Do Telephone Call Interruptions Have an Impact on Radiology Resident Diagnostic Accuracy?

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Rationale and Objectives: The purpose of this study was to measure the effect of distractions, in the form of telephone call interruptions, on radiology resident diagnostic accuracy.

Materials and Methods: Radiology resident discrepancy reports and reading room telephone logs at an academic tertiary care pediatric hospital were collected over a 13-month period. Phone call times and durations were recorded. Major discrepancy shifts (defined as a call shift where at least one major discrepancy was discovered the following morning by the attending radiologist between the resident preliminary and attending final reports), and dictation time stamps for each discrepant preliminary dictation were also recorded. Telephone call volume and preliminary report time stamps were compared between "discrepancy shifts" and "no discrepancy shifts."

Results: Each call shift spanned 14 hours, during which one radiology resident was responsible for the generation of preliminary interpretations. Review of the discrepancy log data revealed 51 major discrepancies in 41 shifts, of which 39 discrepancies had documented error details and resident preliminary report time stamps. The average number of telephone calls for the "discrepancy shifts" was slightly greater than the "no discrepancy shifts" (48.59 vs. 44.02) but was not statistically significant ($P = .0575$). However, there was a statistically significant increase in the average number of phone calls in the 1 hour preceding the generation of a discrepant preliminary report versus the "no discrepancy shifts" (4.23 vs. 3.24 calls, $P = .027$). One additional phone call during the hour preceding the generation of a discrepant preliminary report resulted in a 12% increased likelihood of a resident error ($P = .017$).

Conclusions: Distractions in the form of telephone call interruptions may negatively impact on-call radiology resident diagnostic accuracy. Efforts should be made to limit distractions in the reading room.

Key Words: Interruptions; diagnostic accuracy; patient safety.

At many academic institutions, diagnostic radiology residents are often the sole practitioner responsible for after-hour radiology coverage, generating preliminary interpretations of examinations that are later reviewed and finalized by the attending radiologist. Radiology resident on-call responsibilities often require the ability to multitask, toggling between medical functions (interpreting examinations, interacting with consulting physicians and technologists, and consenting patients) and nonmedical functions (answering telephone calls and returning pages). The shifting of focus between multiple tasks has the potential to alter the resident's mind-set with the potential for the introduction of medical errors.

Research and experience in complex "knowledge-intensive service environments" have shown that interruptions in workflow create inefficiencies, introduce barriers to productivity, and can contribute to errors (1). This is also true of the medical environment, a highly complex, cognitive-rich, service environment, with a great deal of attention and effort directed toward patient safety initiatives and health care system accountability (2–6). Prior research has linked interruptions with errors in the laboratory setting (7,8) and clinical setting and the effect of interruptions on patient safety and workplace stress (3–6,9–14).

Yu et al. (15) recently described their institutional experience with on-call radiologist workflow disruptions in the form of telephone call interruptions. Their results clearly demonstrated a high rate of significant workflow interruptions and, thus, the introduction of a potential root cause for medical errors. However, the effect of these interruptions on diagnostic performance could not be determined because

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of the relative lack of major discrepancies by their attending radiologists. To our knowledge, there have been no prior studies investigating the effect of interruptions on radiologist diagnostic accuracy, let alone radiology resident performance. Therefore, the purpose of this study was to measure the effect of distractions, in the form of telephone call interruptions, on radiology resident diagnostic accuracy.

MATERIALS AND METHODS

This study protocol was reviewed and approved by our institutional review board and waived requirement for informed consent.

Data Collection

During the study period, there was a single on-call resident on duty from 6 PM to 8 AM. The faculty radiologist was absent but available for consultation during this period. All residents were in their third or fourth year of radiology residency training.

The telephone log metadata from nine unique telephone extensions in a pediatric radiology reading room at a tertiary care pediatric hospital, spanning a total of 393 days (April 2, 2012, to April 29, 2013), were collected from the hospital telecommunications center. Telephone call data from 6 PM to 8 AM the following morning were recorded; however, the data spanning from 8 AM to 6 PM were not collected as there was a faculty pediatric radiologist in house during that time. Telephone call start time, end time, and call duration for both incoming and outgoing telephone calls were collected. No telephone call content or recordings were collected.

On-call radiology resident preliminary reports were generated using a voice recognition system (PowerScribe; Nuance Communications Inc, Burlington, MA). Resident preliminary interpretation discrepancy logs were maintained for internal quality control and educational purposes. Each morning, major discrepancies, defined as a change in resident preliminary interpretation requiring direct communication to the ordering physician to document the change in final diagnosis, were entered into the discrepancy log. Minor discrepancies, defined as resident preliminary results that were not felt to alter patient management and were not communicated to the ordering physician, were not included in the discrepancy log. Data entered into the discrepancy log included date of the examination, type of examination, patient medical record number (MRN), and a brief description of the nature of the discrepancy. If there were no major discrepancies encountered during that shift, then the attending radiologist indicated so in the discrepancy log. The examination date and patient MRN were then used to identify the resident preliminary report and dictation time stamp in the picture archiving and communications system (PACS).

Data Analysis

The total number of calls during the study period, the total number of phone calls per shift, the total number of calls for each 1-hour block of time, and the total number of calls in the 1 hour preceding each discrepancy were recorded. The total number of calls during "discrepancy shifts" (defined as a call shift where at least one major discrepancy was discovered by the attending radiologist the following morning) was compared to the total number of calls during the "no discrepancy shifts" using the two-sample *t* test. A linear mixed-effects model was also used to compare the number of calls in the 60 minutes preceding the generation of a discrepant report with the number of calls during the 60-minute periods preceding the hour without discrepancy with each resident treated as a random effect. For these 1-hour "no discrepancy" periods, we used each 1-hour period during shifts when no discrepancies were reported (eg, 6–7 PM, 7–8 PM, and so forth). In summary, we fitted a generalized linear mixed-effects model with each resident treated as a random effect.

RESULTS

Discrepancy log entries were available for 338 shifts of the total 393 study periods (86% of shifts); the remaining 55 days had no entries in the discrepancy log and were therefore excluded from our study. There were a total of 15,504 resident preliminary reports (average of 45.9 preliminary reports per shift) resulting in 51 major discrepancies (discrepancy rate of 0.33%) during 41 total shifts (12.1% of shifts or one major discrepancy every 8.24 shifts). However, the details describing 12 of the 51 discrepancies (including a description of the error and/or the resident preliminary report time stamp) were not available and were therefore excluded from analysis. The resulting 39 major discrepancies during 33 shifts included 28 radiographs (Fig 1), eight computed tomography scans (Fig 2), and three ultrasound examinations. There were no MRI discrepancies as these examinations are primarily of the central nervous system, which are previewed by the resident but then contemporaneously reviewed and finalized by the on-call neuroradiologist. A breakdown of the total number of discrepancies by imaging modality and body region can be seen in Table 1. The most frequently encountered discrepancies were extremity fractures ($N = 8$), chest infection ($N = 5$), and pneumothorax ($N = 5$). Most discrepancies ($N = 21$ or 53.8%) occurred during the first half of the call shift (7 PM–12 AM) and an additional 10 discrepancies (25.6%) occurred during the last few hours of the shift (4–7 AM) as seen in Figure 3.

During the study period and on-call time, there were a total of 14,950 phone calls, with an average of 44.2 phone calls per shift or 3.16 calls per hour. The average telephone call length was 114.9 seconds (range, 1–2949 seconds). A total of 7875 (54.0%) phone calls were ≤1 minute, 10,867 (74.6%) phone calls were ≤2 minutes, and 13,360 (91.7%) phone calls were ≤5 minutes. Only 452 phone calls (3.1%) were ≥10 minutes.

The total number of calls for shifts with known discrepancies ($n = 41$) versus the number of calls for shifts without discrepancies ($n = 297$) were then compared. There