

# Discrepancies Between Overnight Teleradiology and Next Day In-House Radiology Interpretations of Emergency Department Computed Tomographic Scans

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## BACKGROUND

Private teleradiology groups have become the standard means by which emergency physicians obtain after-hours interpretations of non-plain film images in the United States. Teleradiologist interpretation of radiographic studies during after-hours Emergency Department (ED) care has the potential to influence patient management decisions.

## OBJECTIVES

1. Estimate rates of major discrepancies between teleradiology and in-house radiology.
2. Determine what proportion of major discrepancies are due to teleradiology misinterpretations.
3. Assess the effect of major discrepancies on patient management and adverse events.

## METHODS

1. Included **550 consecutive CT scans of the head, cervical spine, chest, and abdomen and pelvis** sent to teleradiology during a 3-month period between December 2004 and February 2005.
2. CT scans initially read by a teleradiologist working at a private, for-profit group (Teleradiology Diagnostic Services); next-day read provided by a private in-house group.
3. For each scan, one study author (TP) compared the teleradiology and in-house radiologist interpretations.
4. **Major discrepancy defined as a difference that could be reasonably expected to result in a change in disposition, consultation or treatment.**
5. Follow up data used to classify major discrepancies as an overread or underread by teleradiology or in-house radiology and to assess for adverse patient events that could be attributed to the discrepancy.

## STATISTICAL METHODS

Sample size was estimated to provide an overall rate of major discrepancies with a margin of error of +/-1%. Using a predicted major discrepancy rate of 2%, a 95% confidence interval, and a power of 80%, this required 765 pairs of interpretations. Based on current usage of teleradiology services, we anticipated enrollment of 10 pairs of study interpretations each day. Allowing for variance in enrollment and lost or incomplete data, we estimated that sufficient cases would be obtained in 3 months.

Discrepancy rates are presented with 95% confidence intervals calculated using exact methods for the four types of CT scans studied.

## RESULTS

1. 787 studies sent to teleradiology during the 3 month study period, 550 included in the analysis (Figure).
2. **Major discrepancies occurred in approximately 6% of studies overall**, with similar rates for the 4 study types (Table 1).
3. Eight of the 32 major discrepancies were attributed to a misinterpretation by the teleradiologist and nine to a misinterpretation by the in-house radiologist (Table 2).
4. Of the eight discrepancies thought to be due to teleradiologist error, four were classified as overreads, two of which led to inappropriate hospital admission. Four discrepancies were classified as underreads by teleradiology.
5. **In only one of 32 major discrepancies did a misinterpretation by teleradiology lead to an adverse event.** This patient presented with abdominal pain, was diagnosed with a small bowel polyp by teleradiology. The next day he was diagnosed with a high-grade small bowel obstruction by in-house radiology. Three days later the patient returned to the ED and that day had surgery for intussusception. The patient was well at 2-year follow up.
6. Four types of pathology accounted for almost half of the major discrepancies: **intraparenchymal cerebral contusion or hemorrhage (6 cases), pulmonary embolism (2 cases), small bowel pathology (5 cases), and renal calculi (2 cases).**

Figure 1. Images sent to teleradiology service during the 3-month study period.

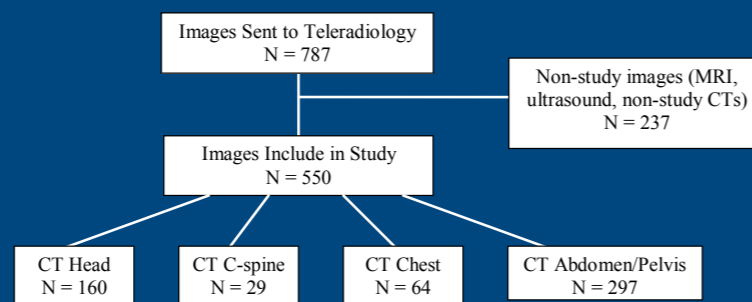


Table 1. Major discrepancy rates for the four types of CT scans

Type of CT	Major Discrepancies	Total Studies	Discrepancy Rate (95% CI)
All	32	550	5.8% (4.1 - 8.1)
Head	7	160	4.4% (2.2 - 8.8)
Cervical Spine	1	29	3.4% (0.8 - 17.2)
Chest	3	64	4.7% (1.7 - 12.9)
Abdomen/Pelvis	21	297	7.1% (4.7 - 10.6)

Table 2. Major discrepancies between teleradiology and in-house radiology. The eight discrepancies classified as misinterpretations by teleradiology are shaded.

	Teleradiology Interpretation	In-house Radiology Interpretation	Diagnosis	Classification
Head	Porencephalic cyst under pressure displacing posterior angle of left frontal horn*	Encephalomalacia	Seizures, discharged next day	Overread by teleradiology
	Negative	Frontal and right parietal contusions	Crush injury to left leg, discharged 6 days later	Overread by in-house radiology
	Negative	Left parietal hemorrhage	Forehead laceration, discharged next day	Unclear
	Chronic ischemic changes, no hemorrhage	Brainstem hemorrhage	Carbamazepine overdose, discharged 4 days later	Overread by in-house Radiology
	Scalp swelling	Right temporal contusion, falx subdural	Open scalp wound, discharged same day	Overread by in-house radiology
	Negative	Left parietal hemorrhage	Seizures, discharged same day	Overread by in-house radiology
	Negative	Right temporo-parietal hemorrhage	Concussion vs. closed head injury, discharged next day	Overread by in-house radiology
	C-Spine	Negative	Atlanto-axial widening	Cervical strain, discharged same day
Chest	Small pulmonary embolism, right pleural fluid*	No pulmonary embolism, tiny right effusion	Lupus, urinary infection, discharged next day	Overread by teleradiology
	Pulmonary embolism, small pericardial effusion	No pulmonary embolism	Chest pain, unclear etiology, discharged next day	Unclear
Abdomen and Pelvis	Bilateral pneumothoraces	Right pneumothorax with extension of subcutaneous air to left chest, no left pneumothorax	Right pneumothorax, transferred next day	Overread by teleradiology
	No evidence of intraperitoneal injury from stab wound	Minimal capsular or subcapsular fluid anterior to right lobe of liver	Stab wound to the abdomen, discharged next day	Unclear
	Left inferior ramus fracture, occlusion of left femoral artery	Left inferior ramus fracture, no occlusion of left femoral artery	Left inferior rami fracture, previous left below knee amputation, discharged 5 days later	Unclear
	Acute pancreatitis, ascites	Ascites, inflamed proximal bowel loops	Acute pancreatitis, discharged 6 days later	Unclear
	Negative	2 mm calculus middle pole of right kidney, no hydronephrosis	Non-obstructive stone, discharged 3 days later	Underread by teleradiology
	Colostomy, otherwise normal	Colostomy, small bowel obstruction vs. ileus	Vomiting, discharged same day	Unclear
	Appendicitis with surrounding fat induration	Negative	Acute appendicitis	Underread by In-House
	Negative except small bowel polyp.†	High grade small bowel obstruction, small bowel polyp	Discharged, returned 3 days later with intussusception	Underread by Teleradiology
	Free fluid in the cul-de-sac	Negative	Facial, chest contusions, discharged next day	Unclear
	Negative	Small bowel contusion	Rib fracture, discharged same day	Unclear
	Left pubic rami fracture, right sacral fracture	Negative	Transferred, lost to follow up	Unclear
	Sigmoid colitis consistent with ischemic bowel	Negative	Gastroenteritis, discharged 4 days later	Overread by Teleradiology.
IVC filter, otherwise negative	IVC filter, bilateral hip osteomyelitis	Discharged same day, patient known to have chronic bilateral hip osteomyelitis at time of discharge	Underread by Teleradiology	
High grade small bowel obstruction	Mild small bowel dilation, no obstruction	Constipation, discharged 5 days later	Unclear	
Negative	Small bowel contusion	Concussion, discharged same day	Unclear	
Mild ileus	Sigmoid colitis	Celiac disease, discharged 41 days later	Unclear	
Adrenal hematoma, right superior rami fracture	Tiny left pneumothorax, right superior rami fracture	Right superior rami fracture, discharged 5 days later	Unclear regarding either adrenal hematoma or pneumothorax	
Small free fluid in cul-de-sac	Inflammatory changes in right buttock extending to gluteus	Disseminated coccidiomycosis, known to providers at time of discharge next day	Underread by Teleradiology	
Appendicitis with induration of surrounding fat	Negative	Acute appendicitis	Underread by In-house	
Negative	Grade I liver laceration, small bowel contusion	Rib fractures, pulmonary contusion, discharged 10 days later	Unclear	
Negative	Faint bilateral calcifications, no hydronephrosis	Abdominal pain, discharged same day	Unclear	
Free gas in gallbladder fossa, consider perforated ulcer	Mild dilation of small bowel	Perforated duodenal ulcer	Underread by In-house	

\* Teleradiology misinterpretations which probably prompted an unnecessary hospital admission.

† Teleradiology misinterpretation which probably caused an adverse event.

## LIMITATIONS

1. We studied a single teleradiology and in-house radiology group. All radiologists from both groups are US trained and board certified. Discrepancy rates for other groups may be different.
2. The study was performed at a teaching emergency department where patient care is provided by a resident with the guidance of a teaching faculty member. Clinical decision-making by emergency medicine residents may have affected the decision to order CT scans, patient management, and the occurrence of adverse events.
3. Images in our study were acquired using a 4-slice CT scanner. Newer CT scanners are widely used and provide more detailed images; these images may lead to different rates of discrepancies.
4. Rates of discrepancies between teleradiologists and in-house radiologists may be different for other types of studies.
5. Clinicians could discuss preliminary findings with the teleradiologist by phone, sometimes leading to changes in the teleradiology report. We do not know how often this occurred. If the teleradiology interpretations we studied do contain amended reports, our estimates of major discrepancies would probably be lower than if communication between clinicians and teleradiologists were not possible.
6. We classified pairs of interpretations as having a major discrepancy if the discrepancy could reasonably be expected to alter the management of the patient during their ED visit. In many cases, the presence of a major discrepancy did not result in a change in management. The number of patients whose management was altered by a major discrepancy is smaller than the number of major discrepancies we identified.
7. We chose follow up information as the criteria on which to classify discrepancies rather than further review by independent radiologists. This method of defining the presence or absence of illness is susceptible to error.
8. Our in-house radiologists had access to teleradiology interpretations and additional clinical information. For this reason, this study is not a head-to-head comparison of two radiology groups. Rather, our goal was to determine how often an emergency physician would be given an interpretation that would be significantly different from the official, next day interpretation

## CONCLUSIONS

Major discrepancies in interpretations between teleradiologists and in-house radiologists occurred for approximately 6% of CT scans. Major discrepancies that we could attribute to teleradiologist misinterpretation occurred in less than 2% of studies, with only one patient suffering an adverse event from a teleradiology misinterpretation. Our findings support the cautious use of teleradiology interpretations for ED decision making; a larger study is needed to validate this conclusion.