

Effectiveness of the YEARS Algorithm Added to Classical Clinical Decision-making Rules in Suspected Pulmonary Embolism

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Abstract

Objective: Pulmonary embolism (PE) is usually non-specific in terms of symptoms and signs and needs to be confirmed by an objective test. Pulmonary computed tomography angiography (PCTA) has been widely used for diagnosis in recent years. Our aim was to evaluate the potential of the YEARS algorithm to reduce the need for PCTA compared with the classical algorithm.

Materials and Methods: This prospective observational study. Between 15.03.2018 and 15.09.2019, patients admitted to the emergency department with suspected PE who underwent PCTA according to the classical algorithm (Wells) were included in the study. YEARS criteria were reviewed according to the patients' files and general laboratory results without knowing the results of PCTA. The need for PCTA was investigated according to classical clinical decision-making rules and YEARS algorithms.

Results: The study included 300 patients. According to YEARS, 69% of patients required PCTA, whereas 31% required the YEARS PE exclusion group. According to YEARS, PE was detected in 16.4% of patients with an indication for PCTA, whereas only 2.2% of patients in the PCTA exclusion group had PE. In the patient cohort that included the "probable PE" group according to the Wells, the sensitivity according to the YEARS was 94.4%.

Conclusion: In this study, the YEARS protocol used in addition to the classical algorithm resulted in a 31% reduction in the need for PCTA. However, we also showed that the YEARS algorithm may be insufficient for the diagnosis of low rate, positive PE.

Keywords: Pulmonary embolism, YEARS algorithm, Wells criteria

Introduction

Chest pain and dyspnea comprise approximately 9% of emergency department (ED) visits, and clinicians consider these indications as potential markers of critical health issues [1,2]. In patients presenting with these symptoms, emergency physicians primarily suspect diseases with a high risk of morbidity and mortality. One of these important diagnoses is acute pulmonary embolism (PE). The signs and symptoms of PE are frequently nonspecific and require verification through an objective test [2,3]. Recently, current guidelines have recommended pulmonary computed tomography angiography (PCTA) as an initial diagnostic tool due to its high diagnostic value. The frequent use of PCTA increases the number of clinically insignificant subsegmental PE diagnoses, increases the cost, exposes patients to unneeded radiation, and results

in unfavorable outcomes like contrast nephropathy [3,4]. To prevent this, the guidelines suggest using certain clinical decision rules to identify risk groups of patients and determine who should undergo PCTA, rather than performing the procedure on every patient with a preliminary diagnosis of PE. Today, the most accepted opinion in the world is to use the algorithm proposed by the European Society of Cardiology (ESC), which determines who should undergo further investigation, such as PCTA, by using the D-dimer blood test together with the determination of clinical probability using Well's and Geneva rules [5]. Although these algorithms are widely used, physicians are still searching for a diagnostic PE algorithm with higher sensitivity to reduce unnecessary PCTA scans. Thus, van der Hulle et al. [6] compared the YEARS algorithm with the classical algorithm in patients with suspected acute PE. The YEARS algorithm recommends that PE



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should be excluded if the D-dimer level is below 500 ng/mL, that PCTA scanning should be performed if the D-dimer level is above 500 ng/mL and one or more of the three criteria [PE as the most probable diagnosis, presence of clinical signs of deep vein thrombosis (DVT), hemoptysis] are present, and that PCTA scanning should be performed if the D-dimer level is above 1000 ng/mL even if no criteria are present [6]. The rationale for this prospective observational study was to evaluate the potential of the YEARS algorithm to reduce the need for PCTA scanning in our population of patients with suspected PE in the ED compared with the classical algorithm currently used and to provide preliminary information for future interventional studies.

Materials and Methods

This study was conducted at the department of emergency medicine, University of Health Sciences Türkiye, Ankara Keçiören Training and Research Hospital Clinical Research Ethics Committee (decision number: 1632, date: 28.03.2018). Between 15.03.2018 and 15.09.2019, patients with suspected PE who presented to the ED and underwent PCTA according to the classical algorithm were included. Patients were evaluated according to the currently used classic Wells algorithm, and patients who underwent PCTA scanning according to these criteria, were 18 years of age or older, and provided informed consent for the study were included in the study. After this stage, we evaluated whether PCTA would have been necessary if we had followed the YEARS protocol with only the available medical information of the patients. Patients' complaints (dyspnea, pleuritic or substernal chest pain, cough, fever, hemoptysis, syncope, unilateral leg pain), D-dimer level, vital signs, presence of DVT findings, history of previous DVT or PE, history of surgery in the last 1 month, presence of immobilization for more than 3 days, presence of hemoptysis, Wells and YEARS scores, and PCTA results were recorded and evaluated. No additional tests were requested from the patients except for tests performed for the existing conditions.

Statistical Analysis

IBM SPSS Statistics for Microsoft 20.0 (SPSS Inc, Chicago USA) program was used for statistical analysis. The Kolmogorov-Smirnov test was used to determine whether the distribution of discrete and continuous numerical variables conformed to a normal distribution. Descriptive statistics were presented as median [interquartile range (IQR) - 25-75] for discrete and continuous numerical variables and as number of cases and (%) for categorical variables. Categorical variables were evaluated using the chi-square test, and continuous variables were evaluated using the Mann-Whitney U test. The statistical significance level was determined as p-value <0.05.

Results

During the study period, 612 patients with suspected PE were evaluated. We included 300 patients who underwent PCTA according to the classical algorithm. The median age was 68 years (IQR 25-75, 52.2-79), and 58.7% were female. The most common complaints at ED admission were dyspnea (48.7%) and chest pain (33.7%), and 52% of the patients underwent a thoracic system examination within normal limits. PE was detected on PCTA in 12% of patients. Pneumonia was detected on CT scan in 14% of the patients. Demographic data and vital signs of the patients are presented in Table 1.

Wells criteria and management of the patients are given in Table 2. According to the ESC 2014 algorithm, 29.3% of patients had a high probability and 70.7% had a low-moderate probability Wells criteria and PCTA was performed because of high D-dimer levels.

According to the YEARS algorithm, 69% of patients required PCTA and 31% were in the YEARS PE exclusion group (Table 3).

According to the YEARS algorithm, PE was detected in 16.4% of patients with an indication for PCTA, whereas PE was detected in 2.2% of patients in the zero criteria group without an indication for PCTA scanning (Table 4).

According to the YEARS algorithm, the sensitivity was 94.4%, specificity was 34.7%, positive likelihood ratio was 1.44, and negative likelihood ratio was 0.16.

Discussion

The aim of this study was to investigate the effectiveness of the YEARS algorithm in the evaluation of ED patients with suspected PE and the feasibility of reducing the need for PCTA compared with the existing classical algorithms. Our results indicate that the YEARS algorithm for analyzing patients with suspected PE can be a substitute for traditional algorithms and can reduce the need for PCTA.

The signs and symptoms of PE are frequently nonspecific and require verification using an objective test. Although many diagnostic algorithms have recently been developed for patients with suspected PE, these algorithms are generally not used sufficiently in the ED or benefit certain patient populations, leading to the overuse of PCTA [7].

Gruettner et al. [8] found PE in 13% of patients in a study he conducted with 326 patients comparing the Wells and Geneva scores. In another study comparing YEARS and Wells scores, PE was found to be positive in 9.8% of patients [9]. Van der Hulle et al. [6] found PE in 13% of patients in his study. In our study, PE was observed in 12% of patients who underwent PCTA.

| Table 1. Demographic data of the patients | |
|--|-------------------------|
| Demographic and clinical characteristics | All patients, n=300 (%) |
| Age median, IQR (25-75) | 68 (52.2-79) |
| Gender | |
| Male | 124 (41.3) |
| Female | 176 (58.7) |
| Complaints | |
| Dyspnea | 146 (48.7) |
| Chest pain | 101 (33.7) |
| Palpitation | 21 (7) |
| General condition disorder | 19 (6.3) |
| Syncope | 9 (3) |
| Leg edema | 3 (1) |
| Respiratory arrest | 1 (0.3) |
| Blood pressure | |
| Hypotension | 39 (13) |
| Normotension | 205 (68.3) |
| Hypertension | 56 (18.7) |
| Heart rate | |
| 60-100 | 59 (19.7) |
| Over 100 | 241 (80.3) |
| Saturation | |
| 92-100 | 129 (43) |
| 80-91 | 142 (47.3) |
| Below 80 | 29 (9.7) |
| Body temperature | |
| 37.5 and higher | 63 (21) |
| 37.5 below | 237 (79) |
| Physical examination | |
| Normal | 156 (52) |
| Abnormal | 144 (48) |
| Presence of embolism in PCTA | |
| Segmentary | 22 (61.1) |
| Massive | 14 (38.9) |
| Additional finding in PCTA without pulmonary embolism | |
| No | 136 (45.3) |
| Pneumonia | 42 (14) |
| Bronchiectasis | 7 (2.3) |
| Consolidated mass | 16 (5.3) |
| Emphysema | 12 (4) |
| Atelectasis | 36 (12) |
| Nodule | 14 (4.7) |
| Pleural effusion | 36 (12) |
| Aortic dissection | 1 (0.3) |
| D-dimer level median, IQR (25-75) | 1560 (852.5-3940) |

IQR: Interquartile range, PCTA: Pulmonary computed tomography angiography

| Table 2. Wells criteria and management algorithm according to Wells | |
|---|-------------------------|
| Wells criteria | All patients, n=300 (%) |
| History of thromboembolism | 32 (10.7) |
| Tachycardia | 240 (80) |
| Surgical immobilization | 57 (19) |
| Hemoptysis | 8 (2.7) |
| Active cancer | 19 (6.3) |
| DVT clinic | 29 (9.7) |
| Possible absence of diagnosis | 83 (27.7) |
| Management according to ESC 2014 algorithm | |
| High probability PE | 88 (29.3) |
| Low-moderate PE and high D-dimer | 212 (70.7) |

DVT: Deep vein thrombosis, ESC: European Society of Cardiology, PE: Pulmonary embolism

| Table 3. YEARS parameters and management algorithm according to YEARS | |
|---|-----------|
| | n (%) |
| YEARS criteria | |
| DVT clinic | 29 (9.7) |
| Hemoptysis | 8 (2.7) |
| Most likely diagnosis | 84 (28) |
| YEARS algorithm | |
| Zero criteria, D-dimer <1000 | 70 (23.3) |
| Zero criteria, D-dimer >1000 | 135 (45) |
| YEARS >1 criterion, D-dimer <500 | 23 (7.7) |
| YEARS >1 criterion, D-dimer >500 | 72 (24) |
| Management according to the YEARS algorithm | |
| Take PCTA scan (1 or more criteria) | 207 (69) |
| Exclude PE (zero criteria) | 93 (31) |

DVT: Deep vein thrombosis, PCTA: Pulmonary computed tomography angiography, PE: Pulmonary embolism

| Table 4. PCTA results of patients according to algorithms | | |
|---|--------------------|--------------------|
| | PE negative, n (%) | PE positive, n (%) |
| Management according to Wells ESC 2014 algorithm | | |
| High Probability PE | 65 (24.6) | 23 (63.9) |
| Low-moderate PE and high D-dimer | 199 (75.4) | 13 (6.1) |
| Management according to the YEARS algorithm | | |
| Take PCTA (1 or more criteria) | 173 (83.6) | 34 (16.4) |
| Exclude PE (zero criteria) | 91 (97.8) | 2 (2.2) |

ESC: European Society of Cardiology, PE: Pulmonary embolism, PCTA: Pulmonary computed tomography angiography

In a study, Kearon et al. [10] reported that a D-dimer level below 1000 ng/mL was low risk for PE. In our study, the D-dimer level was found to be below 1000 ng/mL in only 5.5% of the 36 patients in whom PE was detected as a result of PCTA. It was observed that these patients had embolism only in subsegmental branches. Studies have shown that elevated D-dimer levels lead physicians to diagnose PE; therefore, many patients undergo unnecessary PCTA. We believe that the YEARS score reduces the need for PCTA because it accepts a D-dimer limit of 1000 ng/mL in the absence of any other criteria.

In a study in which Medson et al. [11] compared the Wells, YEARS, and Geneva scores, 9.3% of patients were classified as having a high clinical probability when the patients were classified as having low and high clinical probability according to the Wells criteria. In our study, 29.3% of patients were considered to have a high clinical probability. This difference may be related to the fact that the criterion of “PE as the most probable diagnosis” in Wells scoring is a subjective criterion.

In his study, van der Hulle et al. [6] compared the diagnostic efficacy of the YEARS algorithm with that of the Wells algorithm in patients with suspected PE. The primary outcome of the study was defined as the number of venous thromboembolic events occurring during 3 months of patient follow-up, and the secondary outcome was defined as a comparison of the number of PCTAs deemed necessary and performed according to the YEARS and Wells algorithms. As a result, the number of patients without the YEARS criteria was 1743, and PE was detected in 55 (3.2%) of these patients. The number of patients with one or more YEARS criteria was 1722. Four hundred one (23%) of these patients were diagnosed with PE. PE could not be excluded as the cause of death in 6 patients. At the 3-month follow-up, 18 patients were found to have PE. The results showed that the YEARS algorithm reduced the need for PCTA scans by 14% compared with classical algorithms [6]. In our study, PE was found in 2 (2.2%) of 93 patients without any YEARS criteria. PE was found in 34 (16.4%) of 207 patients with one or more YEARS criteria. In Medson et al. [11] study, PE was diagnosed in 18 (6.3%) of 286 patients in whom the YEARS algorithm excluded PE. Freund et al. [12], in a study comparing the YEARS algorithm with the classical algorithm, reported a 10% reduction in the need for PCTA scanning with the YEARS algorithm compared with the classical algorithm. In the same study, no decrease in the PE detection rate was observed at 3-month patient follow-up [12]. In another study in which the YEARS algorithm was applied to pregnant patients, it was reported that PE was safely excluded in 32-65% of patients [13]. Another multicenter study reported that the YEARS algorithm reduced the need for PCTA scanning by 14% but increased the PE miss rate by 0.5% [14].

In this study, we evaluated the potential of the YEARS algorithm to reduce the need for PCTA in patients with suspected PE compared with the classical algorithm that we currently use and found a 31% reduction in the need for PCTA compared with the standard algorithm. The difference in these rates may be related to the inclusion of a larger number of patients with high clinical probability in previous studies. We demonstrated that implementing the YEARS algorithm in risk stratification for patients with suspected PE in the ED resulted in a decreased requirement for PCTA compared with other commonly used algorithms. The study demonstrated that the YEARS algorithm was superior to the routine algorithm in excluding acute PE from patients with clinical suspicion of PE and low venous thromboembolism risk, with a sensitivity of 94.4%. However, as shown in previous studies, we found that YEARS has a low risk of PE patient omission.

Study Limitations

This study was single-centered. Because this was an observational study, patients were evaluated by different clinicians working in the ED. The criterion of “PE as the most probable diagnosis” in both the YEARS and Wells algorithms may have led to different evaluations among clinicians because it is a subjective criterion. In addition, PCTA may be performed in the clinic not only to diagnose PE and exclude diagnoses such as pneumonia from the differential diagnosis of PE. The fact that the patients were evaluated only at the time of presentation to the ED and were not followed up for PE in the long term is one of the limitations of this study.

Conclusion

The YEARS algorithm, used in the ED for risk stratification of patients with suspected PE, reduces the need for PCTA in addition to the Wells algorithm used routinely. However, we have shown that YEARS is associated with a risk of missing PE patients, albeit at a low rate. Studies have shown that patients undergo unnecessary PCTA despite the use of different clinical probability scores for PE diagnosis. There is a need to develop new scoring systems to reduce these rates.

Ethics

Ethics Committee Approval: This study was conducted at the department of emergency medicine, University of Health Sciences Türkiye, Ankara Keçiören Training and Research Hospital Clinical Research Ethics Committee (decision number: 1632, date: 28.03.2018).

Informed Consent: Patients were evaluated according to the currently used classic Wells algorithm, and patients who underwent PCTA scanning according to these criteria, were 18 years of age or older, and provided informed consent for the study were included in the study.

Authorship Contributions

Surgical and Medical Practices: H.Ö.O., Y.Ç., Concept: H.Ö.O., Ş.K.Ç., Y.Ç., Design: H.Ö.O., Ş.K.Ç., E.E., Y.Ç., Data Collection or Processing: H.Ö.O., Analysis or Interpretation: H.Ö.O., Ş.K.Ç., E.E., Literature Search: H.Ö.O., E.E., Y.Ç., Writing: H.Ö.O., E.E.

Conflict of Interest: No conflict of interest was declared by the authors.

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