Using a Web-Based Application to Enhance Resident Training and Improve Performance On-call

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Rationale and Objectives: It is common practice in academic hospitals for radiology residents to provide preliminary interpretations for radiologic examinations performed in the emergency department (ED) during off-hours. In this study, we used a software program called Minerva to identify and track discrepancies between resident and faculty interpretation of ED studies. The objective was to determine if missed case conferences could reduce the number of resident discrepancies related to the types of cases reviewed.

Materials and Methods: We used Minerva to identify and grade faculty-modified resident preliminary reports as minor or major discrepancies depending on whether the discrepancy had the potential to affect patient management or outcome. Minor and major discrepancy rates were calculated for all residents to evaluate call performance, establish benchmarks, and develop interventions to reduce the number of discrepant cases.

Results: The total discrepancy rate for all residents (n = 22) was 2.6% with a standard deviation (SD) of 0.7%. The average major discrepancy rate for all residents was 1.1% with a SD of 0.4%. Trend analysis of missed cases was used to generate topic-specific resident missed case conferences on acromioclavicular joint separation injuries, elbow joint effusions, and osteochondral fractures, which resulted in an overall 64% decrease in the number of missed cases related to these injuries.

Conclusions: The systematic evaluation of resident discrepancies using a simple software application provides a competency-based metric to assess call performance, establish benchmarks, and develop missed case conferences. This process is expected to result in further reduction in resident discrepancy rates and missed cases.

Key Words: Discrepancies; on-call; residents.

Improving quality and safety in radiology is becoming increasingly important given the dramatic conclusions of the Institute of Medicine's report "To Err is Human," which states that an estimated 100,000 lives per year are lost due to medical errors (1–3). Studies subsequent to the Institute of Medicine's report identify suboptimal radiology processes and the lack of useful outcome data in the radiology literature as contributors to the overwhelming number of medical errors and the associated economic costs, estimated as more than $38 billion annually (2–6). A critical component to improving radiology quality and safety is the process of defining radiology quality metrics and developing the information technology systems to quantify and track quality metrics. Peer review is a methodology used to evaluate radiologist performance with the ultimate goal of reducing errors and improving patient care (3,7). Although many departments have established peer review systems in place for evaluating and reporting radiologist performance, there are few equivalent programs for evaluating and tracking radiology resident performance.

As part of an ongoing quality assurance project, we have developed a database application called Minerva that accesses the Radiology Information System (RIS) database, identifies all preliminary interpretations provided by residents during independent call, and allows grading and tracking of minor and major discrepancies between resident and faculty interpretations. Discrepancy rates were calculated and used as a competency-based metric to evaluate call performance, establish benchmarks, and track trends in discrepant cases. Trend analysis of discrepant cases was used to generate topic-specific resident missed case conferences. The purpose of this study was to determine if residents missed case conferences focusing on specific types of missed cases could reduce the number of missed cases, thereby improving discrepancy rates.

MATERIALS AND METHODS

The Department of Radiology and Medical Informatics Group at the Hospital of the University of Pennsylvania developed a software application called Minerva that uses Structured Query Language (SQL) queries to mine the RIS

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database for preliminary interpretations provided by residents during independent call. Corresponding faculty-reviewed final reports are captured with preliminary interpretations and report text is automatically compared to isolate reports that had been changed by radiology faculty. Custom display screens are used to present preliminary and modified final reports in tandem for review, allowing classification of minor and major discrepancies by the residency program director. Minerva also mines the RIS for other resident performance metrics such as fluoroscopy time, and can calculate report turnaround time for the residents' exams. Discrepancy rates, average fluoroscopy times, and average turnaround times are used to monitor resident performance.

Minerva was designed using Microsoft Access for database functions and Visual Basic for Applications for the graphical user interface and SQL queries. Minerva performs all functions on a duplicated RIS database located on a dedicated radiology server. Study information is stored in seven separate RIS tables linked by a unique internal examination identification and a diagnostic report text identification. Preliminary interpretations provided by residents and fellows on-call are signed out to a generic account called "nightrad," which corresponds to a specific provider identification in one of the RIS tables. Minerva performs a series of Microsoft SQL queries each morning to identify studies containing the nightrad provider identification and collect relevant study information including the unique examination identifications, modality, exam description, subspecialty, date and time of study completion, date and time of preliminary study dictation, patient location (one of several hospital locations), patient type (inpatient or emergency department [ED]), technologist comment, preliminary report, final report, resident name, and attending name. Study information is stored in an Access database for grading and analysis. Microsoft SQL queries are performed after a 48-hour delay to ensure that all reports are finalized by a faculty member.

While study information is transferred to the Access database, Minerva uses a basic text difference engine to compare preliminary and final reports. If the report text was unchanged between preliminary and final versions, Minerva automatically classified the report as "agreement" and excluded these studies from review. Additionally, faculty members reviewing resident interpretations use the RIS e-mail function to send electronic notification (Emtrac notification) to the ED if there is a change to the preliminary interpretation. Minerva tags studies in which the Emtrac notification process was used for priority review. The residency program director (M.H.S.) performed 100% review of the resident interpretations with the Emtrac notification tag. On average, M.H.S. reviews approximately 50 reports in an hour.

To determine if there was a discrepancy between the preliminary and final interpretations for faculty-modified reports, MHS reviewed both reports using Minerva. A minor discrepancy was defined as a discrepancy between preliminary and final reports that did not have the potential to effect patient management with relation to diagnosis, treatment, disposition, or outcome, whereas a major discrepancy had the potential to effect patient management. A comment was added for every discrepancy to facilitate trend analysis, in which the total number for each type of discrepancy was reported at 6- to 12-month intervals.

In this study, Minerva was used to review all ED studies initially interpreted by on-call radiology residents and referred back to the ED for follow-up after faculty interpretation using the Emtrac notification process. Between March 2008 and September 2009, 13,146 radiologic studies performed in the ED were interpreted by radiology residents on-call. Of these studies, Minerva identified 1253 reports in which either the Emtrac notification process was used or the preliminary report was modified. Faculty-modified reports were classified as minor or major discrepancies by MHS according to the modified Radpeer scoring guidelines described previously. All radiology residents had completed at least 1 month of dedicated cardiothoracic, body computed tomography (CT), ultrasound, neuroradiology, and musculoskeletal rotations.

Total, minor, and major discrepancy rates were calculated for all second- and third-year residents taking independent call and used to generate class averages with standard deviations. Overall major discrepancy rates were calculated for each modality and all cases were exported to an access database for further review.

Selected missed cases were prepared by residents as unknowns and presented to the entire residency class during missed case conferences using PowerPoint and an audience response system, with the opportunity for discussion. Trend analysis of discrepant cases was used to generate topic-specific missed case conferences reviewing acromioclavicular (AC) joint separation injuries, osteochondral fractures of the ankle and knee, and elbow joint effusions. These three topics were selected because all three injuries represented major discrepancies and six to eight misses for each type of injury were identified over the preceding 8-month period, which was more than any other type of discrepancy. The total number of discrepant cases related to these topics during the 8 months preceding the missed case conferences was compared to the total number of discrepant cases during the 8 months after the missed case conferences.

RESULTS

Radiology residents in their second year of training (postgraduate year 3 [PGY-3], $n = 12$) were responsible for interpreting 6968 studies between March 2008 and September 2009. The Emtrac notification process was used for 233 of the 6968 reports with program director review resulting in 107 minor discrepancies and 78 major discrepancies. The total discrepancy rate (minor plus major) for PGY-3 residents was 2.7% with a standard deviation (SD) of 0.7%. The average minor discrepancy rate was 1.5% with a SD of 0.6%. The average major discrepancy rate was 1.1% with a SD of 0.3%. Radiology residents in their third year of training (postgraduate