Effect of Computerized Physician Order Entry on Imaging Study Indication

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Abstract

Purpose: The effect of computerized physician order entry (CPOE) on imaging indication quality had only been measured in one institution's emergency department using a homegrown electronic health record with faculty physicians, and only with one instrument. To better understand how many US hospitals' recent CPOE implementations had affected indication quality, we measured its effect in a generalizable inpatient setting, using one existing and one novel instrument.

Methods: We retrospectively analyzed the indications for 100 randomly selected inpatient abdominal CT studies during 2 calendar months immediately prior to a 3/3/2012 CPOE implementation (1/1/2012-2/29/2012) and during 2 subsequent calendar months (5/1/2012-6/30/2012). We excluded 2 intervening months to avoid behaviors associated with adoption. We measured indication quality using a published 8-point explicit scoring scale and our own, novel, implicit 7-point Likert scale.

Results: Explicit scores increased 93% from a pre-CPOE mean ± 95% confidence interval of 1.4 ± 0.2 to a CPOE mean of 2.7 ± 0.3 ($P < .01$). Implicit scores increased 26% from a pre-CPOE mean of 4.3 ± 0.3 to a CPOE mean of 5.4 ± 0.2 ($P < .05$). When presented with a statement that an indication was "extremely helpful," and choices ranging from "strongly disagree" = 1 to "strongly agree" = 7, implicit scores of 4 and 5 signified "undecided" and "somewhat agree," respectively.

Conclusions: In an inpatient setting with strong external validity to other US hospitals, CPOE implementation increased indication quality, as measured by 2 independent scoring systems (one pre-existing explicit system and one novel, intuitive implicit system). CPOE thus appears to enhance communication from ordering clinicians to radiologists.

Key Words: Computerized physician order entry, diagnostic imaging, referral and consultation, medical informatics

J Am Coll Radiol 2015;12:70-74.

INTRODUCTION

Multiple studies demonstrate that clinical context improves imaging interpretation [1]. As many US hospitals have recently switched from paper ordering to computerized physician order entry (CPOE), we sought to study the effect of this change on the quality of imaging indications received by inpatient radiologists. Based on research showing that CPOE can take longer than paper ordering [2] and can adversely affect communication [3], we considered the possibility that it could worsen the utility of the indications provided by ordering clinicians. However, we also recognized that CPOE allows for dynamic, study-specific imaging order interfaces, which can be used to both remind clinicians that an indication is required and offer them easy access to common indications for a given imaging study. Thus, we also had reason to believe that certain components of CPOE could improve indication quality.

Historically, ordering physicians' indications for imaging examinations have often been handwritten on paper before undergoing various stages of computer scanning and/or human transcribing and being ultimately received by the reading radiologist. This system causes sundry errors [4]. Furthermore, given the time pressures faced by clinicians, asking them to handwrite indications may result in little to no information being provided. Many blank paper order forms provide no reminder to the ordering physician that an indication is necessary.

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1546-1440/14/$36.00 ■ http://dx.doi.org/10.1016/j.jacr.2014.07.028

One prior study showed that imaging indication quality improved when CPOE was implemented [5]. This work was pioneering in its vision, and it provided us the impetus to study CPOE in an inpatient setting with strong external validity to the many US hospitals that have recently implemented CPOE. Three major differences in our study help build on this previous research. First, the prior analysis was conducted at an institution that initially used a custom paper form for the imaging exam studied, with many checkboxes for various common indications. This type of form differs from the blank paper order forms common in most pre-CPOE environments. The studied custom forms could have contributed to higher baseline indication quality, and thereby led to underestimation of the size of any change. Second, the study analyzed the transition to a homegrown medical record with a user interface allowing only free-text input of imaging indications. This differs from the vendor CPOE systems most commonly adopted at US hospitals, which tend to feature a combination of study-specific indication buttons and free text. Third, the study was conducted in the emergency department of an academic institution staffed by employed physicians who could be required to use the interface as a condition of employment. Finally, only one instrument to assess indication quality existed previously [5].

When our large hospital implemented inpatient CPOE, it provided an excellent setting, from the standpoint of external validity to other US hospitals, to further test the effect of CPOE on indication quality. The ordering interface changed from free-text paper to an interface adopted by many US hospitals as a part of their vendor CPOE: study-specific indication buttons and free text. The CPOE was used by both employed and community physicians. This latter group was not contractually obligated to use the CPOE interface in a given way to receive their income. Indeed, like many similar hospitals, our institution sought to minimize hard stops and other cumbersome ordering mechanisms that could drive private physicians to admit their patient to nearby competing hospitals.

We sought to analyze the effect of CPOE on indication quality when implemented under these circumstances, which offered excellent external validity to many other US hospitals. Furthermore, we used a novel indication quality assessment system and compared it to results obtained using the prior instrument. Our novel instrument uses a 7-point Likert scale to capture the opinion of a reading radiologist regarding the quality of the indication.

METHODS

Study Design and Setting

We conducted a retrospective analysis of deidentified imaging orders from before and after implementation of CPOE. Cedars-Sinai Medical Center is a nonprofit medical center with 896 licensed beds. More than 2,000 providers are on its medical staff, including both academic faculty physicians and non-employee community physicians.

Intervention

On March 3, 2012, Cedars-Sinai Medical Center implemented a vendor CPOE (Epic Systems, Verona, WI) commonly adopted by US hospitals. Prior to the adoption of this new system, physician ordering of inpatient radiology studies used paper forms. The form offered space for the physician to write pertinent clinical information. The paper form was then electronically transcribed by an order entry clerk. A series of technical interfaces then relayed this information to the reading radiologist. After implementing CPOE, physicians directly entered indications using a computer interface. The new format still allowed for free-text entries, but it also contained study-specific clinical indication buttons. A hard stop required that at least one of these buttons, including an "other" button that was meant to be complemented with free text, be selected.

We compared physician indications for CT scans of the abdomen from 2 different time periods: the 2 calendar months immediately preceding CPOE "go-live" (1/1/12-2/29/12), and 2 subsequent calendar months during which CPOE was being used (5/1/12-6/30/12). The 2 calendar months immediately following CPOE go-live were excluded, to allow for extinction of any ordering behaviors initially associated with adoption. We randomly selected 100 completed CT abdomen orders from each time period. For each imaging order, we obtained the indication available to the reading radiologist.

We included CT scans that imaged both the abdomen and pelvis. Because we intentionally chose radiologists with experience in interpreting these images to rate the indications, we excluded CT angiograms of the abdomen that are usually read by interventional radiologists.

Primary Outcome Variables—Explicit and Implicit Scoring Systems to Assess Indication Quality

Two independent methods were used to assess the quality of the imaging indications. First, we used an explicit scoring system both tested and cited in prior work [5,6]. Two coauthors independently used a 3-point scale (0-2, where 0 = no information, 1 = 1 piece of information, and 2 = >1 piece of information) to evaluate each study across 4 separate component criteria: signs and symptoms, abnormal lab values, prior history, and relevant clinical question. The raters were blinded to the time period of each order indication.

These 4 component scores were then summed into a global explicit score. A mean score across the 2 raters was