

The Effect of Teleradiology on Time to Interpretation for CT Pulmonary Angiographic Studies

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Purpose: The aim of this study was to evaluate the impact of a teleradiology service on the time to interpretation for computed tomographic (CT) pulmonary angiographic studies.

Methods: A survey of clinical and imaging physicians was performed to develop achievable goals for the interpretation of CT pulmonary angiographic studies. Percentages of studies given preliminary written reports within these thresholds were compared for 485 CT pulmonary angiographic studies completed 3 months before teleradiology was implemented and 617 studies completed 3 months afterward. A total of 1,638 CT brain studies completed over identical periods were used for comparison. Statistical significance ($P < .05$) was evaluated with 2-tailed t -tests.

Results: The median of the optimal time to the preliminary written interpretation of a CT pulmonary angiographic study reported by radiology chairs was 60 minutes, compared with 20 minutes for emergency medicine physicians, who also reported a 40-minute limit for an acceptable time to interpretation. There were statistically significant improvements in the percentages of these studies interpreted within the 60-minute (51% to 62%; $P < .01$) and 20-minute (9% to 13%; $P < .05$) optimal time thresholds, as well as within the 40-minute acceptable time threshold (34% to 43%; $P < .01$). No statistically significant improvements occurred for CT brain studies.

Conclusions: The use of teleradiology to interpret off-hours inpatient imaging serves as an important process improvement tool in decreasing the time to preliminary written reports for CT pulmonary angiographic studies. By establishing agreed-on time standards for reporting such examinations, radiologists and clinicians can collaborate to ensure the prompt diagnosis and treatment of potentially lethal illnesses, such as pulmonary embolism.

Key Words: Teleradiology, CT pulmonary angiography, pulmonary embolism, process improvement

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INTRODUCTION

The diagnosis of an acute pulmonary embolism (PE) is one of the most time sensitive tasks for clinicians in the

acute care setting, because it can result in death within 1 to 2 hours without treatment [1,2]. Because many of the signs and symptoms of PE (eg, tachypnea, tachycardia, and chest pain) are shared manifestations of other illnesses, diagnostic tests must not only be quick but also accurate in identifying the cause of a patient's clinical presentation. The importance of accurate diagnosis is highlighted by the fact that PE can have a mortality rate as high as 30% without treatment, whereas proper diagnosis and subsequent treatment with anticoagulants decreases the mortality rate to between 2% and 8% [3-8]. Although the gold-standard test for diagnosing acute PE has been invasive pulmonary angiography, computed tomographic (CT) pulmonary angiography using intravenous contrast has increasingly replaced this test [9-11]. Benefits cited by many studies for the use of CT pulmo-

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nary angiography over other diagnostic modalities include its ability to examine the entire pulmonary system for abnormalities that may be causing a patient's symptoms [12-14], as well as its safety, speed, and high sensitivity and specificity. Indeed, in the Prospective Investigation of Pulmonary Embolism Diagnosis II trial, with 824 patients, sensitivity and specificity for pulmonary angiography CT were found to be 83% and 96%, respectively, with 90% sensitivity and 95% specificity with the addition of venous-phase imaging [15].

Given the importance of quick and accurate diagnoses for many illnesses, including acute PE, especially in the context of a heightened focus on physician performance and quality improvements in recent years [16], many hospitals have increasingly looked to teleradiology services to assist in providing off-hours radiologic interpretations for both emergent (eg, CT pulmonary angiography) and nonemergent (eg, preoperative inpatient chest x-ray) imaging. In this study, we analyzed times to interpretation for CT pulmonary angiographic studies to ascertain whether the implementation of our own teleradiology service actually accomplished a process improvement. If it did, a similar change might be valuable in many medical institutions. If, however, there were objective disadvantages to the teleradiology service, such as increased report turnaround time, the use of teleradiology in this setting would be questionable.

To determine the impact of a teleradiology service, we first undertook a survey of clinicians and radiologists to determine target benchmarks for times to interpretation for CT pulmonary angiographic studies. We then assessed the impact of an internal model of image interpretation on achieving these various benchmarks and sought to draw conclusions on the benefits of such a model. More specifically, we aimed to show that the implementation of an internal teleradiology service could improve the percentage of time-critical CT pulmonary angiographic studies given preliminary written reports within the clinical benchmarks obtained by a survey of the relevant physicians.

METHODS

Time Standards

To obtain information on radiologists' perceptions of time-to-interpretation benchmarks, a survey (see [Appendix A](#) online) was e-mailed to 75 radiology administrators of academic radiology departments who belonged to the national organization of the Association of Administrators of Academic Radiology Departments, a parallel organization to the Society of Chairman of Academic Radiology Departments. By contacting chairs via their clinical administrators, we surveyed whether there were specific departmental standards from the time of CT

pulmonary angiographic study completion to preliminary written report.

To obtain similar information on treating clinicians' perceptions of these benchmarks, a separate survey (see [Appendix B](#) online) was e-mailed to all 31 emergency medicine attending physicians at Yale-New Haven Hospital. The survey asked demographic information of the respondents, including gender, years of practice, board certification, and type of practice (ie, adults, children, or both). In addition, it asked respondents to quantify how much time they thought radiologists spent interpreting and dictating CT pulmonary angiographic studies. Finally, it asked them for an optimal time and an acceptable time limit for a preliminary written report of the findings by a radiologist. This time limit was defined as the point at which an emergency medicine physician would need to make a disposition or management decision solely on the basis of clinical grounds if the interpretation of a CT pulmonary angiographic study were not provided.

Importantly, our survey made a clear distinction between the concept of "reporting," which generally signifies a "wet" or verbal interpretation of an imaging study given to a clinician, and a "report," which in our survey and subsequent analysis was defined as a preliminary or final written interpretation of the findings by a radiologist.

Teleradiology System

The interpretation of all imaging studies at Yale-New Haven Hospital, including requested inpatient and all emergency department studies, had been performed by the in-house attending radiologist with the assistance of the on-call resident before the full implementation of a teleradiology service in October 2006. The attending radiologist and the radiology resident on call used PowerScribe (Nuance, Burlington, Massachusetts), a real-time voice recognition software package, to dictate imaging study reports. This software package was interfaced with our radiology information system, ImageCast (previously IDX Systems Corporation; now GE Healthcare, Fairfield, Connecticut), and picture archiving and communication system, Synapse (Fujifilm, Tokyo, Japan). Clinicians could access Synapse at computer stations throughout the hospital to obtain imaging study interpretations. These radiologists interpreted all CT pulmonary angiographic studies and emergency department brain CT studies, in addition to other emergent studies performed throughout the hospital, in the reading room of the emergency department. A dedicated neuroradiology service was used to interpret all inpatient neuroradiologic studies.

Because of concerns regarding increased end-of-day volume, decreased end-of-day staffing, and a desire to adequately meet the needs of all clinicians, our department experimented with an in-house or internal off-

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