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Research Article

Evaluation of the Diagnostic Accuracy of the Wells Score in Pulmonary Embolism

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Abstract

Introduction: Pulmonary embolism pulmonary embolism (PE) is a major medical emergency responsible for high morbidity and mortality in the absence of early and appropriate diagnosis and management. Its diagnostic approach is well codified by validated scores, including the Wells score.

Patients and Methods: This was a 3-year descriptive and analytical cross-sectional study carried out in a Burkina Fas university hospital. Patients admitted for suspected pulmonary embolism were included. Study variables were socio-demographic, clinico-biological and scanographic data, clinico-biological and CT scan data. Patients were classified according to the clinical probability level of the Wells score as follows: low (score < 1 points); intermediate (score 2-6 points) and high (score > 7 points). Angioscan was the gold standard, with the Wells score as the diagnostic test.

Results : The hospital prevalence of pulmonary embolism was 21.74%. The mean age of patients was 54.33 ± 16.82 years, and the modal class corresponding to the [60-70] age group was the most represented. The variables significantly associated with the discovery of pulmonary embolism on CT-scan after logistic regression were a history of thromboembolic venous disease (p=0.0171), recent surgery (p=0.0005), shortness of breath dyspnea (p=0.0166), chest pain (p=0.0053), syncope (p=0.0010). The sensitivity and specificity of the Wells score at 2 probability levels were 78.65% and 92.19% respectively, while the positive predictive value value (PPV) and negative predictive value were 92.92% and 76.82% respectively.

Conclusion: Pulmonary embolism, previously rare in sub-Saharan Africa, has become a real health problem. The Wells predictive score appears to be one of the tools of choice in the diagnostic process in our context. However, the score still needs to be adapted to local data from prospective multicenter studies.

Keywords: Pulmonary embolism; Wells score; Diagnosis; Ouagadougou; Burkina Faso

Introduction

Pulmonary embolism (PE) represents a major medical emergency with potentially serious consequences if not diagnosed and treated promptly [1]. This disorder, often caused by a blood clot that blocks one or more arteries in the lungs, is a crucial issue for health systems around the world, particularly in countries with limited resources [2]. In Burkina Faso, as in

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many other developing countries, the effective management of cardiovascular diseases and especially PE in particular is complicated by challenges such as lack of resources, limited access to advanced diagnostic technologies, and sometimes late recognition of symptoms [3]. In this context, clinical probability scores are of capital importance in the diagnostic process. The Wells score is a clinical tool developed to help assess the risk of pulmonary embolism in patients with compatible symptoms [4]. It uses a series of clinical criteria and risk factors to stratify patients into different risk categories [4]. Its validity and effectiveness as a screening tool have been widely documented in clinical contexts in developed countries, but its application and performance have not been validated in black African subjects [5]. This study aims at evaluating the performance of the Wells score in the diagnosis of pulmonary embolism at Bogodogo University Hospital Center.

Materials and Methods

Type, period and setting of the study

This was a descriptive and analytical cross-sectional study with diagnostic purposes, carried out from January 1, 2021 to July 31, 2023 at the Bogodogo University Hospital Center in Ouagadougou, Burkina Faso. The cardiology services and the pulmonology unit served as a framework.

Inclusion criteria

Patients hospitalized for clinical suspicion of PE and in whom a chest CT angiogram was performed were included in the study.

Study variables and operational definitions

The study variables collected upon patient admission were socio-demographic, clinico-biological and scannographic data. The Wells score was calculated from demographic data (age, sex), cardiovascular history, cardinal symptoms and signs of PE and the existence or not of an alternative diagnosis [4]. Patients were classified according to the clinical probability level of the Wells score as follows: **low** (score < 1 points); **intermediate** (score 2-6 points) **and high** (score > 7 points) [4]. For the purposes of calculating sensitivity and specificity, the score was dichotomized into diagnosis of probable PE for a score > 4 or unlikely for a score of ≤ 4. The diagnosis of certainty/exclusion of PE was based on the presence or absence of direct and/or indirect signs of PE on CT angiography of the pulmonary arteries.

Statistical methods and data analysis

Patients were subdivided into two groups: confirmed PE versus excluded PE. The data were entered into Excel and analyzed using R software. The Chi² and Fisher Exact tests were used in univariate analysis to determine the categorical variables associated with the occurrence of PE. For quantitative variables, a 'Student' mean comparison test was used after checking the normality of the distributions. In the absence of normality of the variable, the Kruskal-Wallis test was used for a comparison of medians. The normality of the distribution of continuous variables was tested by graphical methods. A value of $p < 0.05$ defined the significance threshold for the association between the independent variables and the occurrence of pulmonary embolism. All variables whose univariate p-value was <0.2 were included in a multivariate logistic regression model to determine independent predictors of PE.

Considering CT angiography as the "gold standard" and the Wells score as a diagnostic test, true positives (TP) are patients who have a probable clinical score and a positive CT angiogram. False positives (FP) are patients who have a probable clinical score and a negative CT angiogram. False negatives (FN) are patients who have an improbable clinical score and a positive CT angiogram. True negatives (TN) are patients who have an improbable clinical score and a negative CT angiogram. Sensitivity (Se) and specificity (Sp) were calculated respectively from the following formulas: Se = TP/TP+FN; Sp=TN / TN+FP.

The 'ROC' curve (Receiver Operating Characteristics) is the graphical representation of all sensitivity-specificity pairs corresponding to all possible thresholds. It is constructed from the maximum possible score thresholds. It shows on the ordinate the sensitivity of the test, that is to say the proportion of true positives, and on the abscissa the specificity of the test, that is to say the proportion of true negatives.

The accuracy of the test will be defined by the area under the ROC curve (AUC) according to Sweets JA as follows [6]:

♣If AUC= 0.5 then the diagnostic score will be of zero benefit.

♣If AUC is between 0.5 and 0.70 then the diagnostic score will be of little information.

♣If AUC is between 0.70 and 0.90 then the diagnostic score will be moderately informative.

♣If AUC is between 0.90 and 1 then the diagnostic score will be very informative and perfect.

Ethical considerations

The study obtained approval from the institutional ethics committee of the hospital and anonymity was respected during data collection and processing.

Results

During the study period, 1228 patients were hospitalized in the two departments, including 999 patients in cardiology and 232 patients in the infectious and tropical diseases department. There were 472 patients hospitalized for suspected pulmonary embolism. This diagnosis was confirmed by chest CT angiography in 267 cases. The hospital prevalence of PE was 21.74%.

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General characteristics of the study population

Male patients represented 47.88% (n=226), i.e. a sex ratio of 0.93. The average age of the patients was 54.33 years ± 16.82 with extremes of 19 years and 97 years. The modal class corresponded to the age group of [60-70] years with a number of 110 patients or 23.30% of patients (Figure 1).

The main functional signs were dyspnea and chest pain, respectively in 84.32% (n=398) and 80.08M (n=378) (Reference Table 1). The average blood pressure is 125 mmHg; 95% confidence interval [80-231] for systolic and 79 mmHg; 95% confidence interval [47-133] for diastolic. The mean heart rate is 96 beats per min, 95% confidence interval [22-155] and spontaneous oxygen saturation is 96%, 95% confidence interval [44-100]. The proportions of physical signs found range from 1.69% (n=8) for a positive Homans sign at 44.49% for tachycardia (Reference Table 2).

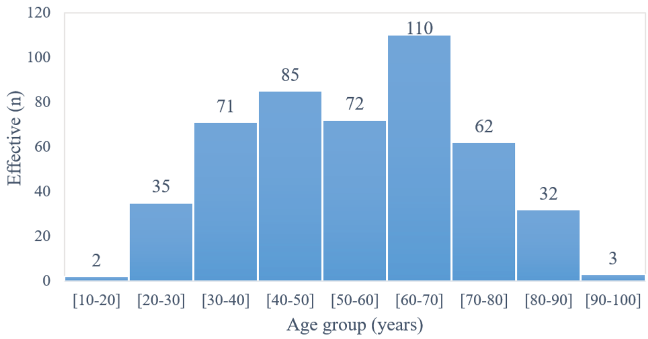

Figure 1: Distribution by age group of 472 patients suspected of PE.

Univariate and multivariate analysis of clinical characteristics associated with the discovery of pulmonary embolism

In univariate analysis, the thromboembolic risk factors, functional and physical signs associated with the discovery of a PE are reported in Table 2. In the multivariate analysis by logistic regression, the variables significantly associated with the discovery of embolism lung on CT angiography were a history of venous thromboembolic diseases (p=0.0171), recent surgery (p=0.0005), dyspnea (p=0.0166), chest pain (p=0.0053), syncope (p=0.0010) (reference Table 3).

Wells Score Performance Assessment Metrics

Contingency Table 4 presents the results of chest CT angiography according to the dichotomized Wells score (0-4 versus >4). The sensitivity and specificity of the Wells score at 2 probability levels were 78.65% and 92.19%, respectively. As for the positive predictive value (PPV) and the negative predictive value, they were 92.92% and 76.82%. Figure 2 shows the ROC curve of the Wells score in our study. The area under the ROC curve was estimated at 0.85, confidence interval at 95% [0.81-0.89].

Table 1: Simplified and original Wells score.

	Clinical decision score points	
Wells score	**Original version**	**Modified**
History of pulmonary embolism or deep venous thrombosis	1.5	1
Heart beat > 100	1.5	1
Immobilization at least 3 days or surgery in the previous 4 weeks	1.5	1
Hemoptysis	1	1
Malignancy cancer/ treatment within 6 months or palliative	1	1
Clinical signs and symptoms of deep venous thrombosis	3	1
Pulmonary embolism most likely diagnosis	3	1
Clinical probability		
Three-level score		
Low	0-1	-
Moderate	45445	-
High	≥ 7	-
Two level score		
PE unlikely	≤4	<2
EP likely	>4	≥2

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Table 2: Univariate analysis of thromboembolic risk factors, functional and physical signs of confirmed versus invalidated PE patients

Variables	Total	P E confirmed	P E excluded	OR	p-value
	N=472	n =267 (%)	n=205 (%)	[IC 95%]	
Thromboembolic risk factors					
Prolonged bed rest	64	36 (13,4)	28 (13,6)	0,9[0,57-1,67]	0,95
Sedentary lifestyle	439	253 (94,7)	186 (90,7)	1,2[0,55-2,64]	0,64
Cancer	17	12 (4,4)	5 (2,4)	1,3[0,44-3,89]	0,61
Hemoglobinopathy	32	24 (9)	8 (3,9)	2,2[0,9-5,37]	0,08
Trauma/fracture	23	18 (6,7)	5 (2,4)	2,6[0,96-7,35]	0,05
Recent surgery	46	35 (13,1)	11 (5,3)	2,1[1,01-4,40]	**0,04**
HIV infection*	31	5 (1,8)	26 (12,6)	0,1[0,05-0,40]	**<0,01**
Obesity	109	76 (28,4)	33 (16,1)	2,1[1,31-3,27]	**<0,01**
Previous VTE *	51	40 (14,9)	11 (5,3)	3,1[1,55-6,22]	**<0,01**
Functional signs					
Palpitations	18	10 (3,7)	8 (3,9)	0,9[0,37-2,47]	0,92
Painful leg tumefaction	23	15 (5,6)	8 (3,9)	1,4[0,60-3,52]	0,39
Hémoptysis	48	24 (8,9)	24 (11,7)	0,7[0,40-1,35]	0,33
Dyspnea	398	234(87,6)	164 (80)	1,7 [1,07-2,92]	**0,02**
Chest pain	378	230(86,1)	148 (72,2)	2,3 [1,50-3,80]	**<0,01**
Syncope	38	35 (13,1)	3 (1,4)	10,1[3,07-33,52]	**<0,01**
Physical signs					
Tachycardia	210	128(47,9)	82 (40)	1,3[0,95-2]	0,08
Homans sign	8	5 (1,8)	3 (1,4)	1,2 [0,3-5,44]	**<0,01**
Shock	39	30 (11,2)	9 (4,3)	2,7[1,27-5,94]	**<0,01**
Heart failure	23	21 (7,8)	2 (0,9)	8,6[2-37,39]	**<0,01**

HIV infection: positive retroviral serology (+); VTE: Venous thromboembolic disease;

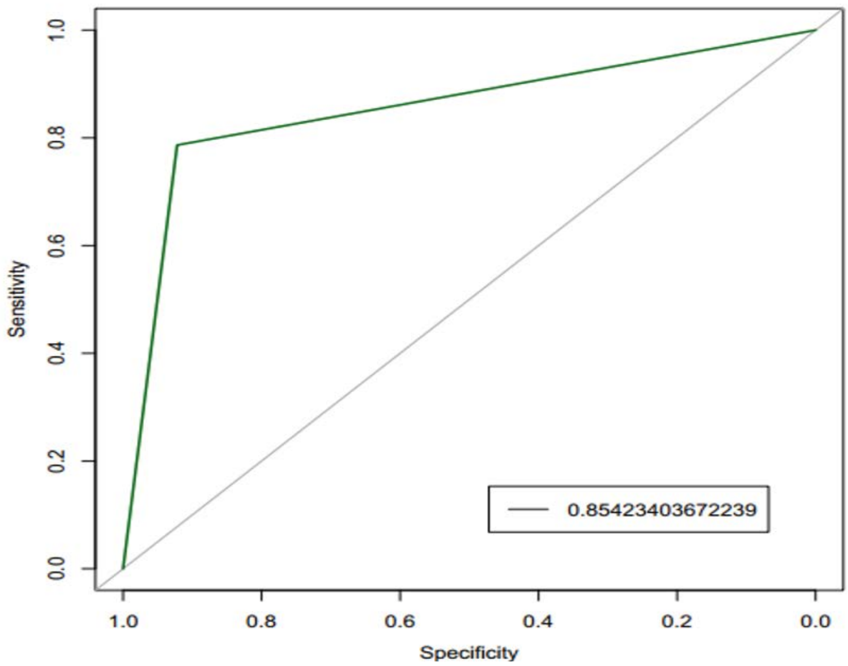

Figure 2: ROC Curve of wells score in the diagnostic of PE.

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Arthur Seghda TA, et al., Cardiol Cardiovasc Med 2024
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Table 3: Multivariate analysis of clinical variables associated with the discovery of PE on the CT-scan.

	Univariate analysis			Multivariate analysis		
Variables	**OR**	**IC 95%**	**p-value**	**O**	**IC 95%**	**p-value**
Previous VTE *	3,1	[1,5-6,2]	<0,01	28800	[1,2-6,8]	0,0171
Obesity	2	[1,3-3,2]	<0,01	15800	[0,8-2,8]	0,1186
Recent surgery	2,1	[1-4,4]	0,04	41879	[1,8-9,4]	0,0005
Cough	0,19	[0,1-0,2]	<0,01	0,1914	[0,1-0,3]	0,0000
Dyspnea	1,77	[1-2,9]	0,02	21659	[1,1-4]	0,0166
Chest spain	2,39	[1,5-3,8]	<0,01	23786	[1,2-4,3]	0,0053
Syncope	10,15	[3-33,5]	<0,01	105107	[2,5-42,7]	0,0010
Tachycardia	1,38	[0,9-2]	0,19	12428	[0,7-2]	0,3740
OR* : odds ratio; VTE : Venous thromboembolic disease;						

Table 4: Contingency table of CT-scan results according to wells score.

Variables	**CT- scan**		**Total**
	Positive	**Negative**	
Probable Wells score	210	16	226
Unlikely Wells score	57	189	246
Total	267	205	472

Discussion

The objective of our study was to evaluate the diagnostic value of the Wells score in pulmonary embolism applied to a sub-Saharan African population. The prevalence of pulmonary embolism was.

The average age of the patients was 54.3 years ± 16.82 with extremes of 19 years and 97 years. The age group of [60-70] years represented the modal class with a number of 110 patients or 23.30%. Similar results were found by Dénakpo et al. [7] in Benin where the average age of patients was 52.31 years, and the age group of 60 years and over, was the largest at around 38.2%, and by Spencer et al. [8] in whom the majority of patients (55%) had an age greater than or equal to 65 years. Our results are nearly similar to those found by Pessinaba et al. [9] in Togo and Daher et al. [10] in Morocco concerning the average age with a divergence compared to the modal classes which can be explained by a means of selection previously quoted.

The female gender was predominant with 52.12% in our study. Most authors agree on the greater predisposition of women to develop VTE [11-13]. This female predominance could be explained by the existence of thromboembolic risk factors specific to this gender, notably pregnancy, peripartum, and cesarean section.

Thromboembolic risk factors in this study include not only pre-existing medical conditions, such as cancer or cardiovascular disease, but also local specific obesity (P<0.01), history of venous thromboembolism (P<0.01). 01), recent surgery (P=0.04) were significantly associated with CT discovery of pulmonary embolism. Samadoulougou et al. found that immobilization (p=0.05) and peripartum (p<0.02) were significantly associated with the CT discovery of pulmonary embolism [12]. Prolonged immobilization, often linked to limited movement or difficult living conditions, constitutes a significant risk factor for thromboembolism [4]. The prevalence of these factors in the local population may influence the validity of the Wells score.

In our study, the reasons for consultation were dominated by dyspnea (84.32%) and chest pain (80.0%). These clinical signs of PE, although the most frequent, remain less specific. They constituted the main reasons for consultations in the studies by Camara Y and Ndongo [14,15]. Tachycardia was the most frequent physical sign (44.49%) in our study followed by edema in the lower limbs as in the study by Chalal et al. [16]. Homans sign (P<0.01) and heart failure (P<0.01) were the clinical characteristics significantly associated with the CT finding of pulmonary embolism. However, these signs, which are also elements of the Wells score, may be less reliable in the event of a high prevalence of leg ulcers, often confused with symptoms of PE.

The prevalence of PE was higher in the "probable" category than in the "unlikely" category (92.92% vs 23.17%) in our study. Penazola and al. in a comparative study of the Wells score with the revised Geneva score to evaluate the pretest probability of pulmonary embolism noted (44.35% vs. 8.5%) [17].

The sensitivity of the Wells score was 78.65%. This sensitivity is lower than that of Gökhan et al. [18] (87.8%) who conducted a prospective study and superior to that of Posadas-Martinez et al. with a sensitivity of 65% [19]. This difference could be due to the not completely objective nature of the Wells score and the retrospective nature of our study. The sensitivity and specificity of a test are not constant, but variable depending on the characteristics of the population to which the test is applied [20].

In our study, the area under the curve was similar to that found by Penazola et al. [17] which is 0.85 (CI: 0.81 to 0.89) and close to that found by Yuxia et al. 0.83 [21]. Nevertheless, Klok et al. in 2008 in the Netherlands had 0.79(95% CI 0.72–0.87) noted 0.76, all lower than ours [22]. Despite the fluctuations in the area under the curve observed depending on the studies, this does not alter the informative value of the score which has an average informative value. In view of the results obtained, the diagnostic value of the Wells score in discriminating sick and non-sick is therefore acceptable. This test could therefore be used in hospitalization in all patients presenting signs suggesting a pulmonary embolism.

Conclusion

Pulmonary embolism, previously rare in sub-Saharan Africa, has become more and more frequent, putting the practitioner to the test in his daily practice. In our context, the geographic unavailability and high cost of pulmonary artery CT angiography constitute our main concern. The use of clinical probability scores constitutes the best alternative for an efficient diagnostic approach. The Wells score can be used as a diagnostic tool in hospitalized patients in a context of precarious technical support with some reservations. An adaptation of the score based on local data from prospective and multicenter studies could improve diagnostic accuracy in pulmonary embolism and, consequently, clinical results.

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