ORIGINAL ARTICLE

Analysis of Low Appropriateness Score Exam Trends in Decision Support–based Radiology Order Entry System

Supriya Gupta, MD[a], Kandace Klein, DO[a], Anand H. Singh, MD[b], James H. Thrall, MD[b]

Abstract

Purpose: Awareness of imaging utilization increased after implementation of Radiology Order Entry with decision support systems (ROE-DS). Our hypothesis is few exams with low Clinical Appropriateness Score (CAS) on ROE-DS are performed. Clinical indications of exams with CAS less than 3 (9-point scale) were re-reviewed and reports analyzed.

Materials and Methods: Structured Query Language–based query retrieved exams with CAS less than 3 in ROE-DS from January 2007 to December 2011. Reasons provided by physicians for ordering these exams and reports of exams performed were analyzed. For each indication, number of exams ordered and performed was calculated. Statistical significance was assessed using Student's t test and χ^2 analysis ($P < .05$).

Results: From 445,984 exams, 12,615 exams (2.8%) had CAS less than 3, and 7,956 exams (63%) were performed. Reasons for ordering of 12,615 low CAS exams were as follows: Requests by physician specialists without further explanation (4,516 = 35.8%), notation of special clinical circumstances (2,877 = 22.8%), requests by nonphysician staff without further explanation (1,383 = 10.9%), absence of suspected finding on previous modality (1,099 = 8.7%), patient preference (737 = 5.8%), and requests based on radiologists' recommendations (706 = 5.6%). Difference between male and female (male < female) preferences for low CAS exams was statistically significant ($P < .01$). Imaging outcome was highest for extremity MRI cases (66.7%; $P < .01$).

Conclusion: Less than 3% of exams ordered had low CAS and about two-thirds of these were performed. Most common indication for ordering these exams was physician specialist request based on opinion of medical necessity without specification. Extremity MRI constituted the highest positive findings for low CAS exams performed.

Key Words: ACR Appropriateness Criteria, decision-based order entry system, low ACR score imaging exams

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INTRODUCTION

Imaging has become a target for cost containment in the evolving health care system in the United States [1], with focus on high-technology, high-cost modalities like CT, MRI, and nuclear medicine [2,3]. To reduce the burden of inappropriate imaging exams, a web-based Radiology Order Entry (ROE) system was introduced in the radiology workflow in our tertiary care center in 2004 as the primary means for requesting and scheduling outpatient diagnostic imaging procedures [4].

Decision support scores based on ACR Appropriateness Criteria (ACR AC) were subsequently added to the system to provide real-time feedback on the requested exam to the ordering clinician [4]. During this study, decision support was available for outpatient CT, MR, and most nuclear medicine examinations, including noninvasive cardiac studies. After selection of a desired imaging exam, clinical information such as the patient's symptoms and working diagnosis could be selected from a prepopulated list customized for that particular exam modality [4]. Radiology Order Entry with decision support systems (ROE-DS) provide a color-coded score suggesting the anticipated diagnostic yield for that exam based on the

[a]Department of Radiology and Imaging, Medical College of Georgia, Augusta, Georgia.

[b]Department of Radiology, Massachusetts General Hospital, and Harvard Medical School, Boston, Massachusetts.

Corresponding author and reprints: Supriya Gupta, MD, Department of Radiology, Medical College of Georgia, 1120 15th street, Augusta, GA, 30912; e-mail: riya10.in@gmail.com.

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presenting signs and symptoms. Scores of 1 to 3 ("red") signify low yield; scores of 4 to 6 ("yellow") signify marginal yield; and scores of 7 to 9 ("green") signify high yield for that exam order [5]. During several years of intensive use, the scores assigned to particular examinations have been modified and adapted based on continuous feedback from practicing clinicians and radiologists [6]. Clinical decision support systems have been proven in multiple systematic controlled studies to enhance physician performance in terms of ordering the appropriate test, including imaging [7–9]. If the system returned a low-yield score, the user could cancel the order, abandon the session, insert additional clinical information, change the requested study to another modality, or proceed with the original order. If the ordering physician chose to proceed with ordering an exam with a score ≤ 3, an explanation was sought but not required to complete the request.

Our hypothesis was that after several years of having the system in place, very few outpatient imaging exams with a low Clinical Appropriateness Score (CAS) on ROE-DS are ordered and performed using the order entry system. We aimed to ascertain the rationale for proceeding with the original order despite a low CAS on DS and to determine the proportion of these exams that were eventually performed. Evaluation of the exam outcomes for presence of findings was performed on a subset of low CAS exams that were surveyed in the study.

MATERIALS AND METHODS

This Health Insurance Portability and Accountability Act–compliant retrospective research was approved by the institutional review board under an expedited protocol for analyzing anonymous aggregated radiology data.

Data Collection

A Structured Query Language–based query was designed to retrieve all outpatient exam orders placed in the ROE database system from January 2007 to December 2011. Exam information such as patient demographics (age, sex), ordering clinical indications (signs, symptoms, diagnosis), decision support scores, and report features (impression, recommendations) were noted and evaluated. The data query was designed and validated to return a single row of data for every unique order instance.

Analysis of Low CAS Exams

Outpatient exam orders with a low decision support score (0-3) were selected, and these exams were analyzed based on patient demographics, reasons for placement of the

requests, and report characteristics. Explanations provided by the ordering physicians for submitting an exam order despite the low CAS were recorded and independently analyzed with subsequent generation and use of descriptive statistical analysis. For each indication, we then calculated the percentage of exams that were performed (calculated as number of exams performed for an indication ÷ number of exams ordered for that indication × 100). Only one reason was associated with each exam.

Patient-Demanded Imaging: Modalities and Outcome Analysis

The low CAS exams with a "patient-demanded" indication were further analyzed for exam modality, patient demographics, medical history, and radiology report findings. The reports were divided into three groups: presence of a clinically significant finding (F+), absence of any finding, and presence of findings that are not clinically relevant to the exam indication. Outcome for performing a patient-demanded exam was then calculated by dividing F+ reports with the total number of exams for each type.

Statistical Analysis

Data were imported into Excel spreadsheets (Microsoft Office Excel 2010; Microsoft, Redmond, Washington, USA) for analysis and statistical evaluation. Values were adjusted for the overall imaging exam orders for the same time period. Statistical significance was measured using Student's t test, and χ^2 analysis was performed to assess the statistical significance of various parameters affecting exam outcomes for low CAS imaging exams using standard software (SAS PROC LOGISTIC, version 9.1; SAS, Cary, North Carolina, USA).

RESULTS

During the designated 5-year period, retrospective analysis of the ROE-DS database generated 445,984 exams with an assigned decision support score. Most of the exams (400,804; 89.8%) had high CAS belonging to the green category, a small percentage had intermediate CAS (32,565; 7.3%) or yellow category, and even smaller number of exams had low CAS or red category (12,615; 2.8%).

Analysis of Low CAS Exams Ordered

Among the 12,615 exams assigned a red score on ROE-DS, 63% (7,956) were performed and 37% (4,659) were canceled. Of the 12,615 exams, 49.9% (6,296) were