Impact on patient care of discordance in radiology readings between external overnight radiology services and staff radiology readings at a level 1 trauma center

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Abstract

BACKGROUND: Overnight radiology services (ORSs) provide computed tomography (CT) scan readings that are automatically reviewed by staff radiologists (SRs) and the trauma service. Discordant readings and their clinical significance were investigated. 

METHODS: ORS-read CT scans over 3 years were reviewed. A discordant reading was clinically significant if it resulted in a substantive change in patient care. All clinically significant findings were reviewed by a blinded radiologist.

RESULTS: Five hundred thirty-four CT scans were identified: 191 (35.8%) head, 187 (35%) cervical, 66 (12.4%) chest, and 90 (16.9%) abdomen/pelvis scans. One hundred twenty-three scans (23%) were abnormal with a DR of 16%: 5 head, 2 cervical, 7 chest, and 6 abdomen/pelvis scans. Seven (6%) scans had clinically significant findings missed: 3 head and 4 abdomen/pelvis scans. ORSs missed 7, and SRs missed 3 clinically significant findings. A blinded radiologist confirmed the clinically significant findings.

CONCLUSIONS: The discordant rate of readings for abnormal CT scans was 16% with 37% considered to be clinically significant. ORSs missed 100%, and 29% of the clinically significant findings were identified after SR/trauma service rounds. SR/trauma service review of ORS readings is supported.

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Since the 1990s, teleradiology services have been used by many emergency departments to provide preliminary interpretations on diagnostic images including computed tomography (CT) scans, x-rays, and magnetic resonance imaging (MRI) for overnight emergency and trauma patients. With US-licensed radiologists stationed throughout the nation and overseas, these teleradiology firms were able to maximize the time zone difference and provide 24/7 coverage to many institutions. Their ability to provide overnight coverage, or “nighthawking,” was their main appeal. They rapidly became the solution for many hospitals struggling with the economic burden of staffing an overnight shift with potentially sleep-deprived radiologists. These teleradiology firms currently provide overnight coverage for more than 1,500 US emergency departments.

Despite their popularity, there are no studies comparing the error rate of preliminary readings of external overnight radiology services (ORSs) with in-house attending...
radiologists. Research has shown that the error rate of radiology residents to attending radiologists varies from 2% to 20%.2 The highest error rates occurred for CT scans and MRIs.3 However, to our knowledge, there have been no reviews specific to the reliability of attending radiologist readings. Specifically, there are no studies concerning the error rates of those performed by ORSs.

Overnight readings of CT scans are provided by an external teleradiology service at our level 1 trauma center. They are then reviewed by a staff radiologist (SR) the following morning during trauma-radiology rounds. CT scans that have only been read by the overnight service and those with discordant readings between the overnight service and our SRs are reviewed. The reading provided by the attending radiologist with the consultation of the traumatologist during these rounds is considered to be final.

We designed a study to determine the discordance rate and its significance to clinical care between the external overnight radiologists and our trauma-radiology rounds. Although mandatory rereads of overnight service–read films are common, our radiology rounds policy is not standard in all teaching hospitals or trauma centers.4 We postulated that the clinical decisions made based on the preliminary readings provided by the external radiologists do not significantly compromise the immediate care provided for our trauma patients. We also postulated that our trauma-radiology rounds review was not necessary for patient safety.

Methods

A power analysis using the published discordance rates comparing radiology resident reads with attending rereads and a significant difference of 5% required 500 CT scans.5 We retrospectively identified ORS-read trauma CT scans over a continuous timeframe from May 4, 2007, to March 21, 2010. The medical records of patients 18 years of age or older who were admitted to or on the consult service of the trauma team who had a CT scan of the head, C-spine, thorax, and/or abdomen/pelvis performed between the hours of 2200 and 0600 were abstracted. All CT examinations performed between those hours interpreted by radiologists from an external overnight service were eligible for review.

The readings given by the overnight service and the subsequent readings by the SRs were reviewed. The reports for each film were compared for any discordance. Any questions regarding discordance were resolved by the lead author. Discordant readings were assigned to 1 of 2 categories: minor or significant. Significant discordance was assigned if a change in patient care was required. An example of a minor discordance would be 3 intracerebral punctuate hemorrhages versus 4. An example of a significant discordance would be a normal spleen versus a splenic laceration.

Significant discordant readings were reviewed by an attending SR blinded to the preliminary and final readings. The blinded radiologist was given the same abbreviated reason for ordering the CT scan that was initially provided to the external radiologist and asked to read the film independently. Simple rates were determined without added statistical analysis.

Results

Five hundred thirty-four CT scans from 236 patients met the inclusion criteria: 191 (35.9%) head, 187 (35%) cervical spine, 66 (12.3%) thorax, and 90 (16.8%) abdomen/pelvis scans. One hundred twenty-two (23%) had abnormalities identified by either the ORS or the SR. Twenty of the 122 (16%) scans had discordant readings between the final interpretation of the ORS and the SRs: 5 head, 2 cervical spine, 7 thorax, and 6 abdomen/pelvis scans. Seven of the 20 (35%) discordant readings were significant: 2 liver lacerations (requiring serial hemoglobin evaluation), 2 intracranial hemorrhages (1 false-positive resulting in an unnecessary repeat CT scan and 1 false-negative intracerebral hemorrhage resulting in a failure to get a follow-up CT scan), 1 vertebral fracture (resulting in MRI and a Thoracic lumbar support orthotic [TLSO] brace), 1 rib fracture (resulting in the use of our rib fracture protocol), and 1 pelvic fracture (resulting in orthopedic evaluation).

Comments

We began this study with an undocumented observation. It appeared during our routine trauma-radiology rounds that there were more missed injuries on those films read by the ORS during the off-hours. This prompted a review to examine our perception. In addition, we wondered what the effect on patient care would be if our routine review had not been taken place.

Clinically significant misses clustered in the head and abdomen/pelvis films, with liver injury and cerebral hemorrhage predominating. This is consistent with the findings of others. Strub et al6 reviewed 22,500 head CT scans and found a 4.6% miss rate in all films and a 13.6% miss rate for hemorrhages. Terreblanche et al7 found that 34% of the discordant CT readings were abdomen/pelvis scans and 16.5% were head scans. Although none of our missed clinically significant injuries resulted in actual harm to any patient, the potential for harm was real.

The overall discordance rate between ORS readings and our SRs was 3.7% (20/534) with a total clinically significant miss rate of 1% (7/534). Of those films that had abnormalities found by any radiologist, the clinically significant miss rate was 6% (7/122). A blinded review of the clinically significant findings found that the ORS missed all 7 (100%), whereas our SRs found 5 of 7 (71%). Two of the 7 (29%) were identified only during combined trauma/radiology rounds. A review of all 122 abnormal films showed that an additional 2 nonclinically significant missed findings were found with the aid of
trauma rounds. The discordance rate found in our study is similar to that reported by Carney et al\(^8\) (3.8%). The clinically significant miss rate in our study (1%) is less than that reported in the studies performed by Terreblanche et al\(^7\) (7.7%) and Carney et al\(^8\) (14%).

Although the percentage of discordant findings appears relatively small, it equates to 100 potential missed injuries for every 10,000 studies. We perform over 1,500 CT scans a year for our 1,200 trauma admissions. Extrapolated to only the 17 level 1 trauma centers in the state of Pennsylvania, this discordant rate would yield approximately 400 potentially missed significant injuries every year.

The finding that 29% of the clinically significant findings and 3.4% of all discordant findings were only identified during our trauma radiology rounds was intriguing. We looked for possible technical reasons for the discordance. However, the quality of the films was the same for both the ORS and our radiologists because they use the same Picture Archiving and Communication System (PACS) equipment and the transmission is high resolution. Our radiologist reviewer (SG) postulated 5 interventions based on the results of this review that potentially could reduce missed readings: (1) a direct communication of clinical findings and initial readings between the trauma surgeon and radiologist; (2) a careful review of bone windows on CT scans because 2 were missed fractures; (3) the importance of having comparison studies readily available; (4) the importance of following up on the finding of fluid of CT density suggesting blood by making a meticulous look for solid organ lacerations; and (5) the consideration of spiral CT scans for heads with multiplanar reformats rather than axial acquisition.

Hoff et al\(^4\) noted a 9.7% new diagnosis rate, 67% of which was clinically significant when a radiologist reread films previously read by the surgeon. Their conclusion was that formal radiology rounds were the “final component of the tertiary survey.”\(^4\) This study supports their suggestion specifically for CT scans of the head and abdomen. A policy of mandatory morning trauma-radiology rounds, which include the trauma attending, residents, and the staff attending radiologist, has been the standard at our institution for over a decade. It is well received by the radiology and trauma departments. The perception now supported by this study is that the additional insight from the trauma team ultimately results in previously missed findings being identified. The ORS is isolated from this information.

There are limits to our study. We did not review all films that were read by 2 radiologists as normal. Films read only by the trauma surgeon and the radiologist were not reviewed either. The significant misses, although meeting the criteria for altering the care pathway, did not dramatically change management and would have been classified as a level 2 finding by Hoff et al’s scale.\(^4\) High-grade/severe acutely life-threatening findings were not missed; however, the choice of care pathway was (ie, observation vs discharge, follow-up laboratory values vs none, and a repeat CT scan vs none). The ultimate effect on over hundreds of such cases cannot be assessed.

**Conclusion**

The absolute discordance rate between ORSs and final SR readings was 3.6%, with an overall clinically significant miss rate of 1%. This represented a discordance rate of 16% and a clinically significant miss rate of 37% for abnormal CT scans. The discordant readings clustered in CT scans of the head and abdomen/pelvis. ORSs missed all 7 of the clinically significant findings. Five of these findings were found by our SR alone, and 2 were identified only during combined trauma-radiology rounds. We suggest that all trauma CT scans should be viewed by 2 clinicians, at least one of which has the entire clinical picture. Routine trauma surgeon/radiologist rounds are an ideal way to accomplish this. Suggestions are made for improving the process of trauma film review.

**References**


**Discussion**

James G. Tyburski, M.D. (Detroit, MI): You and your coauthors ought to be congratulated for trying to quantify this growing scenario across trauma emergency rooms across the nation where offsite radiology personnel interpret the films. This article boils down to 7 discordant readings that were significant along with another 13 that were not as significant. The most sensitive place you guys found to find all these was the trauma radiology rounds in the
morning. I have 4 questions. Is there any difference in the resolution of the readings or the resolution of viewers of the readers off-site and on-site? Second, can you try to quantify the amount of clinical information the off-site people get? Third, if I put my program director’s hat on for a second, tell me a little bit more about this conference in the morning and who is there for the residents (the ones coming off duty and the ones that are coming on duty). Who is there? How do you work that out? Finally, the last one, which of the recommendations have been implemented in your institution?

Tutu Cheng, M.D. (Johnstown, PA): Regarding the resolution and the equipment available, unfortunately, I am not aware or familiar with the equipment that is available to the off-site facility I imagine that they should have the state-of-the-art equipment compared with our facility, but I do not have the data on that. Second, regarding the information that is provided to the off-site facility, it is really a brief history that they have in terms of the basic demographic of the patient in terms of age, sex, mechanism of injury, and any obvious deformities that were noted at that time period. However, the communications are very brief and limited with an external radiologist. Third, in terms of the members who were present during the radiology rounds, it generally includes the staff radiologist, the traumatologist, and everyone who is part of the trauma team at the time in terms of the residents (whether or not they be postcall or not). If they prerounded in the morning, they are present during the rounds at that time period; we also have physician extenders who function in terms of seeing patients, and they contribute their clinical findings during the rounds there, which leads to my answer to your last question. I believe it is the direct communication between the team that is present who is most familiar with the patient at the time providing the information to the radiologist in terms of assisting them evaluating the study that is most beneficial.

Peter Hallowell, M.D. (Charlottesville, VA): Staying in our resident education theme, focusing in on systems-based practice, have you shared these results with the administration of your hospital because I’m quite certain they’re paying a lot of money for these services?

Dr Cheng: This study was performed on behalf of multiple departments, including the radiology service, and they have supported us in the sense that they provide us a separate room for trauma radiology rounds and better imaging monitoring to accommodate everyone who was involved.