoff value was >1. The Wells score combined with the D-dimer level had a sensitivity of 88.46% and specificity of 90.21%, and the YI was 0.787. The Wells score combined with the D-dimer level showed a better discrimination with an AUC of 0.949 (95% CI: 0.913–0.973) than the D-dimer level (AUC = 0.898, 95% CI: 0.854–0.933, $Z = 18.795$, $P < 0.0001$) and the Wells score (AUC = 0.784, 95% CI: 0.728–0.834, $Z = 10.147$, $P < 0.0001$).

Chest pain is a common emergency manifestation. As chest pain has various causes and can indicate severe illness, the condition requires careful diagnostic evaluation. Despite many new insights over the past two decades, the assessment of acute chest pain remains challenging. Of the patients who present to an emergency department with chest pain, 10% to 20% are diagnosed with ACS.[2] Some patients with coronary heart disease present with chest pain as the first symptom. Such patients tend to be diagnosed by emergency doctors with ACS, which is often a misdiagnosis and can lead to missed diagnoses. Moreover, repeated reviews of myocardial enzyme concentrations increase the duration of emergency stay and the economic burden.

APE ranges from an accidental discovery to a life-threatening condition; thus, the differentiation of APE from cardiovascular disease is particularly important for patients with an unstable blood flow. There are currently no epidemiological data available on coronary heart disease with APE. Zöller *et al*[3] found that the pathogeneses of cardiovascular diseases caused by venous thromboembolism versus atherosclerosis were entirely different. In complex families with 2 or >3 siblings diagnosed with coronary heart disease or venous thromboembolism, there is no significant correlation between coronary heart disease and venous thromboembolism. However, many recent studies have found that coronary heart disease and venous thromboembolism have similar risk factors, and that patients with cardiovascular disease have a higher prevalence of APE than those without cardiovascular disease.[4] Furthermore, heart disease increases the risk of recent pulmonary embolism, and coronary heart disease is considered a predisposing factor for APE. Computed tomography angiography of the lung reportedly reveals coronary artery calcification in 43.3% of patients with suspected APE.[5]

The Wells score is helpful in the preliminary judgment of the possibility of APE, while the plasma D-dimer level is important in the exclusion of APE. Therefore, a combination of the Wells score and the plasma D-dimer level may be used to safely exclude a diagnosis of APE, reduce the application of radiological examinations, and improve the specificity of APE diagnosis. The present study showed that the Wells score combined with the D-dimer level was suitable for predicting the presence of APE in emergency patients with chest pain and a history of coronary heart disease. In clinical practice, the D-dimer level is still the main detection method used in the emergency department to exclude APE. However, for patients with coronary heart disease, most emergency physicians initially screen for APE

using the D-dimer level instead of the Wells score, especially in an emergency department with a large workload, and only consider a higher possibility of APE after attaining positive D-dimer results; this increases the time taken to diagnose APE. The present study showed that the Wells score, which indicates the clinical possibility of APE, was an effective means for the rapid diagnosis of APE in patients with coronary heart disease.

The present study had some limitations. It was a single-center, retrospective study with a small sample size that only represented the current status of emergency diagnosis and treatment in one research center rather than in the overall population of patients with coronary heart disease and concomitant APE. Due to research limitations, the included cases comprised patients with APE confirmed in the emergency department and admitted to hospital. In accordance with the ESC guidelines on the diagnosis and management of acute pulmonary embolism, non-inpatients with lower risk stratification were not included in the present analysis. Studies with larger sample sizes are needed to further evaluate the factors affecting the time taken to diagnose APE in patients with coronary heart disease in the emergency department.

Conflicts of interest

None.

References

1. Torbicki A, Perrier A, Konstantinides S, Agnelli G, Galiè N, Pruszczyk P, *et al*. Guidelines on the diagnosis and management of acute pulmonary embolism: the Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC). Eur Heart J 2008;29:2276–2315. doi: 10.1093/eurheartj/ehn310.
2. Lindsell CJ, Anantharaman V, Diercks D, Han JH, Hoekstra JW, Hollander JE, *et al*. The internet tracking registry of acute coronary syndromes (i*trACS): a multicenter registry of patients with suspicion of acute coronary syndromes reported using the standardized reporting guidelines for emergency department chest pain studies. Ann Emerg Med 2006;48:666–677. doi: 10.1016/j.annemergmed.
3. Zöller B, Li X, Sundquist J, Sundquist K. Venous thromboembolism does not share strong familial susceptibility with coronary heart disease: a nationwide family study in Sweden. Eur Heart J 2011;32:2800–2805. doi: 10.1093/eurheartj/ehr223.
4. Zuin M, Rigatelli G, Faggian G, Zonzin P, Roncon L. Short-term outcome of patients with history of significant coronary artery disease following acute pulmonary embolism. Eur J Intern Med 2016;34:e16–e17. doi: 10.1016/j.ejim.2016.05.015.
5. Johnson C, Khalilzadeh O, Novelline RA, Choy G. Coronary artery calcification is often not reported in pulmonary CT angiography in patients with suspected pulmonary embolism: an opportunity to improve diagnosis of acute coronary syndrome. AJR Am J Roentgenol 2014;202:725–729. doi: 10.2214/AJR.13.11326.

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