Inadequate Clinical Indications in Computed Tomography Chest and Abdomen/Pelvis Scans

Alyssa Finger; Mark Harris; Emily Nishimura; Hyo-Chun Yoon, MD, PhD

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ABSTRACT

Context: As the use of computed tomography (CT) scans, which are expensive and result in considerable radiation exposure to the patient, continues to increase, communication between physicians and radiologists remains vital to explain the clinical context for the examination. However, the clinical information provided to the radiologist is often lacking.

Objective: To determine whether the clinical information provided in CT scan requests meets minimum criteria for requesting the examination.

Methods: We reviewed the clinical indications for 400 CT chest scans and 400 CT abdomen/pelvis scans performed from January 1, 2016, through March 8, 2016. We determined whether each CT study indication was complete on the basis of whether the clinical information included an adequate clinical history with 1) a primary symptom, 2) the location of the symptom, and 3) the duration of the symptom as well as a suspected etiology.

Results: Of the CT chest indications, 56 (14.0%) of the clinical histories were considered complete and 17 (4.3%) had none of the components. A principal etiology was included in 195 (48.8%) of the indications. Of the CT abdomen/pelvis indications, 94 (23.5%) of the clinical histories were complete and 13 (3.3%) had none of the components. A principal etiology was included in 173 (43.3%) of the indications. Only 23 (5.8%) of the CT chest studies and 35 (8.8%) of the CT abdomen/pelvis studies had information considered sufficient for the radiologist.

Conclusion: The percentage of complete clinical indications for both CT chest and abdomen/pelvis scans was much lower than 50%, suggesting that more emphasis should be placed on providing complete clinical indications.

INTRODUCTION

Communication between physicians ordering imaging studies and the radiologists reporting the findings of those studies is important. In the advancing digital age, there are fewer face-to-face interactions between physicians, which increases the need for concise but complete written information. There have been considerable efforts made to standardize radiologic reports, especially for complex imaging studies such as computed tomography (CT) or magnetic resonance imaging. Most of this work has focused on how to best report the findings of such imaging studies using reporting templates. There has been less emphasis on the clinical information provided to the radiologist explaining the indications for the examination and the clinician's principal diagnostic concerns.

In a study analyzing the radiologists' perspectives on communication with other clinicians, the authors found that insufficient information in the request forms from referring physicians was a major concern expressed by the radiologists.[1] Lack of relevant clinical information, unclear clinical questions, and use of uncommon abbreviations were also highlighted as problem areas.[1]

The purpose of our study was to determine whether the clinical indications and diagnostic concerns provided for CT studies of the chest and abdomen/pelvis meet minimum criteria for requesting the examination to better determine appropriate utilization of imaging as it is necessary for clinical interpretation by the radiologist. On the basis of the clinical experience of our staff radiologist and other colleagues in the Radiology Department, we predicted that less than 50% of the clinical indications would contain sufficient information.

METHODS

This was a retrospective study approved by our institutional review board with a waiver of consent because this was a data-only study with no patient interactions. We reviewed the clinical indications associated with 400 sequential CT chest scans and 400 sequential CT abdomen/pelvis scans that were performed from January 1, 2016, through March 8, 2016. We estimated that this number of studies would yield an adequate sample size to identify statistically significant differences. We included only those CT scans ordered by primary care or emergency medicine physicians. Although specialists should also provide adequate information in their clinical indications, they often request specific CT studies for unique indications such as CT colography for detection of colon polyps by gastroenterologists and high-resolution chest CT for interstitial lung disease by pulmonologists. Therefore, we chose to focus this study on the clinicians who contribute the majority of orders for routine CT studies of the chest and abdomen/pelvis in this health maintenance organization. We also kept track of the individual ordering physicians so that no ordering physician comprised more than 5% of the total for each of the 2 types of imaging studies, potentially skewing the data. However, our results showed that no physician ordered more than 3% of the studies, meaning our concern was not an issue. All CT studies were performed on members of a health maintenance organization for whom

Alyssa Finger is a Senior Undergraduate Student at Creighton University in Omaha, NE (amf70738@creighton.edu). **Mark Harris** is a Traumatic Brain Injury Clinical Research Coordinator at the University of California, San Francisco (mark.harris2@ucsf.edu). **Emily Nishimura** is a Junior Undergraduate Student at Pomona College in Claremont, CA (emna2016@mymail.pomona.edu). **Hyo-Chun Yoon, MD, PhD,** is the Assistant Chief of Diagnostic Imaging for the Hawaii Permanente Medical Group (hyo-chun.yoon@kp.org).

all radiology orders are placed through an electronic medical record (EMR; Epic, version 2015, Epic Systems, Verona, WI).

We determined whether each CT study indication included an adequate clinical history and a suspected etiology. We defined the minimum criteria for an adequate clinical history as including 1) at least one primary symptom, 2) the location of the symptom, and 3) the duration of the symptom, as was recommended in a previous study by Ihuhua and Pitcher.[2] Additional clinical history such as pertinent laboratory results or prior imaging findings were noted but not required for the clinical history to be considered adequate. The Royal College of Physicians' definition of adequacy of clinical details for an imaging study requires inclusion of a clear clinical question.[3] Therefore, a complete clinical indication should also include a primary suspected etiology, meaning a primary suspected cause of the symptoms the patient is experiencing (ie, "suspect pneumonia" or "possible aortic dissection").

To account for subjectivity, 3 authors individually graded each CT study and determined whether they included the minimum criteria to constitute a sufficient clinical history. Discrepancies were discussed as a group to reach a consensus. We first recorded the relevant keywords for each field of the clinical history: 1) the primary symptom, 2) the location of the symptom, and 3) the duration of the symptom. See Table 1 for our scoring system. A score of 0 was given if the field was not complete and a 1 was given if it was complete. For the duration criteria, we graded continuous and ordinal data as complete, meaning that specific dates or amounts of time and words that provide a rough estimate of time such as "persistent," "ongoing," "acute," and "chronic" were all counted as a 1. A clinical history with a score of 3 was considered adequate. An additional point was given if there was a principal suspected etiology. If the CT request included both a complete clinical history (ie, including a primary symptom, a location, and a duration) as well as a principal suspected etiology, then the request was considered to have an adequate clinical indication with a total score of 4. We also identified the most frequently used words within each clinical criterion. Associations between the 2 categories of data, namely CT chest scans and CT abdomen/pelvis scans, were analyzed using the χ^2 test with significance defined as $p \leq 0.05$.

RESULTS

The CT chest scans evaluated spanned a period from January 1, 2016, to March 8, 2016. Of the clinical indications analyzed, only 56 (14.0%) of the clinical histories were considered complete, 327 (81.8%) had 1 or 2 components, and 17 (4.3%) had none of the components. A principal etiology was included in 195 (48.8%) of the indications; 23 (5.8%) of the studies had both a complete clinical history and etiology present (Table 2). The CT abdomen/pelvis scans evaluated spanned a period from January 1, 2016, to February 15, 2016. Of the clinical indications analyzed, 94 (23.5%) of the clinical histories were complete, 293 (73.3%) had 1 or 2 components, and 13 (3.3%) had none of the components of a clinical history whatsoever. A principal etiology was included in 173 (43.3%) of the indications; 35 (8.8%) of the studies had both a complete clinical history and etiology present (Table 2).

Table 1. Scoring chart

Factor	Score
Primary sign/symptom	Present = 1 Not present = 0
Location of symptom	Present = 1 Not present = 0
Duration of symptom	Present = 1 Not present = 0
Primary suspected etiology	Present = 1 Not present = 0
Total score	Sum all scores

Table 2. Prevalence of clinical indication fields for CT chest and CT abdomen/pelvis scans, no. (%)

Clinical indications	CT chest (n = 400)	CT abdomen/pelvis (n = 400)
Clinical history score: 0	17 (4.3)	13 (3.3)
Score: 1	156 (39.0)	82 (20.5)
Score: 2	171 (42.8)	211 (52.8)
Score: 3	56 (14.0)	94 (23.5)
Suspected etiology	195 (48.8)	173 (43.3)
Complete clinical indication (score 4)	23 (5.8)	35 (8.8)

CT = computed tomography.

Table 3. Prevalence of components in clinical histories with at least one component, no. (%)

Component	CT chest (n = 383)	CT abdomen/pelvis (n = 387)
Symptom	350 (91.4%)	369 (95.3%)
Location	209 (54.6%)	299 (77.3%)
Duration	107 (27.9%)	119 (30.7%)

CT = computed tomography.

As shown in Table 2, CT chest scans were less likely to have a complete clinical history and etiology than CT abdomen/pelvis scans (χ^2, $p < 0.001$). As shown in Table 3, CT abdomen/pelvis scans were more likely to have any component of the clinical history than CT chest scans (χ^2, $p = 0.01$). The primary difference in the clinical histories arose in the inclusion or absence of a location. In CT chest scans, a location was provided in only 209 (54.6%), whereas it was provided in 299 (77.3%) of the CT abdomen/pelvis scans. We found that there was no significant difference in the presence of a primary sign or symptom and duration between CT abdomen/pelvis and CT chest scans (χ^2, $p = 0.73$). There was no significant difference in the presence of a primary suspected etiology between CT abdomen/pelvis and CT chest scans (χ^2, $p = 0.12$).

As shown in Table 3, the most consistently included component for CT scans of the chest was the primary symptom, which was found in 350 (91.4%) of the 383 studies where at least 1 component was present. Duration was the least commonly included component of the clinical history, as it was found in only 107 (27.9%) of the studies where at least 1 component was present. For CT scans of the abdomen/pelvis, a sign or symptom

was again the most included component; it was found in 369 (95.3%) of the 387 studies where at least 1 component was present. Symptom duration was found in 119 (30.7%) of the clinical histories, again making it the least included component.

As shown in Table 4, the most commonly used words to describe a sign or symptom among the CT chest scans were "nodule" or "mass," as they were included in 90 (22.5%) of the 400 scans evaluated. The most common word used to describe location was "x lobe," for example, right upper lobe. The most common word used to describe duration was "x months," for example, 6 months. The most commonly used word to describe the primary sign or symptom for CT abdomen/pelvis scans was "pain," as it was present in 267 (66.8%) of the clinical histories. The most common location was "x quadrant," and the most common duration was "x days."

A total of 181 referring physicians ordered at least 1 of the 400 CT chest studies that were analyzed. The largest number of studies ordered by a single physician was 12. There were 4 physicians whose CT requests had at least 1 clinical indication with a total score of 1 as well as at least 1 clinical indication with a total score of 4. Each of these physicians ordered between 6 and 12 studies, of which each physician had only 1 study with a complete clinical indication while 3 of these physicians had more than 1 study with a score of 1. A total of 173 physicians ordered at least 1 of the 400 CT abdomen/pelvis studies that were analyzed. The largest number of studies ordered by a single physician was 8. There were 4 physicians whose CT requests had at least 1 clinical indication with a total score of 1 as well as at least 1 clinical indication with a total score of 4. Each of these physicians ordered between 6 and 8 studies. Two of these 4 physicians had 2 studies with complete clinical indications (ie, a score of 4), whereas the other 2 physicians each had 1 study with complete clinical indications. Three of the 4 physicians had more than 1 study with a clinical indication score of 1. There was no physician who accounted for more than 3% of CT chest studies or CT abdomen/pelvis studies, demonstrating that no single physician impacted the results of this study.

DISCUSSION

In this study, we chose to focus on CT examinations of the chest and abdomen/pelvis because these studies result in considerable radiation exposure to the patient and are expensive.[4]

There is little controversy over the utility of providing adequate clinical information when ordering CT scans.[5-7] Despite the importance of having a comprehensive clinical history, several studies have suggested that the information given to the radiologist providing these cross-sectional studies is lacking.[8-12] For the purposes of this study, we defined clinical indication as comprising 2 fields: Clinical history and primary suspected etiology. In a study by Pack et al,[9] 6 neuroradiologists evaluated 100 clinical histories associated with requests for magnetic resonance imaging of the brain. They graded each test to be either low or high indication, which indicated the probability of a positive or negative result. They found that on the basis of the provided clinical history, 54 studies were considered low-indication and 46 were considered high-indication. When the

Table 4. Five most common words used for each component, no. (%)

Word ranking	CT chest symptom	CT chest location	CT chest duration	CT ab/pel symptom	CT ab/pel location	CT ab/pel duration
1	Nodule/mass, 90 (22.5)	X lobe, 61 (15.3)	X months, 17 (4.3)	Pain, 267 (66.8)	X quadrant, 110 (27.5)	X days, 28 (7.0)
2	Pain, 63 (15.8)	Lung, 17 (4.3)	Chronic, 14 (3.5)	Hematuria, 36 (9.0)	Flank, 49 (12.3)	Persistent, 17 (4.3)
3	Density/opacity, 25 (6.3)	Pleural, 17 (4.3)	Persistent, 9 (2.3)	Nausea/vomiting, 20 (5.0)	Lower abdomen, 25 (6.3)	X months, 17 (4.3)
4	Cough, 21 (5.3)	Bilateral, 12 (3.0)	X days, 8 (2.0)	Weight loss, 15 (3.8)	Epigastric, 16 (4.0)	Chronic, 7 (1.8)
5	Abnormal CXR/ abnormality, 20 (5.0)	Back, 12 (3.0)	X weeks, 7 (1.8)	Diarrhea, 16 (4.0)	Upper abdomen, 16 (4.0)	Yesterday, 7 (1.8)

Ab = abdomen; CT = computed tomography; CXR = chest radiograph; Pel = pelvis.

Table 5. Examples of CT chest and CT abdomen/pelvis clinical indications with no clinical history compared with those with a complete clinical history

Examples of CT chest clinical indications with no clinical history	Examples of CT chest clinical indications with complete clinical history	Example of CT abdomen/pelvis clinical indications with no clinical history	Examples of CT abdomen/pelvis clinical indications with complete clinical history
"metastatic lung cancer"	"12-month follow-up for right upper lobe pulmonary nodule. Suspect granuloma"	"CT renal stone protocol, no IV/ oral contrast, please evaluate for kidney stone"	"3 days of anorexia now with pain localizing to RLQ. Suspect appendicitis"
"f/u stg 3 lung ca, c/w prior imaging please"	"Suspect pneumonia in patient with 7 days of cough and right-sided rhonchi"	"abdominal pain, IV, and oral contrast"	"LLQ pain and tenderness for 1 week, now with fever and white count. Evaluate for diverticular abscess"
"sarcoma follow-up"	"1-day history of severe midline chest pain radiating to back. Possible aortic dissection"	"suprapubic pain"	"Diffuse abdominal pain and tenderness after no bowel movement for 5 days. Constipation versus SBO"

ca = cancer; CT = computed tomography; c/w = consistent with; f/u = follow-up; IV = intravenous; LLQ = left lower quadrant; RLQ = right lower quadrant; SBO = small-bowel obstruction; stg = stage.

neuroradiologists reviewed the patients' medical charts, they determined that 62 were low-indication requests, whereas 38 were high-indication. On the basis of the provided clinical information alone, 37% of the high-indication studies had positive findings. After full medical chart review, 61% of the high-indication studies yielded at least 1 positive finding.

When inaccurate information is provided, the report is also more likely to be inaccurate. In a prospective study of 50 consecutive patients undergoing CT scans, 2 radiologists interpreted each study before and after knowledge of the clinical information[13]; 19 of these reports were changed after clinical information was provided. On the basis of clinical follow-up, 10 reports were found to be more accurate after clinical information was provided, but in 5 cases the report was found to be more inaccurate. In 3 of those 5 cases where accuracy was reduced, the clinical information was incorrect.

Before the advent of an EMR, physicians filled out request forms on paper and wrote down the patient's information, which included patient's sex, age, and date of birth. This led to many opportunities for incomplete or inaccurate information to be supplied to the radiologist.[8] Now, all imaging studies ordered within this health maintenance organization are done so electronically. Therefore, when the request for a CT study is generated, some of the patient's demographic information, such as age and sex, as well as an International Classification of Diseases, 10th Revision code are automatically included as part of the clinical indication.

In our version of the EMR, there is currently no method to directly extract the primary symptom, duration, and location from the referring physician's electronic progress note or history and physical examination into the clinical indication. This problem is further complicated by the fact that the CT order can be placed before the physician's note has been completed in the EMR, which is especially common in orders from our Emergency Department. Finally, there is no requirement that the International Classification of Diseases, 10th Revision code, which the referring physician selects, must be the primary suspected etiology. Frequently, it can be a sign or symptom that initiated the patient's visit to the referring physician but not the reason for which the CT study was ordered.

Our results showed that only 5.8% of the CT chest studies and 8.8% of the CT abdomen/pelvis studies had information that we considered sufficient for the radiologist. One possible explanation for the difference between chest and abdominal CT studies could be that patients with suspected chest pathology often have nonlocalizing symptoms such as cough, hemoptysis, or shortness of breath. Ordering physicians usually provided a primary sign or symptom, but its location and duration were frequently missing. The primary suspected etiology was provided in less than half of the CT requests.

In a busy clinical practice, referring physicians cannot be expected to fill out long requisition forms, nor should radiologists be expected to peruse the EMR of every patient with a CT study. Therefore, we believe a reasonable compromise is to require a 1 or 2 sentence clinical indication, which includes the chief sign or symptom, its location, and its duration, as well as the principal suspected etiology.

To write a concise 1- or 2-sentence indication that provides sufficient information, the physician's word choice is crucial. There were 17 CT chest scans and 13 CT abdomen/pelvis scans with no clinical history. Fortunately, all of the pertinent information for the clinical indication can be provided in 1 or 2 concise sentences.

Examples of clinical indications with no clinical history compared with clinical indications with a complete clinical history expressed in 1-2 sentences are shown in Table 5. These incomplete clinical histories could have been readily supplemented with more information while still keeping the indication brief. "Metastatic lung cancer" could be changed to "Metastatic lung cancer, right upper lobe, 6-month follow-up, eval for progressive disease"; and "follow-up stage 3 lung cancer, consistent with prior imaging please" could be changed to "stage 3 lung cancer, originated from right lower lobe, 6-month follow-up, eval for progressive disease." "Sarcoma follow-up" could be changed to "primary retroperitoneal sarcoma originally diagnosed 1 year ago, evaluate for metastases." "CT renal stone protocol, no IV/oral contrast, please evaluate for kidney stone" could be changed to "right kidney pain, 3 days, please evaluate for kidney stone."

We sampled clinical indications from a large number of different requesting physicians for both the CT chest scans and CT abdomen/pelvis scans. The physicians who wrote a complete or incomplete clinical indication varied for both types of scans. In several cases, a physician had both a clinical indication that was complete for one CT scan request as well as another CT request in which the clinical indication contained only a single component.

To prevent this sort of variation, we propose including a short reminder at the beginning of every computerized order entry request that states, "To prevent a possible delay in scheduling, please include 1) sign/symptom, 2) location, 3) duration, 4) etiology." Another possibility would be to implement an EMR "hard stop" (with check boxes and area for comments or additional information) built in that does not allow clinicians to complete the order until the requested information is provided.

A limitation of this study is its retrospective nature as there was no requirement for physicians to input a complete clinical history to order a CT scan at the time they wrote the request. This was performed at one location at one point in time, which might not be reflective of clinical practice in other locations. Additionally, there is also currently no consensus on what constitutes a complete clinical history. We used the Royal College of Physicians' recommendation as a reference.[3] Finally, to our knowledge improved outcomes have not been proven in the medical literature even with provision of additional clinical history.

CONCLUSION

The percentage of complete clinical indications for both CT chest and abdomen/pelvis scans was much lower than 50%, indicating a need for a method to assist clinicians in documenting the clinical indications for the studies they order. ❖

Conflicts of Interest

The author(s) have no conflicts of interest to disclose.

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