Appropriateness and clinical outcome of chest computed tomography without intravenous contrast; A study conducted in Pakistan

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ABSTRACT

Background: CT chest including high resolution computed tomography (HRCT) has become an integral part of modern healthcare. This enables the physician to make a diagnosis by a noninvasive approach. Our practice has shown than many CT chest without IV contrast including HRCT have no proper clinical indication. For the same reason, we have assessed the appropriateness of CT chest without IV contrast as per evidence based American College of Radiology (ACR) appropriateness criteria.

Methods: CT chest without IV contrast examinations were reviewed to evaluate if the examination is based upon the evidence based ACR appropriateness criteria. All clinical indications, positive physical examination findings, laboratory test findings and the radiological record submitted at the time of CT chest exams were reviewed

Results: Out of 1205 CT scans, 538 (44.6%) were "inappropriate", 367 (30.4%) were "appropriate" and 300 (24.8%) were "may be appropriate". CT scans of 241 (20.0%) of the patients were performed without any record of any clinical history whereas 148 (12.3%) examinations in patients less than 40 years of age were performed with no positive physical finding. Positive results that affected the management were 4.43 times more likely to be appropriate as compared inappropriate (AOR: 4.43, 95% CI: 1.81-10.87).

Conclusion: This study showed a high percentage of chest CT scans without IV contrast examinations not meeting the ACR appropriateness criteria. Chest CT is a valuable tool for evaluation of chest diseases only in the presence of adequate detailed history and physical examination

Keywords: ACR appropriateness criteria; CT chest without IV contrast; clinical indications; Outcome

INTRODUCTION

Computed tomography (CT) and magnetic resonance imaging (MRI) have become an integral part in modern health care as they provide a diagnosis by a noninvasive approach and have remarkably improved the outcome as well. However, a heavy reliance on imaging is straining the healthcare budget and harming the healthcare system's sustainability [1]. Appropriateness of indications of many of these examinations is controversial. Many authors have worked on this subject and many guidelines and criteria have been published [2-4].

High resolution computed tomography (HRCT) has revolutionized the chest imaging by utilization of thin cuts and image reformatting to yield accurate results. Its role is well established in diagnosis of many pulmonary pathologies and guiding management [5-8]. Indications for the use of chest HRCT have been well established [6,9-12]. HRCT together with appropriate clinical history can result in a highly specific diagnosis [13].

In developing country like Pakistan, chest diseases are significantly prevalent [14]. In particular, tuberculosis covers a major part of chest diseases in this cohort [15]. Our university hospital is located in one of a densely populated city and has a specialized chest institute comprising of approximately 200 beds. This institute provides free of cost treatment to all chest disease patients and is declared center of excellence for Tuberculosis by World Health Organization (WHO). However, subsidized charges for diagnostic studies are obtained from the patients. Getting a CT examination in a low income country is a privilege and health insurance coverage is not covered by the government.

In our practice, it was observed that most of the general physicians and chest physicians recommend CT chest without IV contrast, more specifically plain HRCT chest to reach the early diagnosis on the basis of disease suspicion without any preliminary chest X-ray or lab investigation. Moreover, many CT scans are prescribed without any clinical indications. Each clinical indication, when provided, is usually assessed by a radiologist. In case when clinical indication is not provided or there is any ambiguity regarding diagnostic investigation, clarity is established after taking detailed history from patient and talking to primary

physician for patients admitted in our institute. However, it is difficult on cases coming from various parts of the city/country as it takes a lot of time to find out the primary care physician contact or lost hard copies by the patients. The needless use of CT chest without IV contrast and plain HRCT could not only increase the risk of exposure to high radiations but also as a population of low and middle income country, creates a large financial burden on the patients. Studies have reported that most of the patients belong to low socioeconomic status in a developing country [16-18]. For the same reason, appropriate use of CT chest is highly recommended particularly in developing country.

The American College of Radiology (ACR) appropriateness criteria are the evidence based guidelines for primary care physicians to provide assistance to them for appropriate use of an imaging technique for a specific clinical condition. Utilization of these guidelines can lead to effective use of radiology services and improve the quality of patient care. Therefore, this study was undertaken with the aim to assess the appropriateness and outcomes of CT chest examinations without IV contrast according to the ACR appropriateness criteria in a developing country.

MATERIALS AND METHODS

A retrospective review of medical records from 1st January till 31st December 2015 was carried out. The electronic medical record was searched for CT chest, CT chest without IV contrast and plain CT chest. The ACR appropriateness criteria [19-21] that included radiological procedure "CT chest without IV contrast" was used to assess if each examination met the appropriateness criteria based upon the clinical indication provided by the primary care physician. (Table 1) The reports of radiology were reviewed for the clinical indications or the presenting complaints of the patient. Any available clinical detail, positive physical examination finding, laboratory test finding or the radiological record before the scan date was also reviewed. A senior radiologist applied the appropriateness criteria on the reviewed records within one year of 2015. On the basis of available information, these

records were labeled as appropriate, may be appropriate and inappropriate according to the ACR appropriateness criteria.

After the initial analysis of clinical indications, the radiology reports and medical records related to that particular examination were reviewed and analyzed. The final diagnosis were noted from the radiology report or available medical record and based on those diagnosis the records were grouped into four categories: positive result that affected management (active infection, acute on chronic infection, bronchogenic carcinoma, chronic obstructive pulmonary disease with or without exacerbation, pulmonary metastasis, occupational lung disease, foreign body), positive results that did not have role in management (changes of old healed infection in lungs), positive findings that were unrelated to the clinical indications (incidental findings, cardiac and vascular related abnormalities) and negative (normal scans or nonspecific findings that did not fit into a single clinical spectrum such as calcified lymph nodes or calcified granulomas).

The protocol of this study was approved by the Institutional Review Board (IRB-814/DUHS/Approval/2016/32, Dated: 21st January 2017). The requirement for signed informed consent was waived as data was retrospectively collected from the electronic medical records.

For the purpose of statistical analysis, first, frequencies and percentages were calculated for the variables like gender, clinical indications, outcome and ACR appropriateness. Chi-square test was applied to see the difference of outcome of the examinations (positive and affected management, positive and did not affect management, positive and unrelated to management and negative) with appropriateness level (appropriate/may be appropriate/inappropriate). Second, a multinomial logistic regression was applied to estimate the odds ratio and two-tailed 95% CI. Inappropriate level was taken as reference category.

RESULTS

Out of 1205 patients, majority were females 688 (57.1%). Median age of the patients was 51.5 (40-63) years.

Interstitial lung disease (ILD) was the most frequent final diagnosis on CT chest examinations without IV contrast, i.e. 276 (22.9%) followed by active infection 268 (22.2%), acute on chronic infection 214 (17.8%) and old healed infection 165 (13.7%). (Table 2)

Majority 538 (44.6%) cases were inappropriate as their clinical indications did not match the ACR appropriateness criteria for CT chest without IV contrast, 300 (24.8%) were may be appropriate while only 367 (30.4%) were appropriately indicated.

Two hundred and forty one (20.0%) CT scans were performed without any record of any clinical history whereas 148 (12.3%) examinations in patients less than 40 years of age were performed with no positive physical finding. Inappropriate clinical indications are shown in detailed in Table 3.

Outcome of imaging showed that overall 836 (69.4%) patients had positive results that affected management, 175 (14.5%) had negative results, 159 (13.2%) had positive results that did not have role in management while 35 (2.9%) patients had positive findings that were unrelated to the clinical indications.

Comparison of outcome of imaging with appropriateness categories showed that negative outcome was significantly higher (n=115, 65.7%) among patients with inappropriate status as compared to appropriate (n=33, 18.9%) and may be appropriate (n=27, 15.4%) (p-value <0.001). (Figure 1) Positive results with affected management were 4.43 times significantly more likely to be appropriate as compared to inappropriate (AOR 4.43, 95% CI 1.81-10.87, p-value 0.001). Moreover, positive results with unaffected management were 3.61 times more likely to be may be appropriate than that of inappropriate (AOR 3.61, 95% CI 1.36-9.57, p-value 0.010). (Table 4)

DISCUSSION

The study reports high proportion of inappropriate cases as per ACR appropriateness criteria [22]. Majority of these inappropriate cases were prescribed with no clinical indications. ACR guidelines recommend that a clinician's request should provide enough information related to patient's condition to justify the HRCT use and allow the adequate performance and interpretation of the examination requested [23]. Additional information with specific reason should be documented with relevant diagnosis or provisional diagnosis that may be helpful for interpretation.

In addition to this, a considerable number of patients with <40 years of age without any risk factors or positive physical findings were advised for CT chest without IV contrast which is also not recommended by ACR appropriateness criteria. A chest radiograph should be prescribed in patients with symptoms of acute respiratory infection having positive signs on physical examination [24]. According to appropriateness criteria a chest radiograph may have been appropriate in these patients as study by Butcher et al. showed no difference in clinical findings among patients with positive and negative radiographic finding [25]. In our study, few patients had suspicion of acute exacerbation of COPD and acute asthma but had no other symptom thus making the use of plain CT chest inappropriate in these patients as well. It is reported that HRCT in such patients can be performed when pneumonectomy or lung volume resection surgery is to be planned [26].

The finding of our study also reported that more than one fourth examinations were appropriate. Among which, chronic dyspnea and complicated infection was found to be predominantly higher. Among patients with chronic dyspnea, ILD was predominantly higher. Studies reported that involvement of lung parenchyma by diffuse interstitial disease processes is best assessed by HRCT [27,28]. Many diffuse lung diseases have characteristic HRCT pattern and a confident diagnosis is usually possible and other additional

examinations and biopsy are usually not needed [29]. In addition to diagnosis, the progression of the disease process is also indicated by HRCT [30].

In our study, frequent examinations were prescribed to evaluate the reactivation of primary tuberculosis or to assess its sequelae and complications but according to ACR appropriateness criteria, CT chest without contrast is appropriate in the setting of complicated pneumonia when the infection is not resolving or if any intervention is being planned. Pulmonary tuberculosis forms a major burden of respiratory disease in our country. Such indications were considered appropriate because tuberculosis frequently involves bronchial walls resulting in bronchiectasis and is an important feature of inactive as well as reactivation of tuberculosis [31,32]. Aspergilloma formation was also observed in majority of our patients with chronic pulmonary tuberculosis. This finding also matched with the finding of other study as well [33].

In our study, CT chest without IV contrast was also prescribed in few patients for screening of pulmonary metastasis as well as staging of bronchogenic carcinoma. A study reported that tumor staging and invasion can be accurately described hence indicated as appropriate for these indications.[34]

In this study, a significant number of cases were categorized as "may be appropriate" as per ACR appropriateness criteria. Almost all such cases were above 40 years of age and had symptoms of acute pulmonary illness. No information regarding physical examination finding was provided. International guidelines suggest that a chest radiograph should be ordered in patients suspected to have pneumonia as it can help make the diagnosis and differentiate active infection from other causes of cough such as bronchitis [35]. In the presence of normal radiographs, CT scan may show positive findings in patients suspected to have infection, however the utilization of CT in such patients is not clear [35]. Some

studies indicate that in adults with comorbidities presenting with cough, fever or chest pain, CT scan is necessary when chest radiograph is negative [36,37].

Our study results demonstrate a significantly higher rate of negative outcomes in cases categorized as inappropriate. This finding also matched with another study utilizing evidence based guidelines [3]. However, this study [3] was not conducted only for HRCT but for CT and MRI of many regions. A study evaluating the validity of different assessment tools for reporting also reported that examinations with a high negativity rate may be inappropriate [38].

The findings of our study could be observed in the light of following limitations. Most importantly, in majority of the cases there was no direct discussion with the referring physician related to the physical findings. However, this was minimized by retrieving as much adequate data from medical records as possible and calling patients on phone to assist in examination interpretation. This was used especially in patients coming in our hospital as outpatient from primary healthcare units to have other investigations. In addition, lack of electronic medical record facility in most of the primary care setups is another important limitation. Primary care referrals from outpatients are the most common form of referrals received in our center. Another limitation was the inability to collect the radiation dose exposed to the patient during examinations.

Despite these limitations, this study is the first of its kind to thoroughly assess and analyze the CT chest without IV contrast requests from a developing country like Pakistan. In short, a relatively high percentage of CT scans of chest were inappropriate according to the ACR appropriateness criteria. This is to emphasize that a detailed request comprising of patient's presenting complaints as well as positive physical examination findings which can aid in the interpretation of imaging should be provided to keep the diagnosis pin point or limited to few differentials. Also, by digitizing the medical records of the patient in the primary and

tertiary care setups and its integration with the evidence based guidelines such as ACR appropriateness criteria can enhance the ability of a clinician to proceed with a correct imaging technique or to decide when not to proceed with the examination.

CONCLUSION

In this retrospective analysis, a high percentage of chest CT scans without IV contrast did not meet the ACR appropriateness criteria. Moreover, negative outcomes were significantly higher in scans that were inappropriate. It is suggested that ACR appropriateness criteria should be utilized while making a radiological referral to improve quality of patient care. With proper clinical indications, chest CT without IV contrast including HRCT is a valuable tool for the evaluation of chest diseases and can yield significant information for diagnosis and management of the patient.

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Author Contributions

AS, HA, conceived the idea. AS supervised the study. AS, HA, SAK designed the study; SOA carried out the statistical analysis; SOA, HA, KS contributed to interpreting of the results; HA and SOA drafted the manuscript, all authors approved the final manuscript.

Conflict of interest

The authors have no conflicts of interest

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Figure Legends

Figure 1: Comparison of appropriateness with outcome of the patients