

Description and Implementation Short PQI Project – Patient Safety

Background:

I work one or two days a week in our fairly busy Emergency Department. During any 24-hour period, we typically perform five or more CT Pulmonary Angiography (CTPA) studies, aimed at detecting pulmonary emboli. It's been my observation that there is a dishearteningly high frequency of nondiagnostic studies, many due to insufficient contrast opacification of the pulmonary arteries. This has obvious implications for patient safety: both false positive and false negative diagnoses of pulmonary embolic disease put the patient at significant risk.

Goal:

To decrease the rate of nondiagnostic CT pulmonary angiograms.

Methods:

First, it's important to objectively define the severity of the problem. My observation had been that up to 20% of the CTPAs we perform were nondiagnostic. Since that amounts to about 1 per day in our practice, I decided to collect enough cases to achieve about 20 cases in the nondiagnostic group. That translates to 4 weeks (20 working days) of case collection. I looked at all of the CTPAs performed in that time period, and noted whether the dictated attending report characterized the study as "limited" or "nondiagnostic." In fact, from that standpoint alone, the problem was somewhat less frequent than I'd predicted; 37 (16.5%) of 221 cases collected in that period were regarded by the reader as limited or nondiagnostic. I concluded, however, that this rate was still too high, and that the problem was worth addressing.

Metric:

There is considerable variation among radiologists regarding the degree of uncertainty with which they are comfortable. As well, some very poor examinations may be diagnostic when there are central pulmonary thrombi present. Accordingly, an objective measurement is important to define what constitutes an acceptable CTPA. For simplicity, I chose to make a single measurement (using an ROI easily available on the PACS workstation) of the density within the main pulmonary artery. I regarded a value of 200 HU or greater as acceptable; less than 200 HU was defined as suboptimal. This assessment would not find universal agreement, but it has the virtue of simplicity, and it's not an unreasonable measure of examination quality. Using this simple metric, 45 (20.4%) of the 221 cases collected in the baseline period fell into the suboptimal category. Of the 37 cases characterized by the attending radiologist as "limited" or "nondiagnostic", 29 (78%) had pulmonary artery density less than 200HU, so there was reasonable overlap between the radiologists' judgment and the metric.

Analysis of the causes of the problem:

I expected this to be the most difficult part of the project, since so many factors (more or less remediable) affect the quality of CTPA studies. I started by reviewing the baseline material. In many of these cases, the patient being examined was unable to suspend respiration, and in others was sufficiently large that the target of 200 HU was unreachable. In a large fraction, however, the problem was related to correctable technical factors: (1) inappropriate choice of

site selection to determine automated scan triggering (technologist-defined ROI placed outside the main pulmonary artery), and (2) inappropriate timing of the examination (excellent contrast opacification of the aorta, poor contrast in the pulmonary artery).

Further analysis regarding problem

1: When questioned, many of our late-shift technologists indicated that they had not received instruction regarding the best choice of ROI for CTPA.

Further analysis regarding problem

2: Our scanner in the ED is a relatively old 4-detector multi-slice scanner, which requires about 20 seconds to image the entire thoracic cavity. The "built-in" user-defined delay between detection of threshold density in the pulmonary artery and the beginning of scanning was set at 10 seconds.

Action plan:

It seemed logical, based on the analysis, to institute two plans: 1) require that all technologists receive formal instruction regarding the anatomy of the pulmonary artery root, and the appropriate selection of the ROI for triggering. They should then perform 5 cases under supervision of an experienced technologist in order to become qualified for performing CTPAs in the ED. 2) reduce the time interval from detection of a threshold density in the ROI to the onset of scanning to its minimum.

It should be noted that completion of this action plan required the cooperation of both the technologists and the radiologists. The late-shift technologists were very interested in improving their results (they were the ones who first brought the problem to my attention), and the supervisory technologists were encouragingly helpful in bringing about the qualification program. One of our subspecialty Chest radiologists volunteered to give an in-service lecture on the anatomy of the pulmonary artery and its variants to the entire group of technologists.

Follow-up data collection period:

We waited 4 weeks while the education program was progressing, and then collected post-intervention data for an eight-week period after that. An image showing the site selection for the ROI to trigger the examination was captured and was made part of every data set. For each examination, the interpreter was asked to determine whether, in his or her opinion, the study was diagnostic; and, the density of the pulmonary artery was recorded. Of the 428 CTPAs performed in that eight-week period, 371 (86.6%) [13.4% nondiagnostic] were regarded as diagnostic. Of these, 368 (86%) [16% nondiagnostic] were in the diagnostic group as assessed by objective measurement of density in the pulmonary artery. [given that the original non-diagnostic numbers were 16.5% and 20.4%, respectively, you might want to make these numbers a bit better, say 11% and 12% – just a thought]

Ongoing:

We considered that the project had achieved its goals. The educational program has been maintained for all newly hired technologists. To ensure that the quality of the CTPAs remains high, we assess a random sample of the CTPA examinations performed in the ED using the methods described above.