# Emergency Room Plain Radiograph Imaging Study Indications:
## An Analysis of Quality and Trends at a Large Academic Medical Center

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**Rationale and Objectives:** This study aimed to assess the quality of and analyze trends among clinical indications received for emergency room radiograph studies.

**Materials and Methods:** Clinical indications provided by the emergency room and rapid care for consecutive chest, abdominal, and musculoskeletal radiographs were reviewed. Chart review was performed to analyze the provided indications compared to clinical information known to the ordering providers. Chest and abdominal radiograph indications were graded according to symptoms and physical examination signs and relevant past medical history. Musculoskeletal indications were graded according to symptoms, mechanism of injury, and positive physical examination findings. Each study indication was graded on a scale from 0 to 2 according to scales modified from those of prior published studies. Grades were further stratified according to ordering location, time of shift, ordering provider level, and specific anatomy involved.

**Results:** For chest and abdomen studies, mean scores for symptom and physical examination and provided past medical history grades were 1.16 and 0.36, respectively. There was a trend toward a significant difference in mean medical history grades among ordering provider levels. For musculoskeletal studies, mean scores for symptom, mechanism, and physical examination grades were 1.04, 0.89, and 0.51, respectively. Mean symptom and examination grades for physician extenders were significantly less than those of attendings and residents. Mean symptom and mechanism grades for extremity studies were significantly less than those for spinal studies.

**Conclusions:** For plain radiographs ordered through the emergency department, certain critical pieces of study indications tended to be underreported relative to other components. Furthermore, significant differences in select categories were seen among ordering provider levels and anatomic location.

**Key Words:** emergency department; clinical indications; plain radiography; ordering trends.

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## INTRODUCTION

Incomplete and irrelevant provided histories accompanying imaging study requisitions are a prevalent problem facing many radiologists in a variety of care settings. Inadequate histories can be particularly problematic in the emergency department where the acuity of medical conditions is greater and rapid turnaround times are critical to provide optimal care.

Numerous studies have shown the importance and value that high-quality clinical histories can have on radiologists' image interpretation across multiple modalities (1–6). Given time constraints and high volumes emergency radiologists face, obtaining relevant histories by routinely contacting clinicians or searching medical records is not feasible. Furthermore, as imaging volume through emergency departments continues to increase (7), radiologists will need to increasingly rely on clinical histories provided to them through study requisitions.

Numerous strategies have been implemented in attempts to improve histories including hospital and radiology systems integration (8), education of ordering clinicians (9), adoption computer order entry (10,11), and adding technologist-supplemented histories (12) although no single study has compared any of the strategies head-to-head. Varying degrees of success have been seen with these undertakings. Although many different strategies can be undertaken to improve the problem of inadequate histories, each approach has varying financial, time, systems, and personnel costs and constraints. Thus, to pursue more targeted and therefore more efficient strategies of change, one must understand the problem of inadequately provided histories. To date, no published study has examined the underlying trends of provided clinical histories.

The purpose of this study is to assess the quality of and analyze trends among clinical indications received for emergency room radiograph studies.

## MATERIALS AND METHODS

This study was based on a Health Insurance Portability and Accountability Act-compliant and institutional review board-approved retrospective review of patients' records, and informed consent of patients was not required.

### Patient and Study Selection

Consecutive plain radiograph studies for adult patients presenting to the emergency department during a single week time frame at a nonprofit, 1000+ bed urban tertiary care medical center were evaluated in this study. Radiographs of the chest, abdomen, spine, and extremities were included for analysis. Radiographic shunt series and follow-up or repeat (ie, post-reduction) studies were excluded from this analysis. For each included study, the provided indication was recorded as well as the study time, ordering provider and credential level (ie, attending, resident, mid-level provider), and ordering provider location (ie, emergency room or rapid care).

### Assessment of Indication Quality

Each provided indication was assessed according to multiple criteria as modified from those used by Pevnick et al. (11). For chest and abdominal radiographs, criteria included symptoms and physical examination findings, relevant past medical history (PMH), and abnormal laboratory findings. For musculoskeletal radiographs, criteria included symptoms, presence of trauma and mechanism of injury, physical examination, and relevant PMH. For each examination, electronic medical record chart review was performed, and all documented information pertinent to the aforementioned categories was recorded. Subsequently, for study, each criteria for a provided indication was graded on a scale from 0 to 2 (0 = no relevant information provided, 1 = incomplete information provided, 2 = all relevant information provided) as compared to information available to clinicians as determined by electronic medical record review. For both study types, an indication was omitted from analysis for the PMH category if the patient did not have any PMH relevant to the presenting complaint. Furthermore, for chest and abdominal radiographs, the study was omitted from analysis if relevant laboratory values were within normal limits or not drawn for the encounter. For intra-user analysis, studies were reassessed by the grader who was blinded to the initial assessments. For the inter-user analysis, studies were assessed by a second grader who was also blinded to the first grader's assessments.

### Data Analysis

All statistical calculations were performed using Stata (version 9.2, Stata Corporation, College Station, TX). All descriptive statistics were reported as mean ± standard deviation. For each study type, study grades were analyzed according to study time period, provider level, ordering locations, and anatom-

ic site (ie, chest vs abdomen, spine vs ribs or extremities). Comparisons between two subgroups were performed using independent-sample Student $t$ tests, and one-way analysis of variance was used to compare means among more than two groups. All $P$ values represent two-sided tests, and a $P$ value less than .05 was considered to be statistically significant. The kappa statistic was used as a measurement of interobserver and intraobserver variability (13).

## RESULTS

A total of 446 plain film studies were initially identified, with 430 meeting the specified inclusion criteria (4 shunt studies and 12 follow-up or repeat films were excluded). Basic demographics and ordering data are summarized in Table 1.

Scoring within each subcategory for chest and abdominal studies is summarized in Figure 1. Overall, data regarding relevant PMH (0.36 ± 0.66) and laboratory values (0.06 ± 0.33) were underreported relative to symptoms and physical examination (1.16 ± 0.55). By ordering shift, there was a trend toward a significant difference ($P = .09$) in PMH reporting. There was also a trend toward significantly greater ($P = .06$) reporting of symptoms and physical examination (1.29 ± 0.52 vs 1.13 ± 0.55) and underreporting of PMH in the rapid care setting. A near significant difference ($P = .06$) in PMH reporting was observed among ordering provider levels, with residents demonstrating higher scores −0.45 ± 0.71 vs 0.25 ± 0.62 for attendings and 0.14 ± 0.35 for physician assistants (PAs) or certified nurse practitioners (CNPs).

Scoring within each subcategory for musculoskeletal studies is summarized in Figure 2. Overall, data regarding physical examination findings (0.51 ± 0.70) and PMH (0.17 ± 0.49) were underreported relative to symptoms (1.04 ± 0.78) and mechanism of injury (0.89 ± 0.69). Among ordering shifts, there

**TABLE 1. Study Characteristics**

| | Chest and Abdomen | Musculoskeletal |
|---|---|---|
| Number of studies | 218 | 212 |
| Average age | 54.6 | 47.5 |
| Number of females (%) | 120 (55%) | 141 (67%) |
| Anatomy | Chest: 199 | Ribs or extremities: 169 |
| | Abdomen: 19 | Spine: 43 |
| Shift | 12 AM–8 AM: 52 | 12 AM–8 AM: 30 |
| | 8 AM–4 PM: 78 | 8 AM–4 PM: 99 |
| | 4 PM–12 AM: 87 | 4 PM–12 AM: 94 |
| Patient location | Emergency room: 183 | Emergency room: 173 |
| | Rapid care: 35 | Rapid care: 39 |
| Provider role (no. of unique providers) | Attending: 48 (15) | Attending: 56 (12) |
| | Resident: 133 (15) | Resident: 78 (14) |
| | CNP or PA: 37 (11) | CNP or PA: 78 (10) |

CNP, certified nurse practitioner; PA, physician's assistant.