Correlation Of Emergency Department Radiographs: Results Of A Quality Assurance Review In An Urban Community Hospital Setting

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Background: **The study objective was to compare the accuracy of radiograph interpretation by emergency and family physicians with radiologists' overreadings.**

Methods: **We undertook a historical chart review of patients seen consecutively during a 1-year period at an inner-city emergency department of a medium-volume community hospital. The participants were a racially mixed group of 22,141 patients for whom 12,083 radiographs had been ordered. We compared interpretations by emergency and family physicians with those of radiologists who performed overreadings within 24 hours. This intervention was performed retrospectively. Measurements consisted of descriptive statistics, such as percentages and chi-square analysis.**

Results: **The main result was an overall discrepancy rate (ODR) of 1.1 percent. This figure is significantly different ($P < 0.0001$) from the lowest reported overall discrepancy rate to date (2.8 percent).**

Conclusions: **Consistently low overall discrepancy rates have specific implications for the medical practice and reimbursement of primary care physicians for radiograph interpretation. (J Am Board Fam Pract 1993; 6:255-259.)**

We undertook a study to assess the ability of emergency and family physicians to interpret radiographs ordered for their patients in the emergency department of a community hospital. Our goal was to assess the value of radiological overreading in the acute setting of the emergency department. This study was prompted by a number of issues relating to efficient utilization of resources, cost of medical services, and potential revenue shifts.

A time-honored rule has been that all radiographs should be overread by a radiologist to minimize errors, satisfy community standards, and avoid potential malpractice litigation. Recent changes toward lower discrepancy rates reported in the medical literature, however, suggest a reevaluation of the requirement for radiological overreading. Gratton, et al.[1] suggested that less than 3 percent of clinically important misinterpreted radiographs be used as the reference standard in evaluations. Other investigators have reported rates that ranged from 9.2 percent to 16 percent.[2-7] The impact on outcomes of delayed correction of errors has never been fully investigated. The medical literature contains no reports that demonstrate radiological overreading as a means to improve quality of care or lower the threat of legal action.

This study explores several questions. How does the ability of a community emergency department to interpret radiographs compare with current standards? Are the most frequently missed findings in a community-based emergency department similar to those in an academic center? Have quality assurance efforts lowered overall discrepancy rates (ODR) to the point that emergency readings meet the standard of care?[2] If so, how should this change affect reimbursement for this service?

It is clear from the outset that any new data which cause one to question the value of radiological overreading will have important fiscal implications and will probably lead to further interspecialty conflict, particularly if the primary care

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physician can demonstrate a level of accuracy in radiological interpretation consonant with quality assurance standards and community standards of care.

Methods

Quality assurance protocols in a medium-volume, inner-city, community hospital require that all radiographs performed in the emergency department be officially interpreted by the emergency department physician. These films are then overread later by a radiologist, normally within 24 hours. Discrepancies between the two readings trigger a follow-up mechanism to reveal misdiagnoses and to arrange for appropriate treatment, if indicated.

No emergency department physicians were aware of the study presented here, which was completely retrospective. Physicians staffing the emergency department included board-certified emergency physicians (5), board-certified family physicians (3), a board-certified internist (1), and general practitioners (2). Two physicians were board certified in both family practice and emergency medicine. No primary care physician had additional radiologic training beyond what they obtained in their residencies. All 9 radiologists interpreting films in this study were board certified. Physicians were aware of the ongoing quality assurance program but were unaware that these data would lead to this study. Both the number of misdiagnoses (MD — missed findings that related to the presenting complaint of the patient) and incidental findings (IF — missed incidental findings that did not relate to the patient's complaint) were recorded. The overall discrepancy rate (ODR) was calculated as the total of the number of misdiagnoses (MD) plus the incidental findings (IF) as the numerator, with the total films reviewed by the radiologist as the denominator:

$$\text{ODR} = [(\text{MD} + \text{IF})/\text{total films}] \times 100^{2}.$$

Immediate interpretation by a radiologist was available to the emergency physician for films taken during normal office hours (0700 to 1700 hours). The primary care physician was responsible for the radiological interpretation, without the benefit of an on-site consulting radiologist, 70 percent of the week (118 hours out of a 168-hour week). Radiologists were available for after-hours consultation at the request of the emergency department physician.

Data were evaluated by the discrepancy severity group (DSG) criteria of O'Leary, et al.,[2] a format accepted by quality assurance programs in emergency department radiograph follow-up. DSG-1 cases are defined as missed findings that have the potential for a patient outcome of major morbidity or mortality. DSG-2 cases have only moderate possibility for poor outcome. DSG-3 cases have minimal risk. Examples of DSG-1 cases include congestive heart failure, cervical spine fracture, major vessel aneurysms, and free air in body cavities. The DSG-2 group includes fracture, pneumonic processes, and lung masses. The DSG-3 group includes foreign bodies, ileus, and gallstones.

All patients were contacted immediately upon discovery of any discrepancy. No discrepancy scores were assigned at follow-up, because the patients were called immediately. The data were reviewed retrospectively to characterize the missed findings according to the defined discrepancy severity groupings.

Results

Emergency department volume for 1990 was 22,141 patients and 12,083 radiographs. All radiographs were interpreted twice, first by the emergency department physician and subsequently by the radiologist. All films were read and overread within 24 hours. The overall discrepancy rate of 1.1 percent is the lowest for this volume of films reported in the medical literature to date.

One hundred thirty-five films required further follow-up because of missed or incidental findings. If the finding directly related to the patient's complaint, it was classified as a missed finding. If the finding did not relate to the complaint, it was classified as an incidental finding. All patients were contacted for follow-up of these new findings. The most commonly missed finding was fracture (34.8 percent). Following fracture, the most commonly missed findings were pneumonia, hilar mass, lung nodule, congestive heart failure, renal calculi, pelvic mass, and ileus (Table 1). Other miscellaneous findings accounted for 22.6 percent of the misdiagnoses. The percentages of missed and incidental findings relative to total radiographs are shown in Table 2. Evaluation of data by the discrepancy severity group criteria is

Table 1. Number and Percentage of Missed and Incidental Findings in 135 Radiographs Requiring Further Follow-up.

Finding	No. (%)
Fractures	47 (34.8)
Pneumonia	14 (10.3)
Hilar mass	11 (8.1)
Lung nodule	10 (7.4)
Congestive heart failure	9 (6.6)
Renal calculi	6 (4.4)
Pelvic mass	4 (2.9)
Ileus	4 (2.9)
Other	30 (22.6)

presented in Table 3. The total overall discrepancy rate was 1.1 percent with a missed diagnosis rate of only 0.6 percent. Twelve percent of the misdiagnoses fell into the category of DSG-1. Sixty-seven percent of the misdiagnoses fell into DSG-2, and 21 percent into DSG-3. Table 4 provides a list of all missed diagnoses and incidental findings.

Discussion

Previous studies have shown overall discrepancy rates ranging from 3 percent to 16 percent.[1-6] Our results compare favorably with these previous reports. McLain and Kirkwood[7] established an overall discrepancy rate of 9.2 percent in a 1985 study of a rural hospital. The frequency of radiographs taken to total number of emergency department visits in that study was approximately 25 percent higher than in our study. The presence of a seasoned, permanent staff in the emergency department could account for a total overall discrepancy rate of only 1.1 percent with a misdiagnosis rate of only 0.6 percent. Alternative explanations include a higher level of radiologic interpretive training, similarity of descriptive language between primary care physicians and radiologists leading to more congruent interpretations, fewer subtle pathologic conditions, or a patient population who had presented no standardized nomenclature and who sought help for a limited clinical spectrum of complaints that were more consistently managed (i.e., no pediatrics, no obstetrics-gynecology, limited trauma).

Most previous studies in quality assurance for emergency department radiograph interpretation accuracy have been done in academic settings. The total overall discrepancy rate of 1.1 percent with a missed diagnosis rate of only 0.6 percent could account for the differences in our diagnostic severity group percentages. The 12 percent DSG-1 rate is higher than previously reported by O'Leary, et al.[2] In addition, we had 67 percent of our findings fall into DSG-2, compared with 5 percent and 13 percent, respectively, as reported by O'Leary, et al.[2] The percentage of DSG-1 to total radiographs is 0.1 percent, however.

Many possible explanations exist for the increase in our diagnostic severity group score. First, this study might have inadvertently included more film interpretations in the more severe categories in an effort to avoid missing findings, such as coin lesions versus calcified granulomas. Perhaps the very low overall discrepancy rate in this study is secondary to fewer DSG-3 findings noted by the radiologists. The possibility also exists that, in fact, more clinically important diagnoses could have been missed than were reported by O'Leary, et al.[2] Further studies using the diagnostic severity group concept are needed to obtain a standard for normal levels of different diagnostic severity groups of missed diagnoses.

Gratton, et al.[1] evaluated total errors in an emergency medicine residency program and

Table 2. Number and Percentage of Missed and Incidental Findings Relative to All Radiographs Taken during Study Period.

Month and Year	Number of Radiographs	Missed Finding No. (%)	Incidental Finding No. (%)
Dec. 1989	983	11 (1.1)	1 (0.1)
Jan. 1990	1,005	12 (1.2)	2 (0.1)
Feb. 1990	828	2 (0.2)	3 (0.3)
Mar. 1990	930	7 (0.7)	2 (0.2)
Apr. 1990	1,148	11 (0.9)	4 (0.3)
May 1990	1,058	4 (0.3)	6 (0.5)
June 1990	994	8 (0.8)	12 (1.2)
July 1990	1,052	5 (0.4)	6 (0.5)
Aug. 1990	1,026	6 (0.5)	9 (0.8)
Sep. 1990	1,046	4 (0.3)	7 (0.6)
Oct. 1990	951	4 (0.4)	4 (0.4)
Nov. 1990	1,062	2 (0.1)	3 (0.2)
Totals	12,083	76 (0.6)	59 (0.5)

Table 3. Number of Discrepancies between Emergency Department Physician and Radiologist in Each Diagnostic Severity Group (DSG).

DSG-1		DSG-2		DSG-3	
Diagnosis	No.	Diagnosis	No.	Diagnosis	No.
Congestive heart failure	9	Fractures	44	Gallstones	10
Cervical spine	3	Pneumonia	14	Foreign bodies	4
Abdominal aortic aneurysm	2	Hilar mass	11	Ileus	2
Subphrenic air	1	Lung nodule	10	Other	13
Thoracic aneurysm	1	Multiple myeloma	3		
		Osteomyelitis	2		
		Renal mass	2		
		Small bowel obstruction	1		
		Appendicolith	1		
		Sella tursica lesion	1		
		Lytic bone lesion	1		
Total	16		90		29
Total films read (%)	0.1*		0.7*		0.2
Total missed films (%)	12.0*		67.0*		21.0*

*Numbers rounded.

found that 51 percent of total errors were in the interpretation of back, extremity, and facial films. This figure compares with a 33 percent error rate when similar errors were compared from our data. Perhaps the discrepancy results from fewer total facial films in our study. Thirty-two percent of errors reported by Gratton, et al.[1] occurred in the interpretation of chest radiographs. Thirty-three percent of the errors in our study occurred from the interpretation of chest radiographs. Again, the results from this nonacademic setting compare favorably with similar error rates on the same type of films in an academic setting.

Although no adverse outcomes and no litigations arose as a consequence of the 12 percent DSG-1 misdiagnoses, the clinical and legal implications must be considered. Are errors by nonradiologists more likely to lead to malpractice suits? The answer is unclear. Many variables affect outcome, not the least of which are the patient care styles of the emergency physician and the patient's expectations given the information provided.

The overall trend found in our review of the medical literature was toward lower overall discrepancy rates. In one of the first attempts to look at discrepancy rates between radiologists in 1949, Garland[8] found a 30 percent discrepancy rate between radiologists reading the same film. Berlin[9] suggested in 1977 that errors up to 30 percent could continue to occur between radiologists' interpretations. Another more recent evaluation of staff radiologists overreading their residents showed an overall discrepancy rate of 11 percent.[10] Perhaps recent emphasis on quality assurance has improved accurate interpretation rates between radiologists. Reports from emergency medicine literature show a downward trend in the total overall discrepancy rates reported. Overall discrepancy rates of 8.9 percent and 16.4 percent were reported in 1983 and 1984.[4,5] Recent reports show 3.4 percent, 3.3 percent, and our 1.1 percent.[1,2] Although a causal relation with quality assurance programs would be difficult to prove, it remains interesting that this trend parallels the trend in increased quality assurance review.

A 1985 survey by the American College of Emergency Physicians showed that radiology coverage for online interpretation of radiographs averaged 9 hours per day at nonteaching hospitals and 11.5 hours at teaching hospitals.[11] Weekend online coverage was 2.9 and 8.1 hours, respectively.[11] These findings mirror the online coverage of our department.

Conclusion

Currently most payers do not routinely pay the primary care physician for radiograph interpretation. Our findings support the assertion that

Table 4. Missed Diagnoses and Incidental Findings.

Diagnosis	No.	Diagnosis	No.
Fractures		**Other**	
Rib	7	Pneumonia	14
Ankle	6	Hilar mass	11
Orbit	4	Lung nodule	10
Nasal	3	Congestive heart failure	9
Cervical	3	Renal calculi	6
Radial head	3	Pelvic mass	4
Finger	3	Ileus	4
Elbow	2	Multiple myeloma	4
Humerus	2	Osteomyelitis	3
Metacarpal	2	Abdominal aortic aneurysm	2
Tarsal	2	Right upper quadrant calcification	2
Toe	1	Renal mass	2
Patella	1	Aseptic necrosis hip	1
Calcaneus	1	Bone infarction	1
Metatarsal	1	Dislocation, coccyx	1
Radial neck	1	Sella tursica lesion	1
Carpal	1	Thoracic aneurysm	1
Femoral head	1	Small bowel obstruction	1
Knee	1	Subphrenic air	1
Thoracic	1	Pancreatitis	1
Clavicle	1	Gallstones	1
Skull	1	Ectopic	1
		Appendicolith	1
		Foreign body, knee	1
		Foreign body, neck	1
		Sinusitis	1
		Lytic bone lesion	1

therapeutic care of emergency patients, as indicated by radiographic diagnosis, is the direct result of the interpretation by the primary care physician. Overreading by a radiologist provides an extra level of safety; however, the overreading does not affect patient care in the emergency setting. The primary care physician's reading is the clinically significant factor. With the advent of teleradiology connecting the emergency department to the radiologist's living room, more immediate online service could be available for many emergency departments. The questions then arise: Can the expense of converting every radiologist's telephone and computer terminal for teleradiology be justified for an overall discrepancy rate of 1.1 percent, or is this move merely an attempt to continue the status quo in spite of quality assurance evidence supporting the claim that primary care physicians should have the right to bill for services that they actually render? Because many of the primary care specialties are losing their ability to attract residents, means to correct the financial discrepancies between primary care specialists and other, more lucrative specialties need to be found. Accordingly, one easy way to redistribute the health care dollar more fairly would be to direct a major portion of the payment for radiograph interpretation to the primary care physician who reads the film. Further study on the actual benefit of radiological overview could allow for the development of more generalizable protocols that address the needs of teaching hospitals, rural community hospitals, and highly specialized facilities. Education in nonradiologic specialties involved in emergency care must also address the core content needed if we are selectively to exclude certain studies from overview.

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