

The Effect of Clinical Decision Support for Advanced Inpatient Imaging

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Abstract

Purpose: To examine the effect of integrating point-of-care clinical decision support (CDS) using the ACR Appropriateness Criteria (AC) into an inpatient computerized provider order entry (CPOE) system for advanced imaging requests.

Methods: Over 12 months, inpatient CPOE requests for nuclear medicine, CT, and MRI were processed by CDS to generate an AC score using provider-selected data from pull-down menus. During the second 6-month period, AC scores were displayed to ordering providers, and acknowledgement was required to finalize a request. Request AC scores and percentages of requests not scored by CDS were compared among primary care providers (PCPs) and specialists, and by years in practice of the responsible physician of record.

Results: CDS prospectively generated a score for 26.0% and 30.3% of baseline and intervention requests, respectively. The average AC score increased slightly for all requests (7.2 ± 1.6 versus 7.4 ± 1.5 ; $P < .001$), for PCPs (6.9 ± 1.9 versus 7.4 ± 1.6 ; $P < .001$), and minimally for specialists (7.3 ± 1.6 versus 7.4 ± 1.5 ; $P < .001$). The percentage of requests lacking sufficient structured clinical information to generate an AC score decreased for all requests (73.1% versus 68.9%; $P < .001$), for PCPs (78.0% versus 71.7%; $P < .001$), and for specialists (72.9% versus 69.1%; $P < .001$).

Conclusions: Integrating CDS into inpatient CPOE slightly increased the overall AC score of advanced imaging requests as well as the provision of sufficient structured data to automatically generate AC scores. Both effects were more pronounced in PCPs compared with specialists.

Key Words: Clinical decision support, appropriateness criteria, computerized physician order entry, utilization management

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INTRODUCTION

The rapid growth of medical imaging over the past decade has led many to question the conditions under which medical imaging is justified and if the potential harms of imaging exceed the clinical benefits for some indications [1-7]. Mechanisms to reduce potential overutilization of medical imaging include unit-cost reductions, insurance preauthorization, radiology benefits management services, and computerized provider order entry (CPOE) with clinical decision support (CDS) software, among other methods [8,9].

Recent changes in health care policy have encouraged adoption of electronic medical records (EMRs) as well as CPOE with CDS [10,11]. With the passage of the Protecting Access to Medicare Act of 2014, health care providers will be required to consult "appropriate use criteria" using a "qualified decision support mechanism" when

ordering advanced imaging for Medicare patients, beginning in April 2016 [12]. The ACR Appropriateness Criteria[®] (ACR AC) is one such system providing evidence-based, expert-consensus guidelines for imaging examination appropriateness that can be incorporated into CDS to aid providers in utilization decisions [13].

Studies have shown low utilization of the ACR AC by clinical providers in determining what is appropriate image utilization [14], limited ability of medical house staff to choose appropriate imaging examinations [15], and a general reluctance of providers to accept changes suggested by CDS systems [16]. Others have reported that, when properly integrated, CDS can have wide acceptance, improve workflow efficiency, and increase adherence to expert guidelines [11,16-18]. Application of the ACR AC has been reported to reduce low-utility imaging and increase the rate of appropriate imaging in certain outpatient [17-21] and emergency department settings [22].

A 10-year analysis found that CDS can be implemented in the inpatient setting and be widely accepted by providers [11]. However, a large academic institution recently abandoned inpatient CDS use after only 12 months, citing

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problems with integration, provider acceptance, and vendor support [23]. That study did not discuss the effect on overall imaging-request appropriateness, and to our knowledge, no other work has discussed the impact of CDS on the appropriateness of inpatient imaging. To measure the effect of CDS in the inpatient setting, this study evaluates how providers utilize CPOE CDS pull-down menus and the corresponding ACR AC scores generated when requesting advanced imaging. Results from before and after the ACR AC scores were displayed to providers at the time of the request are compared.

METHODS

Our radiology department provides inpatient imaging services for the health system's 800-bed level-1 trauma center and a 200-bed community hospital. After institutional review board approval, all inpatient advanced imaging requests for patients aged >18 years during a continuous 12-month period were extracted for analysis. These requests included nuclear medicine, CT, and MRI examinations. Radiography, ultrasound, and interventional procedure requests were excluded. Patient location, the name of the responsible physician, and all clinical information entered by the provider at the time of order entry was collected. Information relating to medical school graduation and specialty training of the responsible staff physician was extracted from our health system directory.

Because many physicians and physician trainees provide services at both facilities, the environments were not categorized separately. Outpatient requests using the same CPOE portal were excluded, as our intention was to examine only inpatient requests. All inpatient imaging requests during the study were required to be made via the CPOE portal, and no paper or external requests were accepted. House officers and authorized nonphysician providers may submit only those requests prescribed by a licensed staff physician in our inpatient department; these requests were categorized as "proxy requests" and assigned to the supervising staff physician during analysis.

The Radiology CPOE and CDS

Like other CPOE systems [11,17,23], our implementation required the following information: the body part to be imaged, the modality and/or protocol requested, the use of intravenous contrast material if desired, an *International Classification of Diseases-9* code for billing purposes, and a senior staff physician as the prescribing provider. Two optional free-text fields for "history" and "comments" were available. Extensive input was provided by end-users during CPOE development, and the radiology department provides round-the-clock support for CPOE. Educational modules

were incorporated into the EMR orientation, and completion of these was required for all end-users.

Structured data were provided for CDS using pull-down menus for "clinical scenario" and "patient signs and symptoms" directly populated from the ACR AC guidance documents [13]. Options were listed alphabetically without the ability to sort or search the lists, and both provided an "other" option. The optional free-text "history" and "comments" fields did not meet the structured data requirements and could not be processed by CDS to generate an AC score.

A confirmation screen displayed during the intervention period provided a link to the applicable ACR AC guidance document, and regardless of the generated AC score, displayed a selectable list of any potential alternative imaging studies using the provided information. Numeric scores were augmented with text and color using the ACR AC categories of "inappropriate" in red, "uncertain" in yellow, and "appropriate" in green, for scores of 1-3, 4-6, and 7-9, respectively. Requests without an applicable ACR AC guidance document and those for which the modality requested was not present in the corresponding ACR AC guidance document did not generate a score, but were recorded separately, and "no guidelines" was displayed on the confirmation screen.

Study Period and Statistical Analysis

The confirmation screen was not displayed to providers during the 6-month baseline period from October 1, 2011 to March 30, 2012. Providers were required to attest that the confirmation screen was reviewed during the 6-month intervention period from April 1, 2012 to September 30, 2012. Analysis was performed using SAS 9 (SAS Institute, Inc., Cary, North Carolina). Comparisons of CDS-generated AC scores were made using the nonparametric Wilcoxon's rank-sum and Cochran-Armitage trend tests, whereas comparisons for requests lacking sufficient structured information to generate an AC score were made using the standard χ^2 test for proportions. *P* values <.005 were considered significant.

RESULTS

The total number of advanced inpatient imaging requests, requests per month, total inpatient admissions, admissions per month, number of unique responsible staff providers, and percentage of proxy-placed requests were not significantly different between the baseline and intervention periods (Table 1). The majority of requests, 73.1% and 68.9% during the baseline and intervention periods, respectively, were not scored by CDS, owing to missing information in either the "clinical scenario" or the "patient signs and

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