Original Article

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Who is More Aggressive in the Race to Diagnose Pulmonary Embolism? General Practitioners or Emergency Medicine Specialists: A Multicenter Study

Pulmoner Emboli Tanısı Koyma Yarışında Kim Daha Agresif? Pratisyen Doktorlar mı Acil Tıp Uzmanları mı: Çok Merkezli Çalışma

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ABSTRACT

Objective: This study compared the rates of computed tomography pulmonary angiography (CTPA) requests, diagnostic yield and clinical outcomes between general practitioners and emergency medicine specialists with residents in suspected pulmonary embolism (PE).

Methods: This retrospective, multicenter, observational study was conducted in a tertiary education and research hospital and a secondary state hospital in Türkiye. Patients over 18 years of age who underwent CTPA for suspected PE were included. Demographic data, physician designation, CTPA results and emergency department outcomes were recorded. Diagnostic yield, admission and mortality rates were compared between groups.

Results: A total of 363 patients were included; the median age was 61 years (interquartile range: 48-72) and 52.3% were female. General practitioners evaluated 101 patients (27.8%), while specialists/residents evaluated 262 (72.2%). The overall PE positivity rate was 30.3%. Diagnostic yield was significantly higher in the specialist/resident group (37.4% vs. 11.9%, p<0.001). In multivariate analysis, evaluation by specialists/residents was identified as an independent predictor of PE diagnosis (odds ratio: 4.76, 95% confidence interval: 2.44-9.09,

ÖZ

Amaç: Bu çalışmada pratisyen hekimler ile acil tıp uzmanları ve asistanlarının pulmoner emboli (PE) ön tanısı ile istedikleri bilgisayarlı tomografi pulmoner anjiyografi (CTPA) oranları, tanısal verimlilikleri ve klinik sonuçları karşılaştırıldı.

Yöntemler: Retrospektif, çok merkezli bu gözlemsel çalışmaya Türkiye'de bir üçüncü basamak eğitim ve araştırma hastanesi ile bir ikinci basamak devlet hastanesi dahil edildi. Çalışmaya 18 yaş üstü, PE şüphesi ile CTPA çekilen hastalar alındı. Demografik veriler, hekim unvanı, CTPA sonuçları ve acil servis sonlanımları kaydedildi. Gruplar arasında tanısal verimlilik, yatış ve mortalite oranları karşılaştırıldı.

Bulgular: Çalışmaya toplam 363 hasta alındı; median yaş 61 (çeyrekler arası aralık: 48-72) idi ve %52,3'ü kadındı. Pratisyen hekimler 101 (%27,8), uzman/asistanlar 262 (%72,2) hastayı değerlendirdi. Genel PE pozitiflik oranı %30,3 idi. Tanısal verimlilik uzman/asistan grubunda belirgin şekilde yüksekti (%37,4 vs. %11,9, p<0,001). Multivaryant analizde uzman/asistan değerlendirmesi, PE tanısının bağımsız prediktörüydü (olasılık oranı: 4,76, %95 güven aralığı: 2,44-9,09, p<0,001). PE pozitif hastalarda taburculuk oranı daha düşük (%21,8 vs. %59,7), servis (%42,7 vs. %20,9) ve yoğun bakım yatış oranları

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ABSTRACT

p<0.001). Among PE-positive patients, discharge rate was lower (21.8% vs. 59.7%), while ward admission rate (42.7% vs. 20.9%), intensive care unit admission rate (35.5% vs. 19.4%) and mortality (19.1% vs. 7.1%) were significantly higher.

Conclusion: Emergency medicine specialists and residents demonstrated greater diagnostic selectivity and markedly higher diagnostic accuracy compared with general practitioners. These findings emphasize the critical role of specialist involvement in PE diagnosis and suggest that structured decision support systems may enhance diagnostic efficiency among general practitioners in emergency settings.

Keywords: Diagnostic yield, emergency medicine, pulmonary embolism, tomography

ÖZ

(%35,5 vs. %19,4) ile mortalite (%19,1 vs. %7,1) anlamlı olarak daha yüksekti.

Sonuç: Acil tıp uzmanları ve asistanlarının CTPA isteminde daha seçici davrandığı ve tanısal doğruluklarının pratisyen hekimlere göre belirgin şekilde yüksek olduğu gösterilmiştir. Bulgular, uzman katkısının acil servislerde PE tanısında kritik rol oynadığını ve yapılandırılmış klinik karar destek sistemlerinin pratisyen hekimler için tanısal verimliliği artırabileceğini ortaya koymaktadır.

Anahtar Kelimeler: Tanısal verimlilik, acil tıp, pulmoner emboli, tomografi

Introduction

Pulmonary embolism (PE) is a serious clinical condition with high mortality that requires urgent intervention, most often resulting from acute obstruction of the pulmonary arteries by thromboembolism as a complication of deep vein thrombosis. PE presents to emergency departments with non-specific symptoms such as sudden dyspnea, chest pain, syncope, tachycardia or hypoxemia, which makes diagnosis challenging, although early recognition and prompt treatment are life-saving (1,2).

Accurate clinical assessment, the use of risk stratification tools such as the Wells score and timely referral for appropriate imaging play a critical role in the diagnostic process (3). Computed tomography pulmonary angiography (CTPA) is considered the gold standard imaging modality in the diagnosis of PE and is frequently employed in emergency department algorithms. However, unnecessary use of this examination may lead to avoidable radiation exposure for patients as well as inefficient utilization of healthcare resources (4-6). Therefore, the accuracy of physicians' decisions to request imaging in suspected PE and the impact of these decisions on diagnostic yield are of great importance (4,7).

In Türkiye, both general practitioners and emergency medicine specialists as well as residents are involved in patient care in emergency departments. Although this distribution of responsibilities varies among hospitals, differences in clinical approach between these physician groups may influence diagnostic decision-making. Physicians with specialty training are expected to perform more systematic evaluations and to base their clinical reasoning on evidence-based guidelines, which may in turn affect diagnostic accuracy (8,9).

In this study, we investigated the extent to which general practitioners and emergency medicine specialists with residents requested imaging for suspected PE, the diagnostic yield and accuracy of these examinations and evaluated the role of physician designation in the diagnostic process within a multicenter study design. Although many studies have evaluated diagnostic yield and utilization of CTPA in suspected PE, to our knowledge, no study has directly compared the diagnostic efficiency of general practitioners versus emergency medicine specialists in emergency settings. This gap is critical, since physician expertise may significantly affect diagnostic accuracy, radiation exposure, and resource utilization. Our study aimed to fill this gap through a multicenter design.

Methods

Study design and Setting

This study was a retrospective, multicenter, observational analysis conducted in two hospitals in Türkiye. The study included two centers, one being a tertiary education and research hospital and the other a secondary state hospital. Data were collected between January 1, 2022 and June 30, 2023, covering an 18-month period. The study was initiated after obtaining approval from the Local Clinical Research Ethics Committee of İzmir Katip Çelebi University (approval number: 0432, date: 21.09.2023) and administrative authorization from the other participating center.

Study Population

Inclusion Criteria

1. Patients aged over 18 years

2. Patients presenting with clinical suspicion of PE for whom CTPA was requested with this preliminary diagnosis.

Exclusion Criteria

1. Patients younger than 18 years

2. Trauma patients

3. Patients with incomplete data

4. Patients whose outcomes could not be followed (those referred to another facility or those who refused treatment).

Study Protocol and Data Collection

In both centers, a similar protocol was followed. Patients presenting to the emergency department were referred for CTPA with a preliminary diagnosis of PE based on clinical suspicion and physician assessment. The decision-making process considered presenting symptoms (dyspnea, chest pain, syncope, tachycardia, hypoxemia, etc.), vital signs, laboratory findings and accompanying clinical risk factors. No standardized clinical decision algorithm was mandated and each center adhered to its routine clinical practice.

Although validated clinical prediction tools such as the Wells, Geneva or YEARS scores were available in both centers, they were not systematically integrated into daily practice. Therefore, CTPA requests were primarily based on clinical judgment and physician discretion.

Data collection was performed through the hospital information management systems of both centers. Records were retrospectively reviewed, all patients who underwent CTPA during the study period were identified and personal identifiers were anonymized. For each patient, age, sex, presenting complaint, physician designation (general practitioner or emergency medicine specialist), CTPA result, additional clinical diagnoses and emergency department outcome were recorded. CTPA results were classified as PE positive or negative based on radiology reports.

From these data, the total number of emergency visits, the rate of CTPA requests, the proportion of positive PE diagnoses and their distribution according to physician groups were calculated. In addition, hospitalization and mortality outcomes for patients diagnosed with PE were documented. To ensure accuracy, all records were reviewed by independent researchers in both centers and verified prior to analysis.

Outcomes

Primary Outcome

The primary objective of this study was to compare the frequency of requesting diagnostic tests for PE between specialists and general practitioners relative to the overall emergency department population and to determine the incidence of confirmed PE within this patient cohort.

Secondary Outcome

The secondary objective was to investigate whether there were differences between specialists and general practitioners in patients diagnosed as having PE.

Statistical Analysis

All statistical analyses were performed using IBM SPSS version 27. Continuous variables were first assessed for normality using the Shapiro-Wilk test. Variables that did not show normal distribution were expressed as median with interquartile range (IQR), whereas categorical variables were presented as frequencies and percentages. Comparisons of continuous variables between groups were conducted using the Mann-Whitney U test. Categorical variables were compared using the chi-square test.

To evaluate the diagnostic yield of CTPA requests, the proportion of positive PE diagnoses was calculated for each physician group and compared using the chi-square test. Clinical outcomes [discharge, ward admission, intensive care unit (ICU) admission] and mortality rates were also compared between groups, as well as between patients with and without PE.

Univariate logistic regression analyses were initially performed to identify potential predictors of PE diagnosis. Multivariate logistic regression was performed to identify independent predictors. Odds ratios (OR) with 95% confidence intervals (CI) were reported. A p value <0.05 was considered statistically significant.

Results

A total of 363 patients who underwent CTPA during the study period were included in the analysis. The median age was 61 years (IQR: 48-72) and 52.3% were female. Specialists/residents evaluated 262 patients (72.2%), while general practitioners evaluated 101 patients (27.8%). PE was confirmed in 110 patients (30.3%). Regarding clinical outcomes, 48.2% of patients were discharged from the emergency department, 27.5% were admitted to wards and 24.2% required ICU admission. The overall mortality rate was 10.7% (Table 1).

When stratified by physician group, the proportion of CTPA requests among all emergency department visits was higher in the specialist group compared to general practitioners

Table 1. Demographic and clinical characteristics and outcomes of study population

Characteristic		Median (IQR) or n (%)
Age		61 (48-72)
Gender	Female	190 (52.3)
	Male	173 (47.7)
Physician group	Specialists/residents	262 (72.2)
	General practitioners	101 (27.8)
Pulmonary embolism	None	253 (69.7)
	Present	110 (30.3)
Outcome	Discharged	175 (48.2)
	Ward admission	100 (27.5)
	ICU admission	88 (24.2)
Mortality	None	324 (89.3)
	Present	39 (10.7)

IQR: Interquartile range, ICU: Intensive care unit

(0.87% vs. 0.50%, p<0.001). The median age was slightly lower in the specialist group (60 vs. 65 years, p=0.037), while gender distribution was similar between the groups (p=0.208). The diagnostic yield (efficiency index) of CTPA was significantly higher in the specialist group compared to general practitioners (37.4% vs. 11.9%, p<0.001) as shown in Figure 1 and Table 2. Differences in clinical outcomes were also observed, with general practitioners' patients more frequently admitted to wards, while specialists' patients were more often discharged or admitted to the ICU (p<0.001). Mortality rates did not differ significantly between the groups (p=0.316) (Table 2).

Table 3 shows the comparison of patients according to PE status demonstrated significant differences in clinical outcomes. Discharge was less common among PE-positive patients compared to those without PE (21.8% vs. 59.7%), whereas ward admissions (42.7% vs. 20.9%) and ICU admissions (35.5% vs. 19.4%) were more frequent in the PE-positive group (p<0.001). Mortality was also higher in the PE-positive group (19.1% vs. 7.1%, p=0.002).

According to Table 4, patients evaluated by specialists/residents had significantly higher odds of a positive PE diagnosis compared to those evaluated by general practitioners (OR: 4.76, 95% CI: 2.44-9.09, p<0.001). Neither age (p=0.065) nor gender (p=0.723) were independent predictors of PE diagnosis.

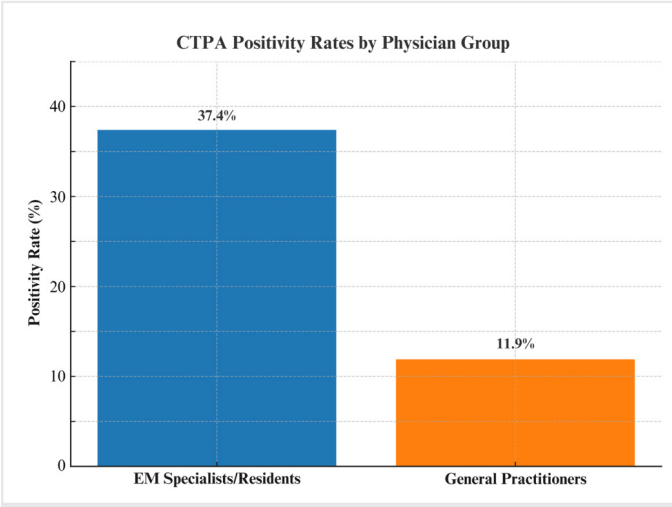

Figure 1. CTPA positivity rates by physician group

CTPA: Computed tomography pulmonary angiography, EM: Emergency medicine

Table 2. Comparison of characteristics and outcomes by physician group

Variable, n (%)		Specialists/residents (n=262)	General practitioners (n=101)	p†
CTPA requests / ED visits‡		262/30,000 (0.87%)	101/20,000 (0.50%)	**<0.001**
Age [Median (IQR)]		60 (47-70)	65 (50-74)	**0.037**
Gender	Female	143 (54.6)	47 (46.5)	0.208
	Male	119 (45.4)	54 (53.5)	
Pulmonary embolism	Present	98 (37.4)	12 (11.9)	**<0.001**
	None	164 (62.6)	89 (88.1)	
Outcome	Discharged	170 (64.9)	5 (5.0)	**<0.001**
	Ward admission	47 (17.9)	53 (52.5)	
	ICU admission	45 (17.2)	43 (42.6)	
Mortality	Present	25 (9.5)	14 (13.9)	0.316
	None	237 (90.5)	87 (86.1)	

‡: Approximate total ED visits during the study period, †: Mann-Whitney U test for continuous variables, chi-square test for categorical variables, CTPA: Computed tomography pulmonary angiography, ED: Emergency department, IQR: Interquartile range, ICU: Intensive care unit

Table 3. Clinical outcomes and mortality according to pulmonary embolism status

Variable, n (%)		PE present (n=110)	PE absent (n=253)	p†
Outcome	Discharged	24 (21.8)	151 (59.7)	**<0.001**
	Ward admission	47 (42.7)	53 (20.9)	
	ICU admission	39 (35.5)	49 (19.4)	
Mortality	Present	21 (19.1)	18 (7.1)	**0.002**
	None	89 (80.9)	235 (92.9)	

†: Chi-square test for categorical comparisons, PE: Pulmonary embolism, ICU: Intensive care unit

Table 4. Logistic regression analyses for predictors of pulmonary embolism

Variable	Univariate			Multivariate		
	OR	95% CI	p	OR	95% CI	p†
Physician group‡	4.33	(2.38-7.99)	<0.001	4.76	(2.44-9.09)	**<0.001**
Age	1.01	(0.99-1.02)	0.208	1.01	(1.00-1.03)	0.065
Gender (male)	0.98	(0.62-1.53)	0.923	1.09	(0.68-1.74)	0.723

‡: Reference category: general practitioners, †: Univariate and multivariate logistic regression analyses, OR: Odds ratio, CI: Confidence interval

Discussion

This study aimed to highlight the differences in diagnosing PE between secondary and tertiary emergency departments. In particular, the comparison of CTPA utilization rates, diagnostic yield and clinical outcomes between physician groups has been scarcely addressed in the literature. Although CTPA remains the gold standard imaging modality in the diagnosis of PE, it is a tool that must be carefully considered in clinical decision-making due to both its diagnostic value and the risk of overuse. In this respect, our study provides an original contribution by focusing on an important aspect of clinical practice.

In our cohort of 363 patients, PE was confirmed in 30.3%. This rate was higher than many previously reported studies. For instance, Yazgan et al. (10) reported a positivity rate of 20.8% in a Turkish cohort of 696 patients. In contrast, Ozakin et al. (11) reported a rate of only 6.4% in a single-center study. A prospective cohort from Montreal reported 15.9% (12), the Sheffield series found 15.9% (13) and a study from Bahrain reported 12.2% (14). The 30.3% rate in our study is above the upper values reported in international literature, suggesting that patient selection in our cohort may have been relatively more accurate.

The diagnostic yield of CTPA has been reported to vary widely in the literature. In a study including 974 patients, Walen et al. (15) reported a diagnostic yield of 23% (n=224), a value that lay at the higher end of previously reported ranges. In contrast, a multicenter study conducted in Western Australia examining trends between 2003 and 2015 demonstrated that the diagnostic yield declined to as low as 5.7%, raising concern regarding the potential overuse of CTPA (16). The 30.3% positivity rate in our study is considerably higher compared to these large series, reflecting a more selective approach in clinical decision-making.

Among patients diagnosed as having PE, the discharge rate was low (21.8%), while ward admission rate (42.7%) and ICU admission rate (35.5%) were significantly higher. In contrast, the discharge rate in PE-negative patients was 59.7% (p<0.001). Mortality was also higher in the PE-positive group (19.1% vs. 7.1%, p=0.002). These results underscore the significant clinical burden of PE in emergency care and its impact on patient prognosis. Similarly, studies from Canada reported high admission rates among PE-positive patients (17) and data from Sheffield supported this finding (13).

The most striking finding of our study was the marked difference between physician groups. The positivity rate of CTPA was 37.4% among specialists/residents, compared with only 11.9% among general practitioners (p<0.001). Moreover, multivariate logistic regression analysis revealed that patients evaluated by specialists/residents had nearly a 4.8-fold higher likelihood of receiving a PE diagnosis compared with those assessed by general practitioners (OR: 4.76, 95% CI: 2.44-9.09, p<0.001). These results indicate that emergency medicine specialists request CTPA more selectively and that their diagnostic efficiency stands out as an independent predictor of accurate diagnosis.

The overuse of CTPA and false positives remain an important debate in the literature. Hutchinson et al. (18) reported false positive rates as high as 59.4% at the subsegmental level. National Institute for Health and Care Excellence and the Royal College of Radiologists guidelines recommend an acceptable CTPA positivity rate between 15.4% and 37 (13,14). The 30.3% positivity rate in our study fell within this range, suggesting that overutilization was not evident. Thus, our findings supported the notion that CTPA was appropriately applied to a well-selected patient population.

In a retrospective study from Bahrain, the positivity rate was 12.2% (14), while studies from Canada reported 15% (17), Türkiye 20.8% (10) and the United Kingdom 15.9% (13). Conversely, the Western Australia study showed that CTPA use increased from 3.3 per 10,000 person-years in 2003 to 17.1 in 2015. Diagnostic yield initially increased from 12.7% in 2003 to 17.4% in 2005 but declined to 12.2% in 2015. These results indicate that despite increased use, diagnostic yield has trended downward over time (16). The 30.3% positivity rate in our study, when compared with both regional and international cohorts, stands out as remarkably high, supporting the possibility that greater involvement of specialists in tertiary centers contributes to higher diagnostic efficiency.

The 2019 European Society of Cardiology guidelines on acute PE emphasize the use of validated clinical prediction scores and D-dimer testing prior to CTPA to

optimize diagnostic efficiency (19). Our findings that specialists achieved higher positivity rates align with these recommendations, suggesting that adherence to structured diagnostic pathways is more consistently practiced by trained emergency physicians.

To our knowledge, there are almost no studies directly examining the diagnostic yield of CTPA requests according to physician groups. This aspect makes our study unique, demonstrating the diagnostic selectivity of specialists with objective data. General practitioners may have a tendency to screen a broader patient population, which could explain the lower positivity rates. These findings highlight the importance of structured training and decision support systems in emergency departments.

Accurate diagnosis of PE not only reduces unnecessary radiation exposure but also directly affects patient outcomes. The higher mortality rate observed among PE-positive patients in our cohort provides the most concrete evidence of this impact. Furthermore, the significantly increased ICU admission rate in the PE-positive group underscores the critical importance of early and accurate diagnosis in the management of these patients.

Study Limitations

This study has several important limitations. First, the individual components required to calculate clinical probability scores such as the Wells or revised Geneva scores were not fully accessible for every patient, which prevented the systematic calculation of these tools. Similarly, D-dimer levels and presenting clinical parameters were not consistently available for all cases. This limitation restricts the ability to evaluate the appropriateness of CTPA requests at the individual patient level.

Second, the anatomical distribution and thrombus burden of PE cases were not assessed. The clinical significance of findings limited to the subsegmental level is known to be variable, as these may be clinically relevant in some patients but of uncertain therapeutic necessity in others. The inability to make this distinction represents a limitation in the interpretation of our findings. Furthermore, markers of right ventricular strain or risk stratification tools such as the simplified PE severity index could not be systematically collected due to the retrospective design, limiting detailed assessment of PE severity and prognosis.

Third, the cross-sectional sample included only patients who underwent CTPA. This selection does not reflect the true prevalence of PE within the entire emergency department population nor does it provide a comprehensive assessment of the appropriateness of imaging indications. Instead, it represents physicians' thresholds and preferences for requesting imaging. Differences between secondary and tertiary centers such as patient demographics, triage procedures, time of presentation, bed and imaging availability, radiologist experience and institutional protocols were not measured and remained as potential confounders. In addition, as with any retrospective design, potential biases such as missing data, variability in documentation, and physician selection differences may have influenced the observed results.

These results highlight the potential role of structured decision-support systems and targeted training programs for general practitioners working in emergency departments. Future prospective studies should evaluate whether integrating such strategies can further improve diagnostic accuracy and patient safety.

Conclusion

This multicenter study showed that emergency medicine specialists and residents had a markedly higher diagnostic yield in detecting PE compared to general practitioners and physician expertise was identified as an independent predictor of accurate diagnosis. Furthermore, PE-positive patients demonstrated higher ward and ICU admission rates, highlighting the substantial clinical burden of this condition in emergency settings.

Our findings underscore the importance of specialist involvement in decision-making for suspected PE and suggest that broader use of standardized risk stratification tools and training for non-specialists may improve diagnostic accuracy and reduce unnecessary CTPA utilization.

Ethics

Ethics Committee Approval: Approval for the study was granted by the Local Clinical Research Ethics Committee of İzmir Katip Çelebi University (approval number: 0432, date: 21.09.2023).

Informed Consent: Informed consent was not obtained due to the retrospective design of the study.

Footnotes

Authorship Contributions

Concept: E.K., E.S.B., C.A., Design: E.K., E.S.B., C.A., Data Collection or Processing: C.A., F.N.K., M.Ö., M.A., Analysis or Interpretation: E.K., F.N.K., M.Ö., M.A., Literature Search: E.K., E.S.B., C.A., F.N.K., M.Ö., M.A., Writing: E.K., C.A.

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

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