Reporting of Critical Findings in Neuroradiology

Valentina G. Viertel1
Stacey A. Trotter
Lukasz S. Babiarz
Fatma Alluwaimi
Paul G. Nagy
Jonathan S. Lewin
David M. Yousem

OBJECTIVE. The objective of our study was to assess compliance among academic neuroradiologists in reporting institutionally derived critical findings.

MATERIALS AND METHODS. We analyzed 3054 neuroradiology CT and MRI reports generated in 1 month. Reports were categorized by whether or not they contained a critical finding based on a previously established list. The reports were subcategorized by whether the reporting neuroradiologist flagged the report as containing a critical finding and whether the radiologist verbally communicated the critical finding to the referring clinician. Reports were divided into day or night categories and the frequency of critical findings for each time period was calculated.

RESULTS. Of the 3054 reports included in this study, 301 (9.9%) had critical findings. Of those 301 reports, 233 (77.4%) were flagged and the referring clinician was called. Of the remaining 68 reports with critical findings, the reporting radiologist did not call the clinician about 35.3% of them (24/68). Of the 2735 reports without critical findings, 2658 (96.5%) were appropriately not flagged and the clinician was not called. However, radiologists called clinicians about 3.5% (95/2735) of the reports without critical findings and erroneously flagged 68.4% (65/95) of those reports as critical. A majority of the cases with critical findings were reported at night (55.1%) despite the fact that 67.2% of the studies occurred during the day.

CONCLUSION. Compliance with reporting and communicating critical findings must be monitored. Calling clinicians to report noncritical findings may result in unnecessary interruptions in work flow for radiologists and referring health care providers.
Materials and Methods

Every CT and MRI report generated by the neuroradiology division at a university hospital over the course of 1 month was reviewed under the goals of this study. The first report was dated January 1, 2011, and the last report was dated January 31, 2011; 3054 reports were included in the study. Single reports that included multiple studies of the same patient were reviewed, grouped together, and counted as a single entry (e.g., a report of cervical, thoracic, and lumbar spine CT).

The data-compiling system had several steps: First, an individual report derived from the list of studies reported during the study period was identified by patient medical record number, the date and time of the study or studies, and type of examination or examinations. The report was read by trained student reviewers or radiologists who determined whether a condition from the institutionally derived 2004 critical findings list (Table 1) had been reported. The reviewer then checked for evidence that the reporting radiologist applied a critical findings macro in the speech recognition dictation software program, which we refer to as having “flagged” the report, as all radiologists on the neuroradiology service had been instructed. This macro is labeled to allow radiology information system queries as part of a safety monitoring initiative within the department. This macro reads as follows:

**THIS REPORT CONTAINS FINDINGS THAT MAY BE CRITICAL TO PATIENT CARE. The findings were discussed with (Physician Name) at (time) hours on (date).**

Thus, for each case, the presence or absence of a critical finding, whether the radiologist applied the critical findings macro (flag), and whether the radiologist verbally notified the referring clinician were assessed.

 Mishandled reports therefore could be reports that did not contain a critical finding but the radiologist had flagged the report as critical, had called the referring clinician, or had both flagged the report and called the clinician and could be reports that contained a critical finding but the radiologist had not flagged the report, had not called the clinician, or had failed to both flag the report and call the clinician.

We also determined the time of day or night a study was reported and the rate at which the critical findings macro was used: 12,607 neuroradiology studies reported over a 2-month period were compiled, a 1-month extension was applied to the original end date to increase the number of included reports for the purpose of significance calculations. The reports were separated into “daytime” reports, defined as between 7:30 am and 4:59 pm, and “nighttime” reports, defined as between 5:00 pm and 7:29 am. The time stamp used for this analysis was the time stamp applied when the referring physician was contacted not when the study was performed. Thus, a study performed at 4:30 pm but read and called in at 5:15 pm would be classified as a nighttime report (between 5:00 pm and 7:29 am). In five cases, this information was not included in the body of the report and thus these cases were not analyzed for this portion of our study.

A grading system was used to evaluate the degree of severity of the critical findings by time of day or night retrospectively for the purposes of this study. This grading system was based on previously published work performed at the Brigham and Women’s Hospital [3]. Grade 1 findings were considered immediately life threatening. Grade 2 findings were not considered immediately life threatening but were believed to require urgent action to prevent further morbidity. Grade 3 findings were deemed not to pose a serious health hazard in the short term. Categorization of the critical findings into one of the three grades was based on an internal poll of neuroradiology faculty (n = 11) at our academic institution.

We compared the number of grade 1, grade 2, and grade 3 critical findings reported during the day and night shifts. We also identified the top critical findings categories and assessed for a difference in occurrence during day vs night shifts. Because of large sample sizes, when comparing the total number of critical findings seen during day and night, we used the chi-square test with Yates correction. For all other analyses, we used the Fisher exact test to look for statistical significance. We computed 95% CIs for the top five critical findings categories. In all analyses, significant differences were rated as p < 0.05.

In accordance with the HIPAA, our institutional review board reviewed and approved the protocol for this retrospective study and waived the requirement for informed consent.

Results

Of the 3054 reports included in this study, 301 (9.9%) had critical findings and the remaining 2753 (90.1%) did not. Of the 301 reports with critical findings, 233 (77.4%) were flagged with the critical findings macro and the appropriate HCP was called. There were no instances in which a study was flagged as critical but the referring physician or his or her designee was not called. Of the 68 reports with critical findings that were not flagged, 64.7% (44/68) elicited a physician notification call and 35.3% (24/68) (inappropriately) did not. Therefore, clinicians were notified verbally about 277 of the 301 (92.0%) critical findings.

For the 2753 reports without critical findings, 2658 (96.5%) appropriately were not flagged and clinicians were not called. However, clinicians were called about 3.5% (95/2753) of the reports without critical findings and 68.4% (65/95) of those reports were inappropriately flagged as “critical” (Table 2).

These results indicate that neuroradiologists followed the protocol—that is, they used the list to determine which reports to flag and which reports had findings that required a phone call to the referring clinician—in 94.7% (2891/3054) of the cases. One hundred sixty-three cases were not handled according to the protocol. In 133 of the 163 mishandled cases (81.6%), the error related to whether the finding was considered critical or
not. Of these 133 reports, 51.1% (68/133) had findings from the critical findings list that the reporting radiologist neither flagged nor verbally communicated to the referring clinician. However, every time a radiologist decided a finding was critical enough to flag, a clinician was called. The other 65 reports (48.9%) contained a critical findings macro (flagged) and clinicians had been notified, but the reports did not contain a finding from the approved list. In 30 of the 163 mishandled cases, clinicians were called about noncritical findings and the macro was not used. Figure 1 details frequency data for reporting behavior.

Nonideal, but nondangerous, instances included cases with noncritical findings that were flagged by the reporting radiologist, were verbally communicated to the referring clinician, or both and cases with critical findings that were not flagged by the reporting radiologist, although the reporting radiologist had called the referring clinician. Potentially dangerous situations are cases with critical findings that were neither flagged nor verbally communicated to the referring clinician. Nonideal situations occurred in 4.6% (139/3054) of all cases and potentially dangerous situations occurred in 0.8% (24/3054) of all cases (Fig. 2).

**Frequency of Critical Findings According to Time**

Of the 12,607 neuroradiology reports generated over the 2-month time interval, 8467 (67.2%) were submitted during the day and 4140 (32.8%) submitted during the night. However, a majority of the 866 cases with critical findings (477/866, 55.1%) were reported on the night shift (Fig. 3). The remaining cases with critical findings were reported during the day (389/866, 44.9%).

During the day shift, the top five reported critical findings differed from those reported during the night shift (Table 3). The top two most common critical findings were the same during the day and at night, hemorrhage and stroke, but more cases of both were seen at night (not statistically significant). Only the number of new or enlarging masses showed a statistically significant difference between the two shifts (p = 0.027), with a greater number being seen during daytime.

**Severity Index**

Grade 3 (least severe) findings were reported more frequently at night (37/56, 66.1%; 95% CI, 53.4–78.7) than during normal daytime hours (19/56, 33.9%; 95% CI, 21.3–46.6); however, this difference was not statistically significant (p = 0.09). Grade 2 findings (intermediate severity) occurred slightly more frequently at night (29/53, 54.7%; 95% CI, 41.0–68.4) than during the day (24/53, 45.3%; 95% CI, 31.6–59.0), but this difference was not statistically significant (p = 1.0). Grade 1 (most severe) findings were also reported slightly more frequently on the night shift (41/757, 54.3%; 95% CI, 50.7–57.9) than on the day shift (346/757, 45.7%; 95% CI, 42.1–49.3) (p = 0.2).

**Discussion**

Our review of 3054 neuroradiology CT and MRI studies shows that reporting radiol-

### TABLE 2: Radiologists’ Actions With Respect to Reporting Critical and Noncritical Findings

<table>
<thead>
<tr>
<th>Reports</th>
<th>Radiologists’ Actions</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flagged Report and Called HCP</td>
<td>Did Not Flag Report and Called HCP</td>
</tr>
<tr>
<td></td>
<td>No. (%)</td>
<td>233 (77.4)</td>
</tr>
<tr>
<td>% Overall</td>
<td>73.6</td>
<td>0</td>
</tr>
<tr>
<td>No. (%)</td>
<td>65 (2.3)</td>
<td>0</td>
</tr>
<tr>
<td>% Overall</td>
<td>2.13</td>
<td>0</td>
</tr>
<tr>
<td>All reports</td>
<td>250 (8.6)</td>
<td>0</td>
</tr>
</tbody>
</table>

Note—HCP = health care provider.
Reporting Critical Neuroradiologic Findings

The American College of Radiology (ACR) [4] has developed detailed communication guidelines to assist in the provision of patient care by radiologists. These guidelines include measures for “situations that may require nonroutine communication”; see section 2.C.2.a of the guideline [4] on the discovery of critical, unexpected, or discrepant findings. For critical findings in particular, the ACR offers suggestions as to what may constitute a critical finding (e.g., a pneumothorax or misplaced catheter) and also encourages expediting the delivery of such reports. These guiding principles were put in place to improve patient outcomes and were also prompted by malpractice lawsuits against physicians who did not properly communicate urgent findings, often communicating urgent findings in a delayed fashion [5]. One option suggested for improving work flow in communicating critical findings is the adoption of surrogates for communicating critical findings to clinicians. Previous studies have shown that the use of surrogates saves radiologists 2–3 hours a day, which would in turn produce faster turnaround of reports [6].

The development of a critical findings list is the first step in ensuring that the Joint Commission’s Safety Goal 2C [1] is properly followed. Health care institutions across the United States are accomplishing this goal in a variety of ways. For example, Cincinnati Children’s Hospital considers any finding requiring direct and immediate communication to the referring physician a critical finding. This policy allows radiologists to use their judgment about what constitutes a critical finding, which may vary from physician to physician [6]. The Department of Radiology at Brigham & Women’s Hospital has classified findings into levels of urgency for care by radiologists. These guidelines include measures for “situations that may require nonroutine communication”; see section 2.C.2.a of the guideline [4] on the discovery of critical, unexpected, or discrepant findings. For critical findings in particular, the ACR offers suggestions as to what may constitute a critical finding (e.g., a pneumothorax or misplaced catheter) and also encourages expediting the delivery of such reports. These guiding principles were put in place to improve patient outcomes and were also prompted by malpractice lawsuits against physicians who did not properly communicate urgent findings, often communicating urgent findings in a delayed fashion [5]. One option suggested for improving work flow in communicating critical findings is the adoption of surrogates for communicating critical findings to clinicians. Previous studies have shown that the use of surrogates saves radiologists 2–3 hours a day, which would in turn produce faster turnaround of reports [6].

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The Joint Commission’s National Patient Safety Goal Requirement 2C [1] focuses on the importance of the communication of critical findings by reporting physicians to referring physicians in a timely manner. The goal of this policy is to create expectations for health care organizations with the prospect of preventing mistakes and unfavorable patient health consequences. Facilities are expected to both develop and implement methods for communicating critical findings, which include defining the term “critical finding” as well as deciding on acceptable methods of communication and the sense of urgency that must accompany such communication.

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proportion—was 94.7%. Potentially dangerous situations in which critical findings were not directly communicated to the clinical team occurred in 0.8% (24/3054) of all cases.

As our analysis proceeded, it became apparent that the types of critical findings varied by the time of day. One third of all neuroradiology studies were performed at night; however, most of the critical findings were flagged during this lower volume time period. Additionally, the top ranked diagnoses varied by time of day. At night, new hemorrhage, new stroke, and fracture dominated as the most common diagnoses, whereas studies performed by day ranked new stroke, new hemorrhage, and new mass as the top three, respectively.

Finally, we found that reporting radiologists called clinicians about low-severity findings with higher frequency at night compared with during the day. The exact cause of this phenomenon is not known. During the overnight shift at our institution, a fellow or resident is responsible for interpreting neuroradiology studies and providing preliminary reports. On-duty fellows and residents may call the attending radiologist at home for backup at their discretion. One hypothesis for the increased frequency of calls to clinicians about low-severity findings at night may be a lack of confidence and lower experience level of the junior radiologist [7–10]. This hypothesis argues for the adoption of department-specific lists of critical findings to assist radiologists-in-training about when it is appropriate to interrupt workflow for the delivery of such results.

The results of our study have several important implications for our initiative to improve patient care. First, the critical findings list should be assessed intermittently for revision to foster compliance with the policy. When actual practice and doctrine differ, it suggests the list must be revised. One source of noncompliance with our critical findings policy is that findings not on the approved critical findings list are being directly communicated to HCPs. Departmental review with clinicians of the findings that are causing this type of situation (e.g., maxillofacial fractures) would be beneficial to reach an agreement about whether urgent communication is necessary; we investigated this topic in a companion study. Although the implications for patient care may be less dramatic if a clinician is frequently called about noncritical findings, the disruptions in workflow for both radiologists and clinicians in the setting of overcalling can have consequences. The fable of “The Boy Who Cried Wolf” may be at play if too many minor findings are phoned to referring physicians. Callback rates on pages to clinicians could suffer if they believe they are being “nuisance-called.”

The use of a random sample of 1 month was one of the limitations of our study. The month that was chosen, January, may have affected the results because of the icy and thus dangerous conditions of the city where this study took place. The city where this hospital is located has a high rate of violent crime, ranked eighth highest among U.S. cities according to a 2011 U.S. News & World Report article [11], so violence-related critical findings occur frequently. In addition, the hospital admits patients from all over the world who seek specialized care available only at a large university medical center. These patients will present with particularly challenging and complex cases, which, in turn, leads to a greater need for direct communication with HCPs. A second potential limitation of this study is that some of the more junior residents who take night call and do not receive immediate feedback from the attending physician may be less confident and believe that more communication is better than less. This belief may lead to overcalling in an attempt to be “better safe, than sorry.” The types of cases that come to the hospital also vary by the time of day, which undoubtedly biases the breakdown of critical findings by time period. Higher acuity and trauma cases at night likely account for the increased incidence of fractures at night, and neurosurgery clinic hours for brain tumors likely account for the increased incidence of masses during the day.

Another issue to consider is that more experienced radiologists would rather trust their professional reasoning and judgment than refer to a list. The list was created so that variations in professional judgment would not harm patients or lead referring clinicians to make wrong assumptions about which findings will or will not be reported to them urgently. A critical findings list that has been approved by all services ensures that “everyone is on the same page.” With regard to the application of the critical findings list used in this study, we should note that what may be appropriate for a tertiary care level one trauma center at an academic hospital may not be relevant for community practice.

Conclusion

The creation of a critical findings list is the first step toward better HCP communication standards, and compliance with a critical findings list is crucial to ensure high-quality patient care. Compliance with such a list leads to more homogeneous communication across all members of the neuroradiology service and allows clinicians to confidently rely on the division to notify them when appropriate. Reporting neuroradiologists complied with the critical findings policy in nearly 95% of cases surveyed.
However, physician judgment about what constitutes a critical finding supersedes any such list because clinical scenarios are highly variable from patient to patient. The amount of time required to communicate findings directly to HCPs is substantial and decreases the work efficiency of both the radiologist and the receiving party. Nevertheless, the effectiveness of a critical findings list relies on physician compliance and thoughtful revision of the list based on practice realities.

References
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