ORIGINAL ARTICLE

Inefficient Resource Use for Patients Who Receive Both a Chest Radiograph and Chest CT in a Single Emergency Department Visit

Tarek N. Hanna, MD, Waqas Shuaib, MD, James M. Kerchberger, BA, Jamlik-Omari Johnson, MD, Faisal Khosa, MD, MBA

Abstract

Purpose: The goal of this study was to examine emergency department (ED) ordering practices in patients receiving both chest radiography (CXR) and chest CT (CCT).

Methods: Consecutive ED patients receiving both CXR and CCT in a single ED visit from January 2009 to December 2013 were included. For each examination, the time of order entry, time of study completion, and time of final interpretation were recorded and analyzed.

Results: A total of 3,627 patients met the inclusion criteria. In 3,437 (94.8%) patients, the CXR was ordered first; in 43 (1.2%), the CCT was ordered first; and in 91 (2.5%), the CCT and CXR were ordered simultaneously. In 50.3% (1,826 of 3,627) of all cases, imaging in the second modality (whether CCT or CXR) was ordered before final report availability of the first exam. In 9.8% (n = 354 of 3,627) of all cases, imaging in the second modality (whether CCT or CXR) was ordered before image availability from the first examination.

Conclusions: These results suggest inefficient resource usage, for which targeted technology solutions may be helpful.

Key Words: Radiology, emergency department, CT, chest radiography, informatics

J Am Coll Radiol 2015;■:■-■.

INTRODUCTION

Emergency department (ED) volumes are increasing, and ED crowding remains an important problem. Between 2008 and 2011, ED visits increased by more than 12 million visits, from 123.8 million to 136.3 million [1,2]. In 34.4% of ED visits, a radiograph was performed, and in 15.8% of visits, CT was performed [2]. In 2011, 10.9% of all ED visits were the result of acute cardiothoracic symptoms, including chest pain, cough, and shortness of breath [2]. Cardiothoracic imaging with chest radiography (CXR) and chest CT (CCT) is integral in the workup of many such patients. CXR is performed in the ED in more than 70% of patients who have acute cardiothoracic symptoms [3], and CCT is performed in more than 13% [4]. A subset receives both CXR and CCT in the same visit.

In this article, we present a systematic evaluation of the process that ensues when a secondary cardiothoracic imaging order is placed by an ED provider. We focus on three key time points in the imaging cascade: order entry, study completion, and interpretation. We documented these three time points for both CXR and CCT, creating a six-point timeline for each patient. The goal is to provide insight into ED ordering practices for patients who undergo duplicate cardiothoracic imaging, and to help identify instances of medical waste and unnecessary radiation exposure.

METHODS

This study was conducted with institutional review board approval and is HIPAA compliant. The requirement for

Division of Emergency Radiology, Department of Radiology and Imaging Sciences, Emory University School of Medicine, Atlanta, Georgia.

Corresponding author and reprints: Tarek N. Hanna, MD, Division of Emergency Radiology, Department of Radiology and Imaging Sciences, Emory University School of Medicine, 550 Peachtree Rd, Atlanta GA 30308; e-mail: tarek.hanna@emory.edu.

James M. Kerchberger, BA, was a student in the Emory University School of Medicine at the time this work was conducted.

Faisal Khosa is the American Roentgen Ray Society Scholar (2013-2015). Dr. Khosa receives support from National Institutes of Health Grant 1R56HL126558-01.

1546-1440/15/$36.00 ■ http://dx.doi.org/10.1016/j.jacr.2015.06.027

written informed consent was waived because the study is retrospective.

Study Population

Consecutive ED patients at two urban, university-affiliated hospitals, from January 2009 to December 2013, were eligible for inclusion if they received both CXR and CCT during a single ED visit. For purposes of this study, a single electronic encounter number was used to define a patient's ED visit. In our health care system, a patient can move among waiting room, ED, and clinical decision unit with a single encounter identifier. Disposition and termination of the ED encounter occurred when the patient was admitted to an inpatient floor or discharged from the ED. Patients aged less than 18 years were excluded.

Chart review to document medical decision making was performed when a CCT was ordered before a CXR, or when they were ordered simultaneously. These two scenarios were selected for chart review because they seemed most likely to represent inefficient ordering practices. CXR examinations consisted of either portable anterior-posterior imaging or posterior-anterior imaging with lateral views. CCT examinations were non—cardiac-gated, spiral, axial images (2 mm) obtained from the thoracic inlet through the upper abdomen, after a weight-based dose of intravenously administered Isovue-370 (Bracco Diagnostics Inc, Monroe Township, New Jersey). The CT scanners available in these two hospitals are: the LightSpeed VCT, 64-detector row; the LightSpeed RT-16 (both from GE Healthcare, Chalfont St. Giles, United Kingdom), and the dual source Somatom Definition Flash (Siemens Healthcare, Erlangen, Germany).

Definition of Terms

Demographic data and radiology reports, including indications for examinations, were obtained from the institutional clinical data warehouse. For each patient encounter, six separate time points were acquired: time of electronic order entry by a physician or midlevel provider; time of technical study completion (at this point, images were available to be viewed in the PACS); time of final radiology report availability, either produced or signed by an attending radiologist. An attending radiologist provided real-time coverage at these institutions all day and all night, every day of the year, throughout the study period. Residents and fellows worked at these hospitals and may have produced initial preliminary reports. We recorded the elapsed time from preliminary report creation to signing of the final report by an attending radiologist. Preliminary reports are generated by residents and are unambiguously marked as preliminary in the electronic medical record, to ensure that clinicians do not mistake them for final, attending-radiologist reports.

Table 1. Most common clinical indications for patients receiving both chest radiograph and chest CT in the emergency department

Clinical Indication	Number of Patients	Percentage of Total Patients
Chest pain	1,451	40
Acute shortness of breath	1,306	36
Pulmonary embolism protocol	254	7
Miscellaneous	616	17

Study Endpoints

The study outcome was a six-point timeline for each patient, detailing the various times of these imaging examinations, and comparisons of these time points for CXR versus CCT. Patients who had the same data timeline were grouped, allowing for generation of cohorts and comparison of ED ordering patterns. Turnaround-time data for time of order entry to time of study completion, and for time of order entry to time of final report, for both CXR and CCT, were obtained from the clinical data warehouse, in the form of means over the 4-year study period, instead of individual data points for each examination.

Statistical Analysis

Statistical analysis was performed using STATA, Release 10.1 (Stata Corp, College Station, Texas). Continuous variables are expressed as mean (±SD); categoric variables are expressed as frequency (percentage). For categoric variables, comparisons between the two groups were made using Fisher's exact test.

RESULTS

During this study, 3,627 patients (2,413 [66.5%] men and 1,214 [33.5%] women) met the inclusion criteria. The average age of the patients in our cohort was 49.2 (±18.3) years. The three most common complaints that required diagnostic imaging were: chest pain (40%); acute shortness of breath (36%); and suspected pulmonary embolism (7%) (Table 1). Among all patients, 56