Critical Review Form

Therapy

Success of a Safe and Simple Algorithm to Reduce Use of CT Pulmonary Angiography in the Emergency Department, *AJR* 2010; 194:392-397

Objective: **"to decrease radiation exposure to emergency department patients with suspected PE, for whom imaging was clinically warranted, by safely increasing the use of V/Q scanning and decreasing the use of CTPA through an educational intervention." (p. 393)**

Methods: **Retrospective before/after study at Montefiore Medical Center comparing the rates of ordering for CT pulmonary angiography (CTPA) and V/Q scans for the calendar year 2006 and 2007. Didactic seminars were held in December 2006 and January 2007 for ED resident and attending physicians led by the director of nuclear medicine in collaboration with the chief of radiology and the cardiothoracic radiology section chief. At these sessions, the radiation dose and diagnostic accuracy of CTPA and V/Q scanning were discussed. The following diagnostic algorithm was recommended.**

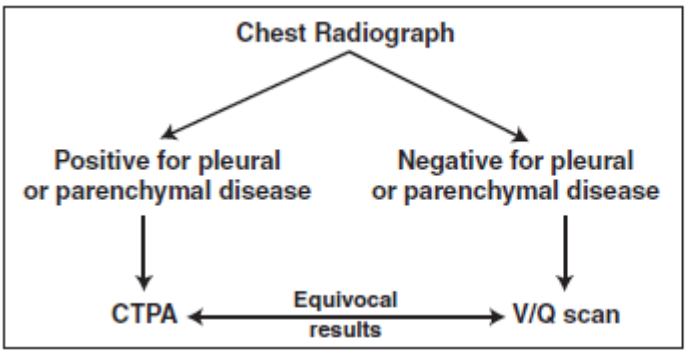

Fig. 1—Flowchart shows algorithm for suspected pulmonary embolism. CTPA = CT pulmonary angiography, V/Q scan = ventilation–perfusion scanning.

After subjective (i.e. clinical gestalt) assessment of PE as a diagnostic possibility, a CXR was recommended with V/Q recommended if no pleural or parenchymal abnormality was noted. The algorithm was reinforced by a telephone call from the radiologist whenever a CTPA was ordered in a patient with a normal CXR, but "the final decision on the appropriate imaging technique for an individual patient in the emergency department." (p. 393)

Outcomes assessed included estimated dose of radiation per patient each (all of 2006 versus all of 2009), proportion of CTPA and V/Q scans, and false negative imaging results. The total radiation dose was estimated using 2.2 mSv per V/Q scan and 10 mSv per CTPA. CTPA were obtained on a 64 slide multidetector scanner (Light-speed VCT or Brilliance 16) using the manufacturer's suggested protocol in 1.25 mm axial and 2mm coronal and sagittal planes after injection of 80-125 mL IV nonionic contrast material. V/Q scans, which were available around-the-clock (24 hours/day, 7 days/week) used 40mCi of 99mTc – labeled macroaggregated albumin for the perfusion study.

During daylight hours board-certified radiologists read all CTPA. In-house radiology residents (PGY 3-5) read CTPA initially during off-hours. Similarly, V/Q scans were read by Nuclear Medicine Physicians with 10-42 years experience during daylight hours and residents during off-hours. All final reports were reviewed by attending radiologists and amended reports were only submitted for approximately 1%.

A "negative" V/Q scan was normal, very low, or low probability. A V/Q scan interpreted as high probability was labeled "positive" and all other results of V/Q were indeterminate. CTPA was positive if the reviewing radiologist identified a PE and negative if no PE was identified.

Using Clinical Looking Glass data mining software, records were reviewed to determine if each patient with a negative examination returned to this medical center with the diagnosis of DUT or PE within 90 days. Electronic medical records and the Social Security Death Index were also reviewed to identify patients with a negative imaging study who died of any cause within 90 days.

Guide		Comments
I.	**Are the results valid?**	
A.	**Did experimental and control groups begin the study with a similar prognosis (answer the questions posed below)?**	
1.	Were patients randomized?	No randomization – this was a before/after retrospective review.
2.	Was randomization concealed (blinded)?	No randomization, no blinding.
3.	Were patients analyzed in the groups to which they were randomized?	Intention-to-treat analysis meaningless in before/after study.

4.	Were patients in the treatment and control groups similar with respect to known prognostic factors?	Although there is no treatment and control group, there are before and after groups of patients. The authors do not present any patient demographics by which to judge the prognostic equivalence of patients in 2006 and 2007. What was the mean age of patients each year? What % had a prior VTE? What % had clinician gestalt of high vs. low risk for PE each year? Each of these variables could affect whether V/Q or CTPA were ordered independent of the educational intervention.
B.	**Did experimental and control groups retain a similar prognosis after the study started (answer the questions posed below)?**	
1.	Were patients aware of group allocation?	Yes. No randomization or blinding, but patient's knew whether they had V/Q or CTPA
2.	Were clinicians aware of group allocation?	Yes.
3.	Were outcome assessors aware of group allocation?	Yes.
4.	Was follow-up complete?	No loss to follow-up was reported.
II.	**What are the results (answer the questions posed below)?**	
1.	How large was the treatment effect?	• The number of CTPA decreased from 2006-2007 - In 2006, 1,979 imaging exams (1234 CTPA, 745 V/Q) - In 2001, 2136 imaging exams (920 CTPA, 1216 V/Q) ($p < 0.0001$) • Resulting decreased CTPA from 60.3-64.6% of PE imaging in 2006 to 39.4% in the final quarter of 2007. • V/Q patients in 2007 were significantly younger than

		CTPA patients. (50.8 vs. 56.7 years). • The estimated radiation exposure per patient dropped 8.0 mSv to 6.4 mSv between 2006 and 2007 ($p<0.0001$), including a drop from 7.2 mSv to 4.9 mSv in women younger than 40. • The proportion of indeterminate CTPA increased from 2.1% to 4.7% ($p=0.001$) and the proportion of negative V/Q scans was significantly lower than negative CTPA in both 2006 (89.4% vs. 84.8%) and 2007 (89.4% vs. 81.8%) ($p <0.0001$). • The number of negative CTPA followed by V/Q did not significantly increase (2.4% and 3.2%) between 2006 and 2007. • False negative rates for V/Q (1.1% and 1.2%) and CTPA (0.8% and 1.1%) did not significantly increase from 2006 and 2007. • All-cause 90-day mortality was higher for CTPA (9.4% and 14.1%) than V/Q (5.7% and 3.9%) in 2006 and 2007.
	How precise was the estimate of the treatment effect?	No 95% CI's were provided.
III.	**How can I apply the results to patient care (answer the questions posed below)?**	
1.	Were the study patients similar to my patient?	Yes, ED patients with suspected PE. However, it would be helpful to evaluate overall patient demographic information to judge external validity.

2.	Were all clinically important outcomes considered?	Yes, patient centric outcomes of all-cause mortality and false negative results are reported. Additional outcomes of interest would include non-PE false negatives (pneumonia, aortic dissection) that CTPA would identify, but V/Q would miss. Clinician acceptability, algorithm violations, and qualitative descriptions of discourse between EM and Radiology would also add to the analysis of this intervention.
3.	Are the likely treatment benefits worth the potential harm and costs?	Yes, a simple educational intervention modeled around an elementary diagnostic algorithm reduced patient radiation exposure without increasing false negative rates or all-cause mortality.

Limitations

1) **Lack of randomization so cannot be confident in the cause-effect relationship between the educational intervention and the diagnostic ordering patterns observed.**

2) **No details are provided on the clinical gestalt for PE. Who's gestalt (resident or attending physician)? What percentage of patients were high, intermediate, or low risk for PE? What does "risk of PE" quantitatively mean to individual clinicians?**

3) **No demographic data for patients was provided so population studied may differ significantly from the population we care for.**

4) **Lack of external validity. Examples: round-the-clock access to V/Q and radiologists interpretations; collegial working relationships between radiology and EM.**

5) **No details provided on physician acceptance, algorithm deviations, barriers encountered, or sustainability efforts.**

6) **No confidence intervals were provided.**

7) **No assessment for a Hawthorne effect.**

Bottom Line

A brief educational intervention coupled with a simple diagnostic algorithm may decrease CTPA ordering rates in favor of V/Q while reducing expected radiation exposures to patients. Future educational intervention trials should qualitatively and quantitatively explore patient and emergency physician acceptability of such multidisciplinary algorithms while defining "PE risk" and exploring alternative explanations for changes in CTPA order rates.