Comparison of four clinical scores for the predicting lower limb deep venous thrombosis in Chinese patients ☆

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Abstract

Objective: To evaluate Wells, Kahn, St.André and Constans scores for the prediction of deep venous thrombosis in Chinese patients. **Methods:** One hundred and seventy-two patients, prospectively, blinded referred for evaluation with four clinical-score systems for suspected deep venous thrombosis, were examined by ultrasonography. Sensitivity, specificity, positive predictive value, negative predictive value and receiver operation curves were calculated for four clinical scores. The difference between areas of the ROC curve for each of the scores was compared with others and reference line. **Results:** Forty-six of 172 patients had deep venous thrombosis proven by sonography. The sensitivity, specificity, positive predictive value and negative predictive value for Wells score was 91.3%, 57.1%, 43.8% and 94.7%, respectively, for Kahn score; 65.2%, 71.4%, 45.5% and 84.9%, respectively, for St.André score; 63%, 38.9%, 27.4% and 74.2% respectively, for Constans score; 95.7%, 34.9%, 34.9% and 95.7% respectively. Area under ROV curve of Constans score was 0.814, which was similar to that of Wells score, then followed by Kahn score and that of St.André score was no difference with the reference line. **Conclusion:** Based on the results of our study, the sensitivity, negative prediction value and area under ROC curve are larger for Constans score and Wells score in Chinese hospitalized patients than that of Kahn score or St.André score. Considering the aim of the clinical assessment, Constans score and Wells score are more efficient for Chinese hospitalized patients.

Key words: deep venous thrombosis; clinical assessment; lower extremity sonography

INTRODUCTION

Clinical assessment is a fundamental step in the diagnostic workup of patients with suspected deep venous thrombosis(DVT). Although the diagnostic yield of individual symptoms, signs, and common laboratory tests are limited, the combination of these variables can be used to express a clinical probability of DVT.

Clinical diagnosis of deep venous thrombosis is important, because treatment must be undertaken rapidly to avoid potentially fatal pulmonary embolism[1]. Some investigators have developed clinical scores based on history and physical examination for predicting the probability of deep venous thrombosis, before confirmation by objective testing[2-5]. These scores include Wells score [2], Kahn score[3], St.André score[4] and Constans score [5]. They can improve the efficiency of early detection. However, the value of these scores in Chinese patients still has not been recognized. In this prospective research, we aim to evaluate their values for Chinese hospitalized patients.

MATERIAL AND METHODS
Study samples

The prospective study was performed from January 2004 to June 2006 at affiliated hospital in Ning Xia Medical College. After Institutional and patients'approval and consent were obtained, Two hundred and seven patients with suspicion of deep venous thrombosis of the lower limb were assessed consecutively with four scores before ultrasound exploration.

Diagnostic methods

For each suspected patient, four scores including Wells, Kahn, St.André, and Constans were blindly performed by four independent investigators. To standardize clinical observations, all investigators met at the beginning of the study to discuss the interpretation of the items on the clinical form. After scores, all patients received the color duplex compression ultrasound within 24 hours. The sonogrophy examiner was unaware of the patient's clinical score when the patient was examined.

The following items and weights were used for scores and categorize:

①Wells Score; we used the following: active cancer (+1), lower limb paralysis or immobilization(+1) confined to bed＞3 days(+1), localized tenderness(+1), whole lower limb enlargement(+1), calf enlargement = 3 cm compared with the other side(+1), unilateral pitting edema(+1), superficial venous dilation(+1) and other diagnosis at least as plausible as deep venous thrombosis(–2).

②For the Kahn score: male sex(+1), orthopedic surgery < 6 months(+1), superficial venous dilation(+1) and local warmth(+1).

③ For the St.André score: active cancer(+1), lower limb paralysis or immobilization(+1), unilateral pitting edema(+1), superficial venous dilation(+1), local warmth(+1), and other diagnosis at least as plausible as deep venous thrombosis(–1).

④ For the Constans score: male sex(+1), lower limb paralysis or immobilization(+1), confinement to bed ＞ 3 days(+1), lower limb enlargement(+1), unilatery lower limb pain(+1), and other diagnosis at least as plausible(–1).

Patients were categorized into three risk groups: low (score≤0), medium(score of 1 or 2), or high(score≥3).

All patients underwent bilateral lower extremity venous sonography from the inguinal level to the calf vein within 24 hours of clinical score using standard compression and Doppler techniques. Sonography was considered to yield positive findings if intraluminal thrombus prevented complete collapse of a vessel during compression. Standard Doppler evaluation was also used but in no patient was a diagnosis of DVT made by Doppler examination alone.

Statistical analysis

For each score, sensitivity, specificity, positive predictive value, negative predictive value and a receiver operating characteristic(ROC curve) was calculated; the area under the ROC curve and its 95% confidence interval were estimated by the software Medcalc (Belgium). We compared the difference between area of the ROC curve for each of the scores with others and reference line, a two-tailed *P*-value of less than 0.05 was used to define statistical significance.

RESULTS
Patients' baseline characteristics

Within the 207 patients, 35 patients were excluded from study, because 16 patients refused the informed consent, 6 patients did not undergo lower extremity sonography in 24 hours after being scored by physician, 13 patients received anticoagulant therapy before arriving at our hospital. Finally, a total 172 patients were enrolled.

Forty-six of 172 patients had deep venous thrombosis were diagnosed by compression untrasonography. The 46 DVT patients included 23 men; median age was 59.5 years(range 16-82). 126 non-DVT patients had 68 men, median age was 61.5 years(range 20-81).

The prevalence of DVT was 26.74%(46/172), and the patients' baseline characteristics were summarized in Table 1.

Performance of four clinical scores

Patients were categorized into low, moderate and high probability of having DVT according the score. Patient's number in three risk groups, and DVT diagnosed by sonography for four clinical scores are shown in Table 2.

When a threshold was introduced between the low group and the other 2 groups, the sensitivity, specificity, positive predictive value and negative predictive value for Wells score was 91.3%, 57.1%, 43.8% and 94.7%, respectively. For Kahn score, the sensitivity, specificity, positive predictive value and negative predictive value was 65.2%, 71.4%, 45.5% and 84.9%, respectively, for St.André score, 63%, 38.9%, 27.4% and 74.2%, respectively, for constans score, 95.7%, 34.9%, 34.9% and 95.7%, respectively.

ROC curve for four scores displayed in Fig. 1, suggest Wells score and Constans score have a similar area, following Kahn score and St.André score. The areas under the ROC curves for the 4 clinical models are shown in Table 3. Compared with the reference line, by pair-wise comparison of difference between areas (DBA) of ROC curves, the area under the ROC curve for St.André score has no difference with reference area (50%) and suggested the lesser value(*, *P* = 0.702) and

Table 1　Baseline characteristics of study sample

Characteristic	DVT,n(%)	Non-DVT,n(%)	P value
male	23/46(50%)	68/126(54%)	0.645
age=65	18/46(39%)	43/126(34%)	0.545
Active cancer	9/46(20%)	11/126(9%)	0.05
lower limb paralysis or immobilization	5/46(11%)	15/126(12%)	0.852
confinement to bed > 3 days	18/46(39%)	30/126(24%)	0.048
orthopedic surgery < 6 months	11/46(24%)	24/126(19%)	0.484
unilateral lower limb swollen	27/46(59%)	11/126(9%)	0.000
calf enlargement ⩾ 3cm compared with the other side	12/46(26%)	5/126(4%)	0.000
unilateral pitting edema	19/46(41%)	8/126(6%)	0.000
local warmth	0/46(0%)	2/126(2%)	0.388
superficial venous dilation	5/46(11%)	18/126(14%)	0.561
unilatery lower limb pain	19/46(41%)	4/126(3%)	0.000
previous DVT	3/46(7%)	1/126(0.8%)	0.028
alternative diagnosis	3/46(7%)	8/126(6%)	0.967

Table 2　Numbers of three risk groups and DVT for four clinical scores

Probability	Wells score		Kahn score		St.André score		Constans score	
	patients	DVT	patients	DVT	patients	DVT	patients	DVT
Low	76	4	106	16	66	17	46	2
moderate	74	26	64	29	105	29	107	29
High	22	16	2	1	1	0	19	15

ROC Curve of Four Clinical Scores

Diagonal segments are produced by ties.
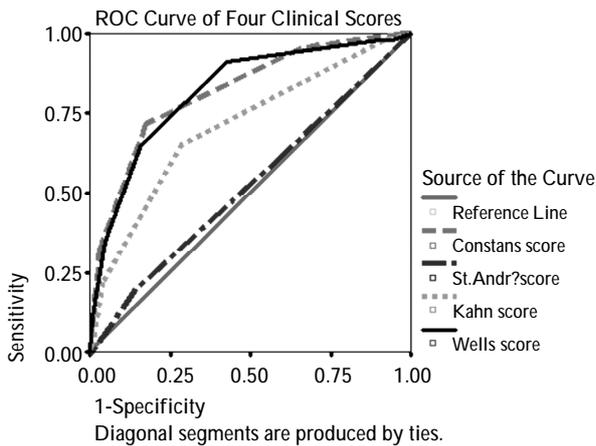
Fig. 1　ROC curve for four scores

Table 3　The area under the ROC curve of four clinical scores

Clinical score	AUC ± sE	95%CI
Wells score(I)	0.812 ± 0.043**	0.742-0.869
Kahn score(II)	0.711 ± 0.049★★	0.634-0.781
St.André score(III)	0.520 ± 0.052*	0.439-0.600
Constans score(IV)	0.814 ± 0.042▲	0.745-0.872

I , Wells score; II , Kahn Score; III , St.André score; IV ,Constans Score.

other three scores all have significant difference(**P = 0.000; ★★ P = 0.000; ▲ P = 0.000).

Pair-wise comparison of ROC curves: Difference Between Areas(DBA) between I and II =0.010 ± 0.035 (95%CI 0.032~0.168), P = 0.004; DBA between I and III =0.292 ± 0.062(95%CI 0.170~0.414),$P <$ 0.001; DBA between I and IV =0.003 ± 0.041(95%CI-0.076~0.082),P = 0.942; DBA between II and III = 0.192~0.063(95%CI 0.068~0.315）, P = 0.002; DBA between II and IV = 0.103 ± 0.050(95%CI 0.005 ~

0.202), P = 0.040; DBA between III and IV = 0.295 ± 0.054(95%CI 0.189~0.401), $P <$ 0.001.

DISCCUSSION

Diagnosis was necessarily made clinically prior to the 1970s, but interest in the discriminatory value of the clinical assessment, other than to alert the clinician to the need for objective testing was abandoned when the advent of imaging demonstrated that clinical diagnosis was frequently incorrect[6,7]. In more recent years, clinical assessment in the form of scoring systems, while unable to exclude or confirm the presence of DVT, has gained favor as a method of stratifying pretest probability into low-probability, intermediate-probability, or high-probability groups.

Since 1990s, based on the symptoms, physical examination and patient history, a few investigators have constructed a formal diagnostic rule categorizing patients into a low, moderate, or high probability of having DVT[2-5]. The rule developed by Wells and colleagues was by far the best known and most often applied[8-12]. Because there are differences between these clinical scores, including numbers of items, influence of subjective factor, and patients which the rule developed from, and the food customs and the spectrum of disease of Chinese patients differ from that of the West. It is necessary to evaluate which one of four clinical scores is more suitable for Chinese hospitalized patients.

We observed similar in the characteristics of Chinese hospitalized patients with suspected deep venous thrombosis as compared with previously reported patients. For example, the prevalence of cancer was very similar: 12%

of Chinese patients had cancer compared with 17% of hospitalized patients for St.André score[4]. But the area under ROC of St.André score is the smallest in four scores, and there is no statistical significance compared with reference line. On the other hand, confinement to bed was much more frequent in hospitalized patients than in outpatients that the other three scores were derived from. The areas under ROC of two scores are largest, 0.814(95%CI, 0.745-0.872) for Constans score and 0.812(95%CI, 0.742-0.869) for Wells score, and followed Kahn score.

Although Kahn score has only four items, is simple to use in practice, and has no influence of subjective factor, the area under ROC is smaller than that of Constans score and Wells score. On the other hand, it is difficult to separate lower limb enlargement, calf enlargement, and unilateral pitting edema, because these conditions overlap. Nevertheless, they were independent predictors in the multivariate analysis from which the Wells score was developed[2]. The area under ROC of Wells score is the second largest, and is similar to that of Constans score($P = 0.942$).

Negative predictive value is much more important for clinical scores for evaluating patients who were suspected as having DVT. When a threshold was introduced between the low group and the other 2 groups using lower limb compression ultrasonography as reference test, the NPVs of Constans score and Wells score are higher than that of the others, 95.7% and 94.7%, respectively. Only 4.3%(2/46) patients were missed in low probability group for Constans score, and for Wells score, that is 5.3%(4/76). These results were similar to that the Wells score and Constans score developed, and also to that other authors obtained using the wells score. It is important to categorize the patients who suspected having DVT into low, medium, or high pretest probability before objective testing. For these low probability group patients, it is recommended[10] that no further objective diagnostic tests should be used and anticoagulant therapy can be held back. In addition to more cost should be spent, some side-effects could happen including allergic response to ipdine, infection in site of venepuncture, and severe bleeding to anticoagulant therapy[13]. On the other hand, for those medium and high probability patients, objective diagnostic tests[14], e.g. compression lower extremity ultrasonography, indirect computer tomography venography, should be used to prove or exclude deep venous thrombosis. Because for the medium probability patients[5], 29%-43% patients proven with DVT, and for the high probability patients[5], 56%-82% patients proven with DVT. These data are similar with ours in this work.

Based on the results of our study, the sensitivity, negative prediction value and area under ROC curve are larger for Constans score and Wells score in Chinese hospitalized patients than that of Kahn score or St. André score. Considering the aim of the clinical assessment, Constans score and Wells score offer more efficiency for Chinese hospitalized patients.

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