Dark is the night (or how fatigue increases errors in abdominal CT reports).

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Purpose

Treatment decisions often rely heavily on the reports of abdominal CT examinations, so these reports have a tremendous impact on the wellbeing of our patients. The process of interpreting medical images is complex, so it is no surprise that errors in interpretation are common and have been noted since the early days of radiology.

Fatigue and excessive workloads are well-established sources of human error.

We analyzed the errors rates and the severity of errors in relation to the time the report was elaborated and the amount of work done prior to elaborating the report.
Methods and Materials

Background.

At our diagnostic center, calls cover imaging at our 500-bed university hospital serving 420,000 inhabitants as well as emergency CT examinations at diverse remote hospitals through teleradiology (9 hospitals covering more than 800,000 inhabitants). Thus, we provide services for a total of more than 1700 hospital beds). Our radiology department is organized by organ/systems. Residents receive training in each area of subspecialization through rotations in the different units dedicated to specific organ/systems.

Our system for emergency calls involves one attending radiologist and two residents: one senior (third- or fourth-year) resident and one junior (first- or second-year) resident. On weekends and holidays, radiology calls are divided into two time frames. In the first, (9 a.m. - 9 p.m.), attending radiologists are present onsite. In the second (9 p.m. - 9a.m.), attending radiologists are available for teleradiology support. On certain days, residents work independently on 24-hour calls with support available from attending radiologists by teleradiology.

On the days when residents work independently on 24-hour calls, all examination are evaluated by the senior resident before delivery.

In a previous study presented at the ECR 2010, our group assessed the correlation between the interpretation of urgent abdominal CT examinations by radiology residents and the posterior interpretation of these examinations by abdominal radiologists. The results of that study showed that the rate of discrepancy at our center (3.8%) was similar to the rates reported in previous studies at other centers.

On the first regular working day after a call, attending radiologists review the CT examinations and reports done during the call for their organ/system first thing in the morning with the resident who is finishing the call. If any corrections are made, an additional report is generated. If the correction necessitates a change in the management of the patient, a revised report is sent to the attending clinician.

Methods and materials.

This is an observational (descriptive) cross sectional study.
We reviewed the reports of emergency abdominal CT examinations elaborated by residents during weekend and holiday calls in which the residents work independently on 24-hour calls between 1/1/2008 and 12/31/2010 and the corrections to these reports by attending abdominal radiologists.

We excluded any report in which an attending radiology might have taken part.

A total of 73 twenty-four-hour calls with 3294 examinations reported met the inclusion criteria. 558 of the 3294 (17%) were abdominal CT reports. (Fig. 1)

Errors.

Each additional report generated by an attending radiologist is considered an error. We analyzed the errors from two points of view:

A. Severity.

We classified errors in three groups (in function of their potential rather than actual consequences).

- No error or unimportant: no error or findings that had very little or no effect on patient management.

- Important but not urgent: important findings that did not involve changes to immediate management.

- Important and urgent: findings that could potentially involve changes to immediate management.

B. Type. (Fig. 2)

- Errors of perception: in which a finding was missed (e.g., failure to see active bleeding) or a reported finding was not present (e.g., identifying a fracture when none was present).

- Errors of interpretation: in which the pathologic finding was correctly identified but interpretation led to an erroneous conclusion (e.g., identifying a hypodense liver lesion and concluding it is a cyst when the radiologic signs point to metastasis).
Error of transcription: in which perception and interpretation were correct but the information was not transcribed correctly to the report (e.g., reporting a lesion in the left lung when it is actually in the right).

Errors types were also subclassified within each group, for example, false-positive or false-negative.

Workload.

To assess the workloads, each examination reported during the call was assigned a workload value (denoting the time required to interpret the examination) determined on the basis of the standards set by the Spanish Society of Medical Radiology (SERAM).

The workload up to the time of each report was calculated by adding together the time accumulated in reporting each prior examination during the call in chronological order. (Fig. 3)
**Fig. 1:** A total of 73 twenty-four-hour calls with 3294 examinations reported met the inclusion criteria. 558 of the 3294 (17%) were abdominal CT reports.
A 70-year-old patient with abdominal pain and clinical suspicion of appendicitis. The resident-on-call reported small bowel dilation without identifying a mechanical cause; the attending abdominal radiologist corrected the report to intestinal ischemia (dilated loops with diminished contrast uptake in the wall).

This was considered an important and urgent error of interpretation.

A 65-year-old man with a history of cryptogenic cirrhosis and diabetes examined for abdominal pain and clinical suspicion of pancreatitis. The nearly 3-cm-long calcified aneurysm (†) of the splenic artery was not identified. Although this error is not important for the initial management of his acute condition, it is an important finding.

Important but not urgent error of perception.

**Fig. 2:** Error classification examples.

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Fig. 3: Workload.

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Results

**Hypotheses.**

The rate of errors in abdominal CT reports elaborated by residents on call (as determined by posterior review by attending abdominal radiologists) would increase with fatigue.

- The rate of errors in abdominal CT reports elaborated by residents on call would be higher at night than during the day.

- The rate of errors in abdominal CT reports elaborated by residents on call would increase with increased accumulated workload.

**Results.**

69 of 558 (12.3%) abdominal CT reports had errors. 55% were errors of perception. More than half of these errors were false-negative. (Fig. 4, Fig. 9)

There were no false-positives in the last 7 hours on call, but the rate of important and urgent errors is almost 3 times higher. (Fig. 5, Fig. 6)

We found no statistical relation between the accumulated workload at the time of reporting and the rate of errors, regardless of whether the data were analyzed independently or together with the time frame of the call. (Fig. 7)

When we compared the errors rate for the reports of examinations performed at our center with the rate for those performed at other centers and interpreted by teleradiology, we found that the rate of errors that could potentially involve changes to the management of the patient was higher in examinations performed at our center. This difference were no statistically significant. (p= 0.07) (Fig. 8)

The fact that no radiologist is physically present in te centers we serve via teleradiology means that other techniques like abdominal ultrasonography are unavailable and thus urgent abdominal CT examinations are indicated in different circumstances than at our center.
As a result, the complexity of the urgent abdominal CT examinations performed onsite at our center is probably higher than of those performed in other centers that we serve by teleradiology.

*Study limitations.*

We could only study the errors reflected in the additional reports generated by the attending abdominal radiologists.

The qualitative aspects of the reports done during the calls, such as the complexity and type of examination, which no doubt contribute to fatigue and stress, have not been evaluated.

We were unable to ascertain the effects of the errors on the management and outcome of the patients for whom an additional report was generated, basically in the cases reported by teleradiology.
Fig. 4: Results. 69 of 558 (12.3%) abdominal CT reports had errors. (3.9% important and urgent errors)
**Fig. 5:** Results. In the last 7h on call, the rate of important and urgent errors is almost 3 times higher.

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**Fig. 6:** Results. In the last 7h on call, the rate of important and urgent errors is almost 3 times higher.

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Fig. 7: Results. Percentage of errors by workload.

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**Fig. 8:** We found that the errors that could potentially involve changes to the management of the patient was higher in examinations performed at our center.

<table>
<thead>
<tr>
<th>Category</th>
<th>Our center</th>
<th>Teleradiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>No error or not important</td>
<td>242 (92.4%)</td>
<td>272 (93.4%)</td>
</tr>
<tr>
<td>Important not urgent</td>
<td>5 (1.9%)</td>
<td>10 (3.4%)</td>
</tr>
<tr>
<td>Important and urgent</td>
<td>15 (5.7%)</td>
<td>7 (2.4%)</td>
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</tbody>
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(p=0.07)

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Fig. 9: Results. Type of error.

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Conclusion

Errors are more common in abdominal CT reports done later in the night.

We found no relation between the rate of errors in the reports of abdominal CT examinations and the accumulated workload prior to the elaboration of the report. It is likely that the rate of errors is influenced more by the intensity of the workload at the moment of elaborating the report than by the number of examinations that were reported prior to this moment. Further studies should address this point.

As some authors suggest: "we cannot change the human condition, but we can change the conditions under which humans work." On 24-hour calls reports done late at night are more prone to errors, regardless of the accumulated prior workload. Thus, examinations should not be done late at night unless they cannot be delayed until the next morning.
References


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