Current Trends in Computed Tomography Referral Practice Experience at a Large Academic Hospital

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Abstract: To evaluate current computed tomography (CT) referral practice with emphasis on correct clinical data and examination choice. Our second aim was to investigate turnaround times on all brain CT scans included in the study. Retrospective analysis of CT examinations in the radiology information system was carried out at King Abdulaziz University Hospital, Jeddah Saudi Arabia. This study was conducted six months after hospital wide implementation of the iRefer criteria, the Royal college of Radiologists imaging referral guidelines. The review included all patients who had attended the emergency department, out-patients, or were inpatients and had a CT request during the period from July to September 2012. Clinical data and indication for all subjects were evaluated and analyzed. Two thousand three hundred twenty two records were investigated, of which 1695(73%) were adults and 627(27%) were pediatric patients. The majority of requests were for brain 856 (37%). Of those, 46% were requested by the Emergency department, (86%) adult and (14%) pediatric patients. The total number of examinations performed with inadequate clinical information was 111; among those were 17(15%) pediatric patient requests. There is a need to increase collaboration between clinicians and radiologists to follow appropriateness guidelines and decrease inappropriate CT requests. Educational tools should be used in raising clinicians' awareness on radiation dose from radiological investigations.

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1. INTRODUCTION

With the advancement in radiology equipment and the technology used in patient diagnosis, there is an increased demand on radiology services worldwide. Computed Tomography (CT) has become an essential mainstay imaging modality in clinical medicine. Every year there is a perpetual increase in the number of CT scans performed. Over 60 million CT examinations are being performed yearly worldwide.[1]Though these examinations are of utmost importance in effective management and follow-up, it is common knowledge that there is a degree of misuse of this modality.[2]A dramatic increase in the amount of ionizing radiation patients are being exposed to has accompanied this technological growth. Therefore, investigators have found it essential to establish guidelines to promote safe practice.[3]

Overutilization of radiology services has been reported in the literature due to the lack of transparency in the area of justification of medical exposure among practitioners.[4] Since justification of medical exposure is dependent on the requesting clinician's knowledge, expertise and ordering patterns, there are substantial differences in the radiology referral practice.

Due to reduced opportunity for communication in a busy teaching hospital, the request form is sometimes the only means of transmission of clinical information from the requesting physician to the radiologist. Missing or inadequately filled request forms lead to questionable radiological investigations that are performed with a degree of error. Assessment of adequate radiological requests has been evaluated in the literature.[5]It was stated that most of the time junior doctors fill request forms while most senior ones report them to make patient management decisions.[6] For that reason, attention has to be given to proper completion of these forms with the appropriate clinical indication for performing any radiological investigation. Inadequately completed request forms are a problem widely experienced among hospitals worldwide.[7,8] In one report, only 4% of 200 requests were found to be complete.[8]

There are several tools available today to help identify the most appropriate investigation for almost every clinical presentation, with radiation dose involved. The Royal College of Radiologists (RCR) has issued several versions and forms of appropriateness criteria. In addition, the American College of Radiology (ACR) and the European Commission (EC) and many others have established similar guidelines to regulate the radiology referral practice and audit the principle of justification. In general, all these guidelines aim to reduce the number

of inappropriate investigations, reduce patient radiation dose, and to lower hospital costs from radiological services.[9]

Clinical audits conducted on a regular basis can be a useful tool to assess the referral practice and ensure proper justification for using ionizing radiation examinations. [9] On the other hand, studies that implement guidelines have seen a measurable drop in unnecessary requests leading to a shorter waiting time in the ER.[10]

Hence the need for regulating diagnostic imaging investigations is of paramount importance, especially as the effective dosage from CT examinations represents 70% of all radiation doses any patient is receiving.[11]

At the King Abdulaziz University hospital, Jeddah, Saudi Arabia, RCR's imaging referral guidelines (iRefer)[12] is utilized to help clinicians make an informed choice. RCR guidelines are developed to assess justification, ensure timely and accurate diagnoses, in addition to providing most up to date appropriateness criteria for imaging investigations in diagnostic radiology. iRefer helps clinicians choose the correct imaging investigation, ensures accurate results , provided in a timely manner, and guides hospitals to efficiently utilize radiological service. iRefer requires institutional or individual membership to access the latest versions.

This study was conducted six months after hospital wide implementation of the iRefer criteria. The objective of this study was to determine the appropriateness of CT examinations conducted with an expected outcome of seeing the effect of proper clinical history and appropriate examination choice.

Optimization of imaging services reporting should be conducted yearly to reach higher standards in delivering diagnostic radiology investigations. Depending on the hospital standards or workload, the turnaround for a verified report after completing an examination might be 3 days for outpatients, 1.5 days for in patients.[11] On the other hand, if urgency is the identified variable, then urgent cases should be reported first, within 24 hours, and all other cases should be reported within 48 hours.[13] Consequently, turnaround times were also investigated to assess the quality of radiological services for all brain CT scans included in this study.

2. MATERIALS AND METHODS

2.1. Study location and design

A retrospective analysis of all CT examinations in the radiology information system (RIS) database was conducted at the King Abdulaziz University Hospital, Jeddah. The King Abdulaziz University Hospital (KAUH) is an 895 bed referral healthcare facility and teaching hospital.

2.2. Study population and data collection

Before the commencement of the study, all the departments including the outpatient blocks in the hospital were educated on the need and use of iRefer through presentations. They were introduced to the codes pertaining to each department in addition to reinforcements during communications with the radiology modalities. The use of iRefer was required but not prospectively monitored. Subjects were adults and pediatric patients who had presented at the Emergency department, were inpatients or had attended outpatient clinics of the hospital, with a CT request between July and September 2012 from the central database of radiology information system .The clinical data for each patient and clinical indication/question from the requesting physician were examined and matched to the iRefer criteria through a direct link from the hospital information system (HIS). The decision not to incorporate the iRefer criteria directly into the HIS but use an external link is because we wanted the current criteria to be always accessible to our clinicians. This link was part of the order form in the HIS; however the use case was not mandated.

All the requests of the included examinations were analyzed by the subspecialty radiologists for adherence to the iRefer, where the information was scanty, either a verbal communication or review of the medical records was performed whenever possible.

2.3. Data analysis

Frequency tables and graphs were used to present relevant variables. Descriptive statistics such as medians and ranges were used to summarize quantitative variables, while qualitative variables were summarized with percentages .

Two radiologists from KAUH reviewed all reports from examinations performed on the study population for appropriateness of requested investigation. A positive score (+) was given to reports with any pertinent finding even remotely relating to the clinical question. All normal studies were assigned a negative score (-). The study population was grouped as follows:

A+: for patients who had an appropriate clinical indication for the referred examination and had a positive result.

A-: for patients with an appropriate clinical indication but with a normal report.

I+: for patients with an inappropriate or poorly defined clinical indication but with positive findings.

I-:for patients with an inappropriate clinical indication and normal report.

The radiology services were assessed by appointment turnaround time, defined as the time from date of request to date of performance, and report turnaround time, defined as the time from date of

performance of examination to date of report issuing. Analysis was done using SPSS version 20.0.

3. RESULTS

A total of 2322 records were available for analysis, of which 1695(73%) were adults and 627(27%) were pediatric patients. Patient characteristics are shown in Table 1. The adults had a mean age of 49.7 ± 18.9 while the pediatrics had a mean age of 6.8 ± 4.2.

Table 1. Patient characteristics (N=2322)

Characteristics	Number of Patients (%)
Male	1300(56%)
Mean age(years)±sd	42.2±23.4
Age range(years)	0.1-107
Female	1022(44%)
Mean age(years)±sd	45.7±21.3
Age range(years)	0.1-101

The majority of CT requests were for brain scans 856 (37%), followed by abdominal/ pelvis 675 (29 %), and chest 280 (12%). Table 2 shows the frequency distribution of the examinations.

Table 2. Frequency distribution of examinations

Type of Examination	Frequency	Percentage
Brain	856	37
Abdo/pelvis	675	29
Neck soft tissue	71	3
Chest	280	12
Paranasal sinus	50	2
Pulmonary abgio	53	2
HRCT Chest	32	1
Kidney	34	2
Cervical spine	39	2
Other	232	10
Total	2322	100

Of all the brain CT scans performed, 396 (46%) were requested by the emergency department, 261 (31%) by inpatient, and 199(23%) by outpatient departments. Among those were 339(86%) adult and 55(14%) pediatric patients.

3.1. Appropriateness of Request

When considering all brain CT examinations, 411(48%) records had adequate clinical information and negative result, while 342(40%) had adequate clinical information and positive result (Table 3). The total number of examinations performed with inadequate clinical information was 111(13%); among those were 17(15%) pediatric patient requests.

Table 3. Appropriateness of results

Appropriateclinicaldata	Frequency	Percentage
A+ adequate clinical information and positive result	342	40
A- adequate clinical information and negative result	411	48
I+ inadequate clinical information with positive result	17	2
I- inadequate clinical information with negative result	94	11

The highest number of requests with inadequate clinical information was by emergency department, 43 (39%), followed by outpatient, 37(33%), and inpatient department, 31 (28%). Figure 1 shows the related complain category for all brain CT examinations performed with inadequate clinical information.

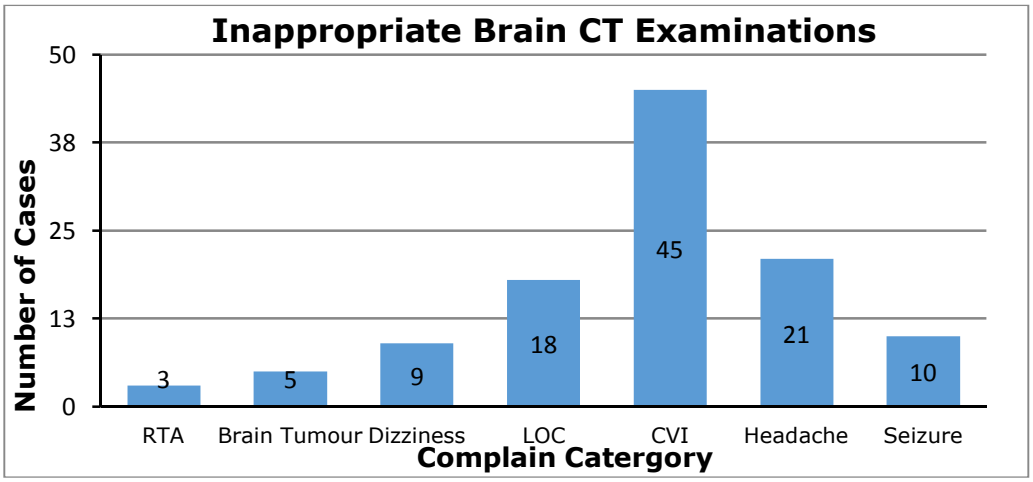

Figure 1. Brain CT requests with inadequate clinical information.

RTA - Road Traffic Accident; Brain tumor - known or suspected cases of brain mass; Dizziness - unexplained sudden onset of dizziness; LOC - Loss of Consciousness as defined by criteria; CVI - Cerebrovascular Incident including stroke and intracranial hemorrhage; Headache - Sudden severe headache not inclusive in the CVI category; Seizure - known and first attach of seizure.

3.2. Radiology services turnaround time

The appointment turnaround time ranged from 0 to 210 days with a median of 0 days, while report turnaround time was 1 day with a range of 0 to 38 days. Figure 2 shows both turnaround times for the 856 brain CT examinations. Majority (644; 75%) had an appointment turnaround time of zero days while only 29 (3%) had 8 days or more.

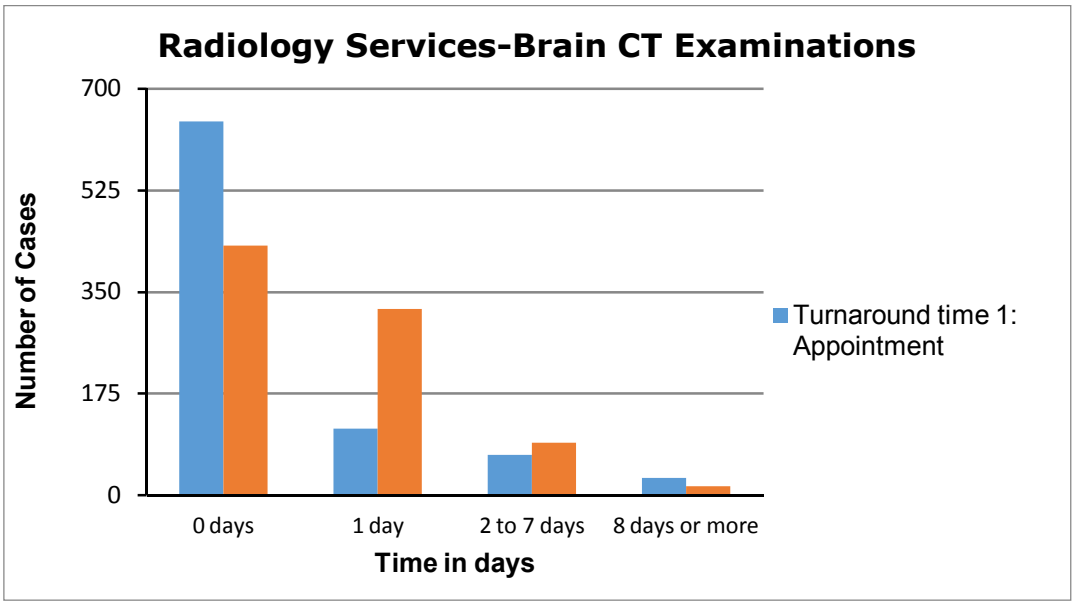

Figure 2. Data represents turnaround times (appointment and report) of radiology services in days; number of cases and percentages as data labels.

A total of 430(50%) had a report turnaround time of 0 days, while only 15(2%) had 8 days or more. Furthermore, 396(46%) emergency brain CT request had a report turnaround time ranging from 5 min to 22 hours, figure 3.

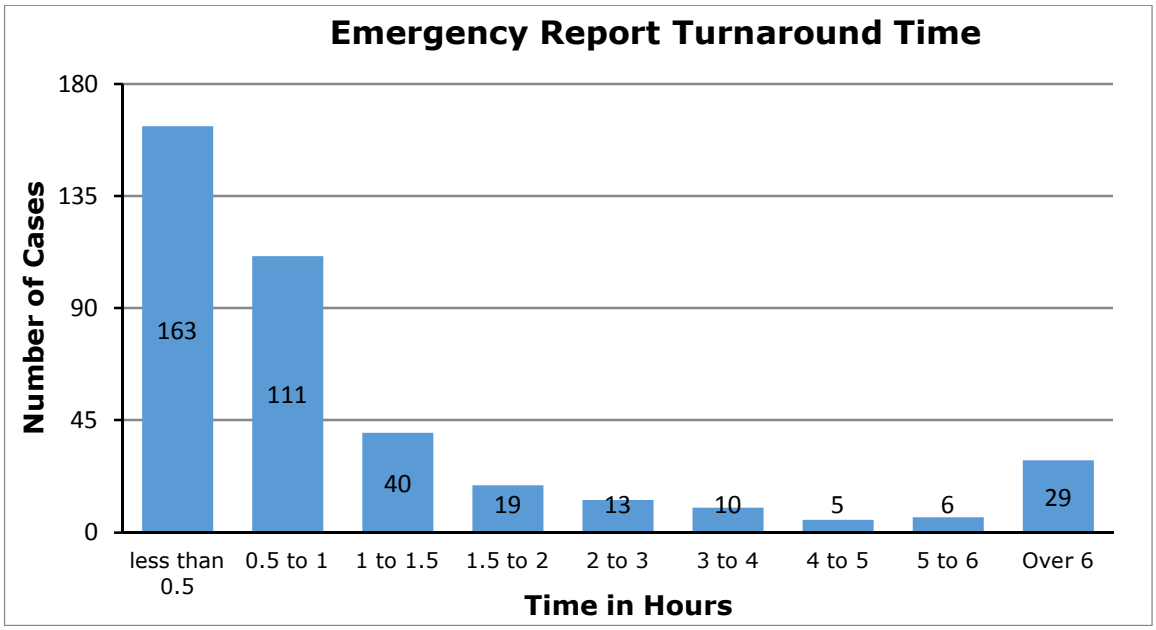

Figure 3. Report turnaround time for emergency Brain CT requests.

4. DISCUSSION

Rapid technological advancements paved the way to new clinical applications in brain imaging. In fact, diagnostic tools have expanded with innovations in contrast agents; molecular radionuclide imaging; perfusion; angiography. These advances present new opportunities for physicians to utilize non-invasive techniques to gain important information about the condition of their patients. However, CT investigations are relatively expensive and use high dose of ionizing radiation (can be equivalent to 100 - 800 chest x-rays depending on parameters and settings)[11]. Overutilization of this imaging modality is without doubt one of its drawbacks.

The literature proves that there is an increase in the utilization of CT examinations by emergency departments[14]. In addition, studies show that patients are being exposed to ionizing radiation without proper clinical justification[9,15,16]. A significant percentage of CT requests are inappropriate, especially those for children; therefore, this raised public health concerns on the current referral practice[7,16]. The need to develop local guidelines or adapt international ones for imaging referrals is of great importance. Applying such guidelines can reduce the number of CT requests that are of no benefit and only contribute to a dramatic increase in patients' radiation exposure.

In most of the radiological service audits in the literature, investigators have assessed two things: examination request forms (including the clinical information) and the justification practice[6,9,15]. With regular audit of justification of radiological requests, a significant reduction in unnecessary radiation dose to patients can be achieved, up to 75%[9]. Such audits improve quality and outcome of patient care and help modify the current practice.

Similarly, the ultimate objective of this audit was to optimize radiological services involved in patient care in a cost-effective manner, keeping in mind the appropriateness criteria and radiation dose justification. Our study shows that 46% of brain CT scan requests are from the emergency department. The results indicated that 744 (88%) request forms had adequate clinical information while 107 (13%) were inadequate. In addition, 94 (11%) of examinations performed were found to be unjustifiable but below published audits[7,15]. The report from the Joint Royal College of Radiologists/National Radiological Protection Board affirms that around 20% of investigations involving ionizing radiation in the UK are "clinically unhelpful"[10].

Our study showed a slightly lower percentage, because the analysis included only the highest type of examination requested during the chosen period (brain CT). This also reflected the efforts by the radiology team during the implementation of iRefer in educating the users in all departments in addition to user adherence at the time of the study due to it being a recent hospital-wide activity. However, we believe that if the study was conducted a year or more after the implementation, the results might shift and the percentage might probably increase. The distribution of these inappropriate brain CT requests where 43 (39%), 37 (33%) and 31(28%) from ER, outpatient and inpatient respectively. Among them, the highest percentage was due to complains like cerebrovascular incidents including stroke and intracranial hemorrhage (41%) followed by sudden severe headache (19%).

Since all patients have the right to receive accurate and timely radiological diagnostic investigations, turnaround time was also reviewed for all brain CT scans with an intended objective of improvement in patient care and assessment of quality of services.

Seven hundred and fifty eight (88%) requested brain CT scans were performed within 24 hours after the request, while 8% were given appointments 2 to 7 days later. Only 3% were not accommodated within the first week. Our audit showed that among the brain CT scans conducted, 50% were reported immediately, 38% reported after 24 hours and only 12% were delayed (48 hours to over a week). When further analyzing all emergency brain CT cases, we found that 274(69%) were reported within the first hour and only 29 (7%) were reported 6 to 22 hours later. This is in compliance with the Accreditation Canada's Diagnostic Imaging standards 11.1 and 11.2, where urgent results should be interpreted within 24 hours while all other results should be reported within 48 hours[17].

We also have to note that in a teaching hospital like KAUH, results might have been communicated verbally during clinical sessions for patient management but report documentation might have been completed at a later stage.

Keeping in mind that all doctor categories (i.e. residents, registrars, consultants, etc...) have the eligibility to make a radiological request and specifically they are all eligible to request a CT examination. Since there are no national regulations on the appropriateness and justification of radiological requests, doctor's background, and level of education, experience, and evaluation of each case remains the only reason for performing the examination. Therefore, some requests could lack clinical information and could be requested for the wrong reason[18].Bosanquet el at al[8], confirm that some

junior doctors request radiological investigations involving ionizing radiation without even examining the patient.

Although the percentage of inadequately performed examinations in our study is low (11%), the radiation dose to those patients is still not justified. In practice, to apply the justification principle is a challenge in busy teaching hospitals. Physicians should be aware of the legal duty they have to provide enough clinical information and to justify patient exposure by choosing the most appropriate examination. Their justification should be based on referral criteria guidelines and not on their own experiences. Moreover, communication problems between clinicians and radiologists or obtaining previous radiological images could result in patient exposure for the wrong reasons.

5. STUDY LIMITATIONS

A baseline was not collected prior to the implementation of iRefer criteria; therefore, we did not have the initial group, pre-implementation, for comparison. Also, this study is limited by the fact that radiological investigation orders from the HIS does not include the iRefer field as a mandatory field. This prevented us from monitoring the use of iRefer for every request in the system. Lastly, network related problems resulted in 3 to 30 minute lag between transfers of reports from the radiology information system to the HIS, where the reports are made available for doctors outside of the radiology department.

6. CONCLUSION

Regular audit of request forms and justification practice could help identify problematic incidents, minimize radiation dose and reduce the economic burden on hospitals.

This study identified the need to increase collaboration between clinicians and radiologists to follow appropriateness guidelines, attain dose reduction strategies for patient protection, and avoid misuse of these technologies. In addition, these guidelines could best support residents and younger clinicians in making correct imaging requests as well as providing sufficient clinical information. Motivation towards using guidelines is a must if they are not sure what the best investigation would be for their patients.

Changing the current referral practice will take time; however there are several forms of educational tools that could be used in raising clinicians' awareness on radiation dose from radiological investigations. The International Atomic Energy Association (IAEA) has published free awareness material and leaflets in several languages; called 'the 10 pearls promoting safe referral for CT examinations'[19]. Other means could be the use of orientation lectures, continuous education workshops, leaflets on best practice, and attaching educational messages on reports reminding of the radiation burden from CT examinations.

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