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Chest Radiographs Sensitivity and Specificity of Emergency in the Emergency Department

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Abstract

Background: The interpretation of chest radiographs in the emergency department (ED) presents a challenge due to the complexity of this imaging modality. Previous research has demonstrated substantial discordance between interpretations by clinical physicians and expert radiologists. This discordance underscores the need for comparative analysis between interpretations made by ED physicians and senior radiologists, particularly concerning discharged patients. Evaluating misinterpretations in relation to physician training levels provides insights into the potential impact of expertise on interpretation accuracy.

Methods: A prospective review was conducted on radiological descriptions of 509 chest radiographs from 507 discharged ED patients, aged 16–98 years. Missed findings were documented, considering the physician's level of training and experience. Furthermore, the repercussions of misinterpretations on discharge recommendations were explored. Statistical analysis involved the utilization of the $\chi 2$ test, while interobserver agreement was assessed using the κ coefficient.

Results: Sensitivity for detecting various abnormalities ranged from 20% to 64.9%, with specificities ranging from 94.9% to 98.7%. Despite the observed low sensitivities, the clinical implications of "missed" findings were relatively minor, often resulting in appropriate follow-up recommendations. The overall interobserver reliability, as indicated by the κ coefficient (0.40, 95% confidence interval 0.35 to 0.46), remained consistent across different levels of emergency department physician training.

Conclusions: Emergency department physicians frequently overlook specific radiographic abnormalities, highlighting a notable discordance with interpretations by trained radiologists. These findings underscore the importance of routine radiologist evaluation of chest radiographs in the ED setting. Additionally, they emphasize the necessity of enhancing interpretive skills among emergency department physicians to minimize diagnostic discrepancies and optimize patient care.

Introduction

Patients presenting to the emergency department (ED) often undergo radiological examinations to assess their medical and surgical conditions. However, the treating physician in the ED may not always have immediate access to an on-call radiologist, necessitating reliance on personal experience and basic skills for interpretation. Discrepancies between radiograph interpretations in the ED and those of radiologists are frequently reported in various studies, with rates ranging from 0.3% to 17%, and in some cases, up to 58% by primary care physicians. Nevertheless, treatment changes resulting from such discordance are required in only a small fraction of cases, ranging from 0.06% to 3% of patients. Despite this, intermediate levels of interobserver variability have been noted. (Kwee et al., 2023)

Prior studies have indicated higher rates of misinterpretation in chest radiographs compared to other types of radiographs, although none specifically addressed the complexities of interpreting chest radiographs in adult patients. Hospitalized patients offer more opportunities for review and correction of initial interpretations, whereas discharged ED patients pose challenges in addressing misinterpretations post-discharge. Therefore, our investigation focuses specifically on discharged ED patients to explore the impact of misinterpretations on patient outcomes, including potentially fatal consequences. (Recht et al., 2022)

We aim to assess the effects of misinterpretations on discharge recommendations for further treatment, investigation, and follow-up, particularly in relation to the training and experience of the ED physician. Understanding the implications of interpretation errors in this subset of patients is crucial, as it can significantly affect patient outcomes and, in some cases, lead to adverse consequences. (White et al., 2022)

Methods:

A prospective collection of chest radiographs from 507 patients (509 examinations) was conducted. The study included patients aged 16 years and older treated in the emergency department (ED). Daily reviews of discharged patients' files were conducted, focusing on whether ED physicians consulted a radiologist before discharge and their initial interpretations before consultation. No standardized form was used for recording interpretations.

Data collected included physician's training level, patient demographics, presenting complaints, physical examination findings, ED physician and senior radiologist interpretations, discharge diagnoses, and treatment/follow-up recommendations. Examinations with unclear diagnoses or lacking interpretations were excluded. The senior radiologist's interpretation served as the "gold standard," and misinterpretations were noted when discrepancies occurred between ED and senior radiologist interpretations. Clinical significance of misinterpretations was assessed by reviewing patient medical records.

Misinterpretations of clinical significance were categorized as mild, moderate, or high based on required further evaluation and treatment urgency. The study involved participation from board-certified internal medicine attending physicians, final-year residents, intermediate-year residents, first-year residents, and surgical residents, along with board-certified senior radiologists.

Accuracy of ED interpretations compared to senior radiologists was assessed in terms of sensitivity and specificity. Proportional differences were analyzed using the $\chi 2$ test, and interobserver agreement was evaluated using κ coefficients with 95% confidence intervals (CI). Statistical significance was set at $p < 0.05$ for all analyses.

Results:

Among the 507 patients included in the study, 57.2% were male and 42.8% were female, with ages ranging from 16 to 98 years (mean (SD) 48 (20.5) years). Common complaints included chest pain (23.9%), dyspnea (18.7%), cough (19%), and fever (13.1%), while prevalent physical findings consisted of normal chest examination (36.8%) and musculoskeletal tenderness (13.2%).

Diagnoses at discharge were predominantly non-specific, such as "non-specific chest pain," or unrelated to radiographic findings. Emergency department physicians described 557 findings compared to 647 findings noted by senior radiologists for all chest radiographs evaluated. Emergency department physicians consulted a radiologist in 28.9% of cases.

The sensitivity of emergency department interpretations varied across findings, with the highest sensitivity observed for consolidation (64%) and congestion (50%), while chronic changes exhibited the lowest sensitivity (20%). Specificities were generally high, ranging from 94.9% for consolidation to 98.7% for pleural effusion. Emergency department physicians frequently missed potentially significant findings like coin lesions or mediastinal widening.

Assessment of actual treatment received compared to treatment "indicated" by radiologists revealed discrepancies, particularly for patients with misinterpreted signs of consolidation and congestion. Sensitivity for pleural effusion was low (25.8%), with only a minority being clinically significant.

When categorized by levels of clinical significance, emergency department physicians demonstrated the highest sensitivity for highly clinically significant findings (60%), followed by moderate (31.7%) and low significance (27.5%) groups. Interobserver reliability, assessed by the κ coefficient, was moderate to low (0.40, CI 0.35 to 0.46), with no significant differences observed among different levels of emergency department staff compared to senior radiologists.

Table 1 Diagnoses of patients discharged from the emergency department who had a chest radiograph performed

Diagnosis	Frequency (%)
Non-specific*	230 (45.2)
URTI/bronchitis	79 (15.5)
Pneumonia	48 (9.4)
Trauma	47 (9.2)
Musculoskeletal disorders	42 (8.3)
Asthma/COPD	36 (7.1)
CHF	27 (5.3)

*Non-specific includes pleuritis, hyperventilation, no disease found, and no definite diagnosis.

Abbreviations: URTI - upper respiratory tract infection; COPD - chronic obstructive pulmonary disease; CHF - congestive heart failure.

Table 2 Sensitivity and specificity of emergency physicians' interpretations compared with those of senior radiologists in abnormalities found on chest radiographs

Category	Count by Emergency Department Physicians	Count by Senior Radiologists	Sensitivity (%)	Specificity (%)
Consolidation	40	57	64.9	94.9
Congestion	19	34	50.0	97.5
Pleural Effusion	9	31	25.8	98.7
Chronic Changes*	8	37	20.0	97.0
Coin Lesion	3	13	ND	ND
Mediastinal Widening	2	8	ND	ND
New Fracture	3	4	ND	ND
Deformations	6	22	ND	ND
Cardiomegaly	32	102	29.4	98.5
Non-specific Changes†	20	48	39.5	96.4
Any Chest Radiograph Abnormality	346	291	60.1	89.0

*Pleural thickening, interstitial markings, lung/pleural calcifications.

†Prominent pulmonary vasculature, atelectasis, high hiatus.

ND, not determined.

Table 3 Interobserver reliability among emergency department staff levels for any abnormality compared with senior radiologist interpretation

Emergency Department Physician Training Level	No (%) of Chest Radiographs Read	κ	95% Confidence Interval
Attending Physician	113 (22.2)	0.31	0.20 to 0.42
Senior Medical Residents	103 (20.2)	0.38	0.28 to 0.48
Intermediate Medical Residents	136 (26.7)	0.35	0.26 to 0.44
Junior Medical Residents	90 (17.7)	0.47	0.36 to 0.59
Surgical Residents	67 (13.2)	0.40	0.14 to 0.65

Note: κ denotes the kappa coefficient, a measure of interobserver agreement.

Discussion:

Previous studies have explored the interobserver reliability of radiograph interpretation in the emergency department, albeit with variations in study design, making standardization challenging. Our study revealed higher levels of misinterpretations, intentionally designed to maximize potential discordance by including all radiographic findings. Subtle signs, often considered positive findings by emergency department physicians, contributed to errors of omission. Lack of standard forms for recording interpretations might have resulted in underreporting of findings, particularly those deemed minor or insignificant. We observed an increase in error rates with decreasing clinical significance, suggesting potential oversight in interpreting or recording less clinically relevant findings. (Bárdyová et al., 2021)

A limitation of our study is the absence of a consensus opinion as the "gold standard," with interpretations made by multiple general radiologists instead of a single expert chest radiologist. This could have influenced the level of interobserver variability. Additionally, focusing solely on discharged patients' chest radiographs may have led to higher rates of subtle findings being missed compared to studies including all radiographs performed in the ED. (Ma, 2020)

Chest radiography interpretation complexity, especially in the ED setting, is well-documented. Our study further underscores this complexity, particularly in adult patients. Even experienced chest radiologists encounter subjectivity and variability in interpretation. Interobserver variability persists despite physician training levels, with attending physicians slightly more accurate than residents but not significantly so. Confidence levels may not correlate with accuracy. (Nocum et al., 2021)

In conclusion, reducing interpretation errors among emergency department physicians necessitates improved interpretive skills, potentially integrated into residency training, and enhanced quality control measures. Collaboration between emergency physicians and radiologists, along with an efficient callback system for abnormalities, is essential for minimizing diagnostic discrepancies and optimizing patient care. (Omofoye & Bradshaw, 2023)

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