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YEARS BEFORE COMPUTED TOMOGRAPHY PULMONARY ANGIOGRAPHY: DIAGNOSTIC UTILITY AND POTENTIAL IMAGING REDUCTION IN SUSPECTED PULMONARY EMBOLISM

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ABSTRACT

Background: Acute pulmonary embolism (PE) is a cardiovascular emergency, yet securing a swift diagnosis is notoriously difficult due to its highly non-specific presentation. Computed Tomography Pulmonary Angiography (CTPA) serves as the diagnostic gold standard, but its routine overuse exposes patients to unnecessary radiation, increases the risk of contrast-induced nephrotoxicity, and heavily strains healthcare resources. The YEARS algorithm offers a streamlined alternative, relying on three core clinical features and variable D-dimer thresholds to safely rule out PE without advanced imaging.

Methods: This prospective observational diagnostic accuracy study evaluated 80 haemodynamically stable adults presenting with suspected acute PE in a tertiary care setting. We assessed the three YEARS items (clinical signs of deep vein thrombosis, haemoptysis, and PE as the most likely diagnosis) prior to any imaging. Patients with zero positive items utilized a D-dimer exclusion threshold of <1000 ng/mL FEU, while those with one or more items used a stricter <500 ng/mL FEU cutoff. Every participant subsequently underwent CTPA as the definitive reference standard.

Results: CTPA confirmed acute PE in 14 of the 80 patients (a 17.50% prevalence). The YEARS algorithm achieved a strong sensitivity of 92.86% and a specificity of 48.48%, alongside an excellent negative predictive value of 96.97%. Implementing the YEARS protocol would have safely bypassed CTPA in 33 patients, achieving a potential absolute imaging reduction of 41.25%. We observed a single false-negative case an isolated subsegmental embolism in an elderly patient whose D-dimer fell just below the algorithm's absolute cutoff, though it would have triggered an age-adjusted threshold.

Conclusion: The YEARS algorithm is an incredibly accurate, patient-safe, and resource-efficient diagnostic strategy. In our high-volume tertiary environment, relying on YEARS as a clinical gatekeeper dramatically curtailed unnecessary CTPA scans without compromising diagnostic integrity, making it a vital tool for modern respiratory and emergency triage.

KEYWORDS: Pulmonary embolism, YEARS algorithm, CTPA, D-dimer, diagnostic accuracy, bedside imaging, radiation reduction.

INTRODUCTION

Acute pulmonary embolism (PE) is a life-threatening event that presents a constant diagnostic dilemma. Since classic symptoms like breathlessness, pleuritic chest pain, and tachycardia closely mimic a host of benign respiratory and cardiac conditions, clinicians frequently have to navigate a maze of diagnostic uncertainty [1-3]. To avoid missing a potentially fatal clot, modern medicine leans heavily on Computed Tomography Pulmonary Angiography (CTPA) [4]. While CTPA is brilliantly accurate, reflexively scanning every patient with chest pain has created an entirely new set of problems: surging radiation exposure, rising rates of contrast-induced kidney damage, and severely strained emergency resources [5, 6].

To dial back this over-investigation, current guidelines strongly recommend pairing structured clinical probability tools with high-sensitivity D-dimer testing, reserving the scanner strictly for patients who truly need it [7, 8]. Traditional scoring systems certainly helped standardize this approach, but they can be cumbersome to apply consistently in a fast-paced clinical setting [9, 10]. Further modifications to clinical decision rules sought to improve diagnostic yield but often added layers of frustrating complexity to the workflow [11, 12].

Enter the YEARS algorithm. Designed to simplify the triage process, YEARS distills the pre-test assessment down to the three strongest predictors: clinical signs of deep-vein thrombosis (DVT), haemoptysis, and the clinician's judgment that PE is the most likely culprit [13]. The real ingenuity of the YEARS algorithm is how it pairs these three simple items with sliding D-dimer thresholds either 500 or 1000 ng/mL FEU. This simple pivot allows doctors to confidently rule out PE in a much wider net of patients, ultimately reducing healthcare costs and patient visit times [14, 15].

However, a clinical rule's performance often shifts when taken out of a controlled trial and dropped into a busy hospital with its own unique demographics, background disease burdens, and scanning habits [16-18]. We set out to evaluate the real-world diagnostic accuracy of the YEARS algorithm in a South Indian tertiary care center, specifically focusing on quantifying the exact proportion of CT scans we could realistically avoid in our local population.

METHODOLOGY

We conducted this prospective, single-center observational diagnostic utility study in the Department of Respiratory Medicine at Sree Balaji Medical College and Hospital over a six-month period. Following formal approval from the Institutional Human Ethics Committee, we obtained written informed consent from every participant.

We consecutively enrolled 80 adult patients (18 years and older) who presented with a clinical suspicion of acute PE and were haemodynamically stable at the time of their evaluation. We specifically excluded pregnant women, as they require a carefully tailored, pregnancy-adapted diagnostic pathway [19-21]. Patients already on therapeutic-dose anticoagulation for 24 hours or more, and those unable to safely undergo a CTPA, were also excluded.

Before looking at any laboratory results or radiological scans, the primary investigator assessed each patient for the presence of the three YEARS criteria [13]:

1. Clinical signs of DVT
2. Haemoptysis
3. PE considered the most likely diagnosis

We retrieved quantitative high-sensitivity D-dimer levels (reported in ng/mL FEU) from their routine clinical workup. Following the YEARS protocol, we classified patients into two theoretical buckets: "PE Excluded" (if they had zero YEARS items and a D-dimer <1000 ng/mL FEU, or 1 or more items and a D-dimer <500 ng/mL FEU) and "CTPA Indicated" for all other combinations.

Because this was an observational study, we did not use the YEARS score to withhold clinical care; every patient received a standard CTPA as requested by their treating physician. The final, verified radiology report acted as our definitive reference standard. We then analyzed the tabulated data using standard statistical software to calculate sensitivity, specificity, predictive values, and potential imaging reduction rates.

RESULTS

We evaluated 80 patients with a mean age of 57.15 ± 15.52 years (range: 18 to 88 years) and a balanced gender split. Acute dyspnoea and pleuritic chest pain were the most frequently observed presenting complaints. Quantitative D-dimer levels varied widely, displaying a significant right-skewed distribution with a median concentration of 1,510.50 ng/mL FEU (Interquartile Range: 476.25 – 3,162.75 ng/mL FEU).

Table 1: Cross-tabulation of YEARS Algorithm Decision vs. Definitive CTPA Outcome

YEARS Decision Pathway	CTPA Negative (No PE)	CTPA Positive (PE Confirmed)	Total
CTPA Indicated	34	13	47
PE Excluded	32	1	33
Total	66	14	80

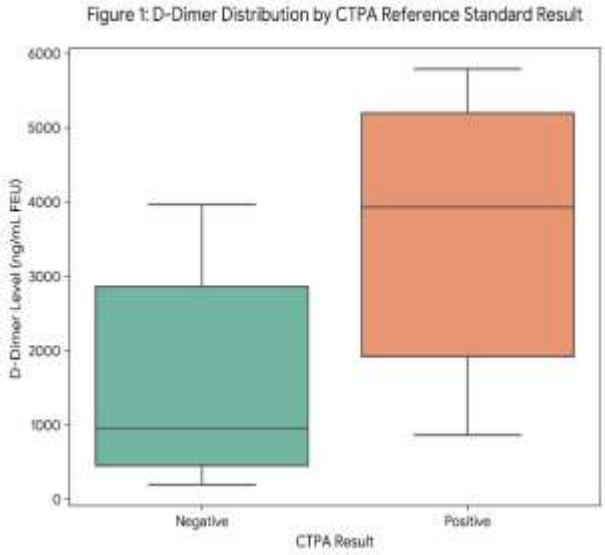

Figure 1: D-Dimer Distribution by CTPA Reference Standard Result

Diagnostic Performance CTPA imaging definitively confirmed acute pulmonary embolism in 14 of our 80 patients, resulting in a baseline institutional diagnostic scan yield of 17.50%. When we applied the YEARS algorithm retrospectively to triage the cohort, 47 patients were flagged as requiring a scan (13 True Positives, 34 False Positives). The remaining 33 patients met the strict algorithm criteria for safe exclusion (32 True Negatives, 1 False Negative).

A Chi-Square test of independence confirmed a statistically significant relationship between the YEARS algorithm's triage recommendation and the definitive CTPA outcomes ($p = 0.0106$). The operational diagnostic metrics for the algorithm were robust:

- Sensitivity: 92.86%
- Specificity: 48.48%
- Positive Predictive Value (PPV): 27.66%
- Negative Predictive Value (NPV): 96.97%

Table 2: Cross-tabulation of YEARS Algorithm Decision vs. Definitive CTPA Outcome

Number of Positive YEARS Items	CTPA Negative (No PE)	CTPA Positive (PE Confirmed)	Total Stratum (N)	Stratum PE Prevalence (%)
0 Items Positive	44	3	47	6.38%
1 Item Positive	16	8	24	33.33%
2 Items Positive	6	3	9	33.33%
3 Items Positive	0	0	0	0.00%
Total	66	14	80	17.50%

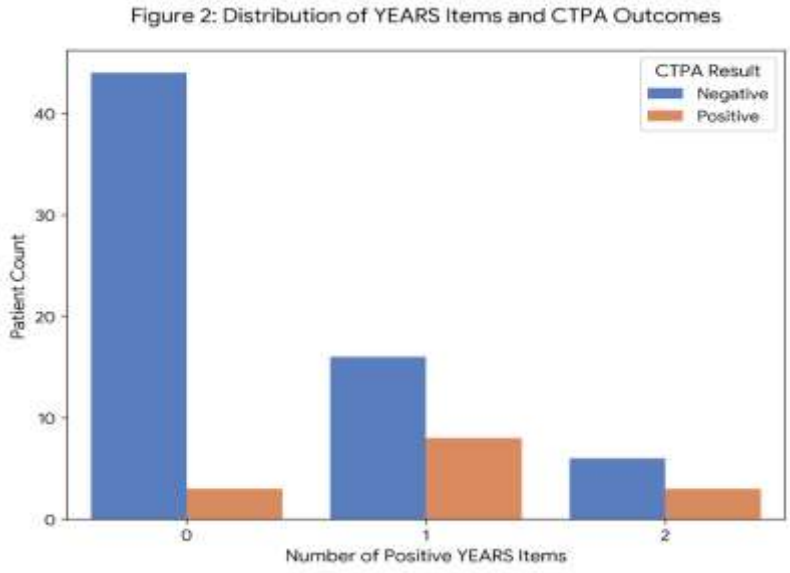

Figure 2: Distribution of Clinical Metrics Across Strata Bar Chart

Potential Imaging Reduction Had the YEARS algorithm actively dictated clinical care, 33 patients would have been safely diverted from the radiology department. This translates to an impressive absolute potential imaging reduction of 41.25%. Furthermore, 40.00% of all CT scans performed during this study were entirely clear but could have been theoretically avoided if the algorithm had acted as the diagnostic gatekeeper.
Analysis of Discordant Cases (False-Negative) We encountered only one false-negative case during the study a 1.25% overall miss rate (or 3.03% among the clinically excluded group). The patient was a 79-year-old female presenting with zero YEARS items and a baseline D-dimer of 860 ng/mL FEU. Because she fell strictly below the absolute 1000 ng/mL FEU exclusion cap for zero items, she was categorized as "PE Excluded." Her subsequent CTPA, however, revealed an isolated subsegmental pulmonary embolism.

DISCUSSION

In our present study, we evaluated the real-world diagnostic utility of the YEARS algorithm among 80 patients presenting to a tertiary respiratory center. Our findings demonstrate that the algorithm is highly reliable, achieving a sensitivity of 92.86% and a strong negative predictive value (NPV) of 96.97%. Most notably, our data revealed that implementing this clinical pathway could safely reduce the need for Computed Tomography Pulmonary Angiography (CTPA) by an impressive 41.25%.
When placed alongside the broader global literature, our results show striking consistencies as well as important local variations. A recent, large-scale meta-analysis pooled data from nearly 14,000 patients, reporting an average YEARS sensitivity of 96% and a specificity of 50% [22]. Our cohort's specificity hit 48.48%, closely mirroring these international trends. This relatively modest specificity is entirely expected in a tertiary care setting; our patients routinely present with overlapping inflammatory conditions, recent surgeries, and acute infections (such as COVID-19) that naturally elevate baseline D-dimer levels regardless of whether a clot is present [23].
Where our study significantly diverges from earlier reports is in the sheer volume of scans avoided. While an emergency department implementation study by Duffy et al. noted an 11.4% drop in CTPA use [24], our 41.25% potential reduction far exceeds this figure, as well as the performances seen when comparing YEARS directly to other traditional scores [25, 26]. This substantial gap likely points to a much more liberal baseline threshold for ordering CTPAs at our institution compared to European or Canadian centers [27-30]. By adopting YEARS as a gatekeeper, high-volume departments like ours stand to see a much more dramatic, immediate drop in unnecessary imaging. Importantly, our baseline diagnostic yield of 17.50% aligns perfectly with optimized yields reported in rigorous international audits, confirming that our patient sample was clinically appropriate and representative.
Finally, it is crucial to examine our single false-negative case, as it highlights a known limitation of the YEARS framework rather than a structural failure. We encountered a "miss" in a 79-year-old female who presented with zero YEARS items and a D-dimer of 860 ng/mL FEU. Because she fell strictly below the 1000 ng/mL FEU cutoff, she was excluded from imaging by the algorithm. However, if we had used a traditional age-adjusted strategy, her specific cutoff would have been 790 ng/mL FEU, which would have successfully triggered a scan [31, 32]. Extensive validation studies have explicitly warned clinicians about this exact conflict when applying the absolute limits of the YEARS protocol to elderly populations, though broader evidence suggests incorporating age-adjusted cutoffs into YEARS adds minimal overall value to the general population [33].
Furthermore, the clot discovered in this specific patient was an isolated subsegmental pulmonary embolism [34]. The respiratory community is currently engaged in intense debate regarding whether aggressively diagnosing and anticoagulating these tiny clots is actually necessary or beneficial. Subsegmental emboli rarely pack enough biomass to drastically spike D-dimer levels, and emerging meta-analytic data suggests that safely managing them without advanced imaging does not significantly impact long-term patient mortality [35, 36]. By trusting the structural markers of the YEARS algorithm, clinicians accept a very small, highly specific margin of error in exchange for protecting nearly half of their patients from the genuine risks of the CT scanner.

CONCLUSION

The YEARS algorithm proves to be an exceptionally accurate, patient-safe, and non-invasive triage tool for evaluating suspected acute pulmonary embolism. Our findings confirm that it easily meets the rigorous safety thresholds required in tertiary respiratory medicine. More importantly, it offers an unprecedented 41.25% potential reduction in unnecessary CTPA scans within our clinical setting. Moving forward, embracing this structured diagnostic pathway can fundamentally shift how we manage respiratory emergencies—drastically cutting back on radiation exposure, minimizing contrast-induced kidney complications, and optimizing workflow in busy hospital departments.

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