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Quality of Clinical History for Musculoskeletal Radiographs at Outpatient Imaging Centers: One Institution's Experience

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Abstract

Purpose: Clinical history is important to inform radiologists' decision-making when producing radiology reports for musculoskeletal imaging examinations. Our objectives were (1) to determine how often imaging requests for outpatient musculoskeletal radiographs have complete clinical history, (2) to determine the likelihood that outpatient musculoskeletal radiographs with corresponding timely clinical progress notes in the electronic health record (EHR) contain complete clinical history as compared to those with no available EHR clinical progress note, and (3) to estimate the frequency of imaging requests for outpatient musculoskeletal radiographs that have corresponding timely EHR clinical progress notes.

Methods: We reviewed retrospectively clinical history on imaging requests for outpatient musculoskeletal radiographs submitted into our institution's Computer Order entry (CPOE) system, determined the frequency of EHR clinical progress notes corresponding to the musculoskeletal radiographs, and stratified EHR clinical progress status as: (1) "On Time"; (2) "Late", or "No EHR Records". We assessed clinical history completeness on both timely EHR clinical progress notes and the CPOE histories from imaging study requests, using a "What", "When", and "Where" methodology. Completeness of clinical history between groups was compared by Fisher exact and chi-square tests. The likelihood to have complete clinical history was measured by the odds ratio.

Results: 48.8% of musculoskeletal radiographs had a timely EHR clinical progress note available on the same calendar day the study was performed. There was no EHR note or a "late" EHR note in 27.8% and 23.4% of cases, respectively. Ninety percent of the "No EHR Records" group had incomplete clinical history, as compared to only 15.2% for the "On Time" group. The "On Time" group had superior quality for the "What" ($p < 0.001$) and "When" ($p < 0.001$) clinical history subcomponents, as compared to the "No EHR Records" group. The "On Time" group had a 50 times greater odds ($p < 0.001$) to have complete clinical information as compared to the "No EHR Records" group.

Conclusion: Musculoskeletal radiographs with a timely EHR clinical progress note are 50 times more likely than those with no EHR clinical progress note to contain complete clinical history for outpatient musculoskeletal radiographs. Clinical history provided by only the imaging study request is incomplete in 90% versus only 15% for those with a timely EHR clinical progress note. However, timely EHR clinical progress notes are only available in approximately 50% of cases. Future performance quality improvement initiatives to improve the clinical history available to radiologists for musculoskeletal imaging examinations are warranted.

Keywords: Clinical history; Electronic health record; Musculoskeletal; Outpatient; Radiograph; X-ray

Introduction

Diagnostic radiology practices rely on referring clinicians to provide clinical history for musculoskeletal radiographs, since most patients interact only with radiologic technologists and administrative staff [1-4]. Most radiologists have no contact with patients and interpret images based on review of clinical history sent with written imaging referrals [1]. Therefore, written communication between referring clinicians and radiologists is a critical component of patient care. Relevant clinical information is important for radiologists' workflow, to improve the accuracy of radiology final reports [5-7]. There is, however, a perception among radiologists that clinical history on imaging referrals is too often uninformative [1,8].

Diagnostic imaging examinations that lack appropriate clinical information, or do not contain a clearly defined clinical question, may in some cases have a detrimental impact on radiologists' final reports, leading to errors in diagnosis [1,7]. Imaging reports that do not provide clarity for the referring clinician or patient may lead to orders for additional imaging examinations or specialist consultation, creating unnecessary financial burdens on the health care system [9,10].

Electronic Health Record (EHR) systems offer the potential for improved communication between radiologists and referring clinicians. The Health Information Technology for Economic and Clinical Health Act of 2009 encouraged medical systems to transition from paper-based systems to EHR systems. Touted benefits of EHR include improvement in health information exchange, Computerized Order Entry (CPOE) systems, and clinical decision support tools [11]. Following this goal, 75% of hospitals in the United States had replaced their paper-based systems with an EHR system by 2015 [12].

In today's clinical practice, referrals for imaging studies are often entered directly into the EHR via CPOE [8,13]. One of the touted benefits of CPOE was elimination of paper-based requests from referring clinicians, with the theory that CPOE would eliminate illegible or incomplete orders [11,14]. However, despite the upgrade brought by EHR, CPOE does not necessarily improve the quality of clinical history for imaging study requests as compared to paper-based referrals [8,15].

With the implementation of the International Classification of Diseases, Tenth Revision (ICD-10) by the United States in 2015, new rules required a higher level of documentation to support the medical necessity of musculoskeletal imaging studies [16]. ICD-10 required a higher quality of clinical information in final radiology reports to justify billing. As a consequence, administrators in our academic practice began to encourage musculoskeletal radiologists more frequently to seek out additional clinical information from EHR clinical progress notes when the CPOE-submitted clinical history accompanying imaging study requests was considered insufficient to justify medical necessity of the imaging examination. We operated under the assumption that clinical progress notes in the EHR were the best source of clinical history. However, there are no studies to-date comparing the quality of clinical history in EHR clinical progress notes to imaging study requests, nor are there studies exploring how frequently imaging study requests have a corresponding clinical progress note in the EHR.

Therefore, our objectives were (1) to determine how often musculoskeletal radiographs at our outpatient imaging center were accompanied by complete clinical history available for real-time review by our radiologists on the same day the musculoskeletal radiographs were performed, (2) to determine the likelihood that timely EHR clinical progress notes contain complete clinical history for outpatient musculoskeletal radiographs as compared to those which were only accompanied by the clinical information sent on the referring clinicians' imaging study requests and (3) to estimate how often imaging requests for outpatient musculoskeletal radiographs have a corresponding timely EHR clinical progress note. We hypothesized that outpatient musculoskeletal radiographs with corresponding timely EHR clinical progress notes provided by the referring clinician would have a superior quality of clinical history as compared to those without a timely EHR clinical progress note. However, based on our anecdotal experience we expected that less than 75% of outpatient musculoskeletal radiographs would have a timely corresponding EHR clinical progress note.

Materials and Methods

Study Participants

This retrospective study was approved by the University of Maryland Baltimore Institutional Review Board which waived the requirement to obtain patients' informed consent. The study was compliant with Health Insurance Portability and Accountability Act guidelines. The study population consisted of all outpatients ≥ 18 years who received musculoskeletal radiographs at a single university-based urban outpatient imaging center over a consecutive 7-week period. Inclusion criteria: participants receiving radiographs of any part of the appendicular skeleton, spine, hip or pelvis. Exclusion criteria: participants receiving radiographs of the chest or abdomen were excluded, since these examinations are not typically considered musculoskeletal studies.

Data Acquisition

Following an electronic search of our picture archiving and communication system (PACS) and EHR system (EPIC at our institution), we identified a total of 445 musculoskeletal radiographs eligible for inclusion in the study (Table 1). The clinical history and radiograph type (e.g., right knee) from the referring clinicians’ CPOE imaging study referrals also were recorded from the EHR.

Imaging request	Number
Knee	103
Lumbar spine	56
Foot	54
Hip	38
Shoulder	37
Cervical spine	30
Hand	28
Ankle	19
Wrist	17
Elbow	14
Femur	14
Lower leg	12
Thoracic spine	10
Pelvis	3
Thoracolumbar spine	3
Scoliosis study	2
Sacroiliac joints	1
Scapula	1
Finger	1
Clavicle	1
Forearm	1
Total	445

Table 1: Frequency of radiographs by imaging request from referring clinicians.

Data Analysis

This study had two phases. In phase 1, we identified the frequency with which clinical history was provided with the imaging referral for the musculoskeletal radiograph(s) by the referring clinical via CPOE. We also separately performed a search in our institution’s EHR to identify the frequency of any relevant EHR clinical progress note(s) that were entered by the referring clinician either before or on the same day that our outpatient imaging center performed the musculoskeletal radiograph(s). We stratified the EHR search into 3 categories: (1) clinical progress note(s) placed into the EHR either before or on the same calendar day that radiograph(s) were available to the radiologist on our institution’s PACS (A.K.A., “On Time”); (2) clinical progress note(s) found in the EHR from the referring clinician, but with the note only available ≥ 1 calendar day after the radiograph(s) was available to the radiologist on our institution’s PACS (A.K.A., “Late”); and (3) no clinical progress note from the referring clinician available in the EHR (A.K.A., “No EHR Records”).

In phase 2, we evaluated the completeness of all clinical history that was available to the radiologist on the day that the outpatient imaging center performed the musculoskeletal radiograph(s). The goal for most diagnostic radiology outpatient imaging practices is to produce a final report on the same day a musculoskeletal radiograph is performed. Diagnostic radiologists’ typical workflow patterns to do not allow for delaying creation of final radiology reports while waiting to see if a referring clinician will place a clinical progress note in the EHR the next day or later in the week. We used a published “What”, “When”, and “Where” criteria introduced by Hawkins et al to assess the completeness of all clinical history available in timely EHR clinical progress notes (“On-Time” group) and also the clinical information submitted by the referring clinician via CPOE when requesting the musculoskeletal radiograph(s) [13,17]. For comparison, we also included the “No EHR Records” group in the phase 2 analysis. An ideal complete clinical history would include satisfactory information for all three elements. The “What” includes pertinent elements of the symptoms, signs, clinical concern, and/or mechanism of injury if applicable. The “When” details the duration or time course of the clinical problem. The “Where” explains the location of the clinical concern. A musculoskeletal radiologist with 10 years of experience and a senior diagnostic radiology resident reviewed study participants’ available composite clinical history which included both any available “On Time” group EHR clinical progress notes and all CPOE histories entered by the referring clinician with the musculoskeletal radiograph(s). Scores for clinical history completeness were determined by consensus. Each of the “What”, “When”, “Where” components of clinical history received one point if complete and zero points if incomplete; points were summed for a composite total score [possible range: 0 (lowest), 3 (highest)].

Statistical Analysis

Stata version 14 (StataCorp, College Station, Texas) was used to perform statistical analysis. Descriptive statistics were performed to determine the frequency of musculoskeletal radiographs per study participant and the frequency of study participants in each EHR clinical progress note category (“On Time”, “Late”, “No EHR Records”). Fisher exact or chi square tests were used to compare the “What”, “When” and “Where” composite scores between the “On Time” group and the “No EHR Records” group as appropriate. Fisher exact or chi square tests were used to compare the individual components of the “What”, “When” and “Where” scores between the “On Time” group and the “No EHR Records” group as appropriate. Odds ratio (OR) with 95% confidence interval (CI) was used to compare the “On Time” and “No EHR Records” groups for likelihood to have a complete clinical history for musculoskeletal radiographs. Fischer exact, chi square, and odds ratio tests were analyzed by study participant (n = 324), with all available clinical history evaluated in aggregate for each study participants with > 1 musculoskeletal radiograph. A P value < 0.05 was considered to represent a statistically significant difference.

Results

A total of 324 study participants received musculoskeletal radiographs, with approximately 24% receiving more than one (Figure 1). All study participants had a clinical history provided by the referring clinician at the time of CPOE for the musculoskeletal radiograph(s), which can be characterized as inclusive of ≥ 1 word entries. Example CPOE histories provided by referring clinicians with imaging requests include “pain”, “right hip pain and stiffness”, and “inability to bear weight”. For the frequency of musculoskeletal radiographs with timely EHR clinical progress notes, slightly less than one-half of study participants were in the “On Time” group (158/324), followed by the “No EHR Records” group (90/324) and the “Late” group (76/324) (Figure 2). There were only 10.0% of study participants in the “No EHR Records” group with the highest composite total score (“3”) representative of a satisfactory complete history for the “What”, “When”, and “Where” categories, as compared to 84.8% in the “On Time” group (Table 2). The “No EHR Records” group also led in the frequency of study participants with lowest composite total score (“1”) at 65.6% as compared to only 1.3% in the “On Time” group.

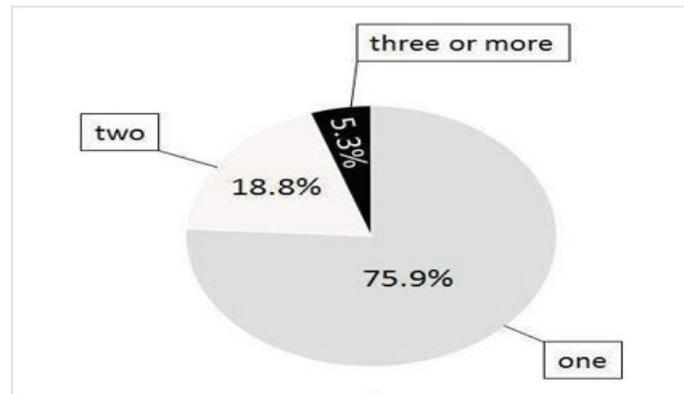


Figure 1: Pie chart illustrating the frequency of study participants with 1, 2, or ≥ 3 musculoskeletal radiographs.

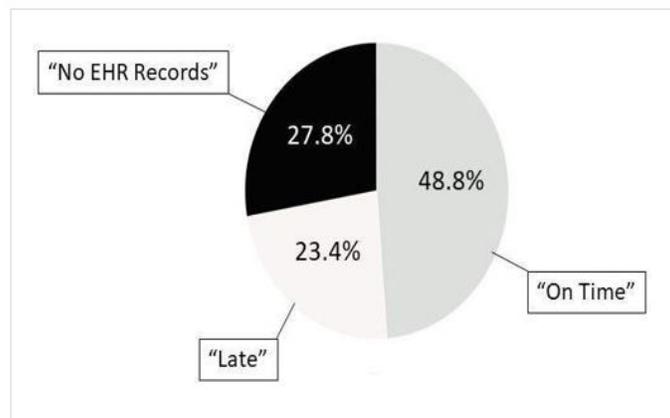


Figure 2: Pie chart illustrating the frequency of clinical progress notes corresponding to musculoskeletal radiograph imaging study requests in the electronic health record (EHR). “On Time”: a clinical progress note is available for review in the EHR on the same calendar day that the radiograph was completed. “Late”: clinical progress note appears in the EHR but only ≥ 1 calendar day after the radiograph was performed. “No EHR Records”: no EHR clinical progress note exists.

Composite Total Score	“On Time” Group % (Number/Total)	“No Records” Group % (Number/Total)	P
1	1.3 (2/158)	65.6 (59/90)	<0.001
2	13.9 (22/158)	24.4 (22/90)	0.037
3	84.8 (134/158)	10.0 (9/90)	<0.001

* = Electronic Health Record

Table 2: Comparison of the What-When-Where composite total score for the “On Time” group versus the “No EHR* Records” group, when considering both the clinical history provided by the referring clinicians’ imaging requests and any available EHR clinical progress note.

All study participants were determined to possess adequate information to determine the “Where” component of clinical history when considering the CPOE provided imaging request information of the desired body part to receive radiographs (e.g., “right ankle”) or information available in the EHR clinical progress notes. However, significant differences existed for the frequency of study participants with adequate information available for “What” and “When” between the “On Time” and “No EHR Records” groups (Table 3). Study participants with no clinical progress note in the EHR (“No EHR Records”) group did not have adequate information for the “What” and “When” categories in 72.2% and 83.3%, respectively. By contrast, study participants with an EHR clinical progress note (“On Time” group), only failed to have adequate clinical history for the “What” and “When” categories in 1.9% and 15.2%, respectively. Study participants with an EHR clinical progress note (“On Time” group) had a 50 times greater odds (OR 50.3; 95% CI 21.1, 126.5; $p < 0.001$) to have complete clinical information for their musculoskeletal radiograph as compared to study participants who did not have an EHR clinical progress note (“No EHR Records” group).

	“On Time” Group % (Number/Total)	“No EHR Records” Group % (Number/Total)	P
What	98.1 (155/158)	27.8 (25/90)	< 0.001
When	84.8 (134/158)	16.7 (15/90)	<0.001
Where	100.0 (158/158)	100.0 (90/90)	1

* = Electronic Health Record

Table 3: Comparison of the “On Time” group versus the “No EHR* Records” group with adequate clinical history in the “What”, “When” and “Where” categories, when considering both the clinical history provided by the referring clinicians’ imaging requests and any available EHR clinical progress note.

Discussion

Our study found that outpatient musculoskeletal radiographs with corresponding timely EHR clinical progress notes are 50 times more likely to provide complete clinical history as compared to those with no EHR clinical progress note. However, we estimate that at our institution only approximately one-half of outpatient musculoskeletal radiographs have a corresponding timely clinical progress note in the EHR on the same day that a final radiology report is expected to be produced (i.e., the date that the musculoskeletal radiograph is performed). Although this is a single center study, this is the first study to the authors’ knowledge to estimate the frequency of outpatient musculoskeletal radiographs with an available corresponding timely EHR clinical progress note or to compare the quality of completeness of clinical history for outpatient musculoskeletal radiographs with and without timely EHR clinical progress notes.

Our finding that 90% of imaging study requests contain poor quality clinical history is in-line with prior studies [13,17]. Hawkins et al., estimated that 78% of radiography examination requests provide inadequate clinical history in patients seen in the emergency department and outpatient setting [17]. During an audit of a large Health Maintenance Organization (HMO) practice, Bor et al., found that referring clinicians provide incomplete clinical history for radiographs 84% of the time [13].

Ideally, referring clinicians should place clinical progress notes in the EHR that summarize patients’ subjective complaints and objective findings, in addition to bestowing an assessment and plan. EHR clinical progress notes aid radiologists by providing (1) complete clinical history to support interpretation of diagnostic imaging studies and (2) the context to justify the medical necessity of imaging examinations for billing purposes. However, referring clinicians may not have incentive to provide appropriate clinical history with imaging study referrals, since there is no tangible penalty for failing to do so [18].

Access to EHR clinical progress notes for radiologists may reduce the risk of producing diagnostic errors and increase the chance of avoiding financial penalties when justifying medical necessity to public and private payors [8,18,19]. Clinical history aids radiologists’ ability to perceive and to interpret abnormal features in the correct context for imaging studies [6,7,20]. Incomplete clinical history increases the likelihood that radiologists will “miss” the correct diagnosis, resulting in diagnostic error [5]. Complete clinical history for musculoskeletal radiographs is particularly important. Kim et al, in a large series of diagnostic errors from seven imaging modalities, reported that the majority of cases involved radiographs and that 66% were musculoskeletal imaging studies [20].

We hypothesize that referring clinicians' workflow accounts for the superior quality of clinical history found in EHR clinical progress notes as compared to CPOE imaging study requests. In general, referring clinicians spend the bulk of their time methodically documenting patients' subjective complaints and objective findings, then carefully recording their medical "Assessments" and "Plans". The EHR clinical progress note is intended as a permanent record, to inform current and future care of the patient. To the contrary, a referring clinician likely spends thirty seconds or less placing a CPOE imaging request, similar to when ordering a medication or laboratory test. EHR systems typically are designed to require placement of "clinical information" into a mandatory data entry field when requesting an imaging study. We posit that referring clinicians view placement of clinical history summarized by a short phrase or a single word as sufficient to meet the requirement imposed by the EHR system.

Performance quality improvement initiatives to improve communication of relevant clinical history to radiologists for musculoskeletal imaging studies is critical to ensure best practices are met for patients. Orthopaedic Surgeons, Rheumatologists, Rehabilitation Specialists, Primary Care Practitioners, among others, can improve the care they provide to patients by partnering with radiologists and their regional medical communities. Our study provides preliminary baseline evidence for future performance quality improvement initiatives designed to improve communication of patient history among healthcare providers relevant for musculoskeletal imaging examinations.

Our study is not without limitations. The study design was retrospective and performed at a single institution. Our study may not be generalizable to diagnostic radiology practices of different size, region, business practice, or EHR system workflow. However, we performed our study to establish a baseline estimate of how often clinical history accompanying outpatient musculoskeletal radiograph imaging requests is incomplete. Our study may serve as a starting point for other healthcare systems or radiology practices to measure themselves against. The methods of the study were designed to measure the completeness of clinical information found in imaging study requests for outpatient musculoskeletal radiographs and corresponding timely EHR clinical progress notes. The study did not attempt to answer the question as to whether or not the provided clinical history made any impact on the actual final report(s) of the musculoskeletal radiograph(s). Future studies will be needed to determine how the quality of clinical history from EHR clinical progress notes, as compared to imaging study requests alone, impacts the actual diagnostic interpretation of musculoskeletal radiographs by musculoskeletal or general radiologists in final radiology reports; and also to quantify the quality of a clinical history's financial impact on diagnostic radiology practices' ability to document radiographs' medical necessity for billing purposes. The study included only outpatient radiographs. Future studies will be needed to determine the effect of quality for the clinical history provided with inpatient musculoskeletal radiographs.

Conclusion

Outpatient musculoskeletal radiographs with corresponding timely EHR clinical progress notes are 50 times more likely to provide complete clinical history as compared to those with no EHR clinical progress note. Musculoskeletal radiographs have poor quality clinical history in 90% of cases when relying only on imaging referrals, as compared to only 15% when a timely EHR clinical progress note is available. However, timely clinical progress notes are available in the EHR only about 50% of the time on the same day an outpatient imaging center performs a musculoskeletal radiograph. Our study provides important baseline evidence for future performance quality improvement initiatives designed to improve communication among healthcare providers and radiologists for musculoskeletal imaging examinations.

Financial Disclosure / Conflicts of Interest

None to report.

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