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Effectiveness of clinical imaging guidelines to reduce inappropriate head computed tomography imaging: a case of Uganda

Michael G. Kawooya[1*], Harriet Nalubega Kisembo[2], Richard Malumba[1] and Ezra Nsereko[1]

Abstract

Background: Clinical imaging guidelines (CIGs) have been demonstrated to reduce inappropriate diagnostic imaging. There is insufficient evidence for CIG effectiveness to reduce inappropriate imaging in Africa. We assessed the effectiveness of CIGs training and implementation to reduce inappropriate diagnostic imaging at Mengo Hospital, Uganda.

Methods: A clinical audit of head CT examinations was conducted at Mengo Hospital. A baseline review of 262 requisitions was done to determine the level of appropriateness for imaging requisitions. We also determined the baseline knowledge level on radiation protection (RP) and CIG use among 15 referrers. We trained these referrers on RP, awareness and use of CIGs and uploaded the iGUIDE onto their smart phones and computer work stations for use. This was followed by a post-intervention assessment where we reviewed 154 requisitions to determine the level of appropriateness. We also assessed the post-intervention knowledge level on radiation protection (RP) and CIG use among the referring clinicians.

Results: We found 53% and 47% levels of inappropriate head CT requisitions for pre- and post-intervention, respectively. At pre-intervention, we found a 73% level of knowledge on radiation protection and CIGs use while we found a 93% at post-intervention assessment among referrers.

Conclusions: Implementation and training referring clinicians on CIGs are effective in reducing inappropriateness of head CT requisitions.

Keywords: Clinical imaging guidelines, Appropriateness, iGuide, Referral guidelines, Computed tomography, Radiation protection

Key points

- Implementing clinical imaging guidelines is effective to reduce inappropriate diagnostic imaging
- Training referrers on clinical imaging guidelines is effective to reduce inappropriate diagnostic imaging
- The iGuide is an effective decision aid tool for referrers to reduce inappropriate diagnostic imaging

*Correspondence: kawooya.michael@ecurei.ac.ug

[1] Ernest Cook Ultrasound Research and Education Institute, Kampala, Uganda
Full list of author information is available at the end of the article

Background

There has been a rapid upsurge in the application of diagnostic imaging over the last two decades [1]. It is estimated from UNSCEAR data that there are about 3.6 billion imaging procedures utilizing ionizing radiation and 33 million diagnostic nuclear medicine procedures performed annually worldwide. Ionizing radiation carries both benefits and risks, and justification of its use in the medical aspect is one of the ICRP (International Commission on Radiation Protection) principles of radiation protection [2]. The exposure to the patient must provide a net benefit, and this is well defined by ICRP as 3 levels

of justification. Although such principles have been put in place, there has been reports of over and underutilization of radiation in imaging world over [3]. There are many reasons for overutilization of radiation in imaging and these include self-referral, patient self-presentation, financial incentives and failure of referring clinicians to understand and use the most appropriate examination for patient evaluation [4].

To enhance justification of imaging procedures, imaging through appropriate requisitions has been proposed. According to Fraser, an appropriate requisition consists of the following: The imaging examination should be indicated as per clinical features. If the same investigation has just been done, it should not be repeated. In addition, if the results expected from the imaging procedure are already available from another type of imaging investigation, or from laboratory or physical assessment, that investigation is not necessary and may not be performed. The investigation should have the potential to change patient's management, or to significantly increase the referrer's confidence in the diagnosis or unveil a potentially treatable condition. The investigation should be the best for the particular clinical condition especially if weighed against non-ionizing imaging alternatives like US and MRI [5]. To make such appropriate imaging requisitions during routine work flow, clinical imaging guidelines have been evidenced to aid decision making for the most appropriate procedures [6].

Several organizations and countries have adapted or adopted clinical imaging guidelines (CIGs) also known as imaging referral guidelines. CIGs are systematically developed as evidence-based statements to aid referrers, radiological imaging practitioners and patients to make decisions for appropriate diagnostic imaging for specific conditions [7]. The World Health Organization was the first organization to develop and publish a document in 1990 titled "Effective choices for diagnostic imaging in clinical practice" [8]. This document was to act as a guideline for making appropriate decisions for diagnostic imaging. The Royal College of Radiologists (RCR) developed their first set of imaging guidelines in 1990 and has since been revised at regular intervals of 5 years, and up to today, there are 14 editions [9]. The current RCR guidelines are now titled as" iRefer" and are available for mobile phone and tablet as apps, web-based and print form. The American College of Radiology (ACR) initiated CIGs entitled "ACR Appropriateness Criteria" in 1993. These criteria over the previous years have gone through subsequent revisions, with annual updates [10, 11]. Currently, the ESR and the National Decision Support Company have developed the "ESR iGuide, " a clinical decision support system for European imaging referral guidelines. This iGuide has been made available as an application which can be incorporated into online systems to be used by referrers and radiologists [12].

Much as such CIGs have been developed, inappropriate diagnostic imaging is still being reported even in areas where these guidelines have been implemented. Malone J et al. estimated that 20–50% of imaging requisitions in various parts of the world may be inappropriate [13]. Such inappropriateness has been sighted to be associated with over utilization of diagnostic imaging which results from self-referral, litigation issues, lack of awareness by referrers and radiologists' conflict of interest [14, 15].

Other factors that have been cited as drivers of inappropriateness include payment methods (most commonly with clients with medical insurance packages), defensive medicine, missed opportunities by clinicians, and patients' expectations and rapid advances in imaging technology [3, 5, 16].

In Africa, the drivers of inappropriate requisitioning may be similar to the developed world. However, lack of awareness by referrers in both public and private facilities, and self-referral in the private facilities may be more common drivers. African countries don't have an indigenous CIG, due to the complexity and heavy investments required for production of CIGs, and therefore have chosen to adopt and adapt already existing evidence-based CIGs. Adopting and adapting are not unique to Africa but have been done by other regions and countries like Canada, Europe and Asia.

There is no published audit assessing the appropriateness for head CT imaging requisitions in Africa. There is also a knowledge gap regarding the effectiveness of CIGs to reduce inappropriate CT requisitions, thus this study.

This study was supported by the International Atomic Energy Agency (IAEA) under project RAF9059. Uganda together with 6 other African countries started on the roadmap to introduction of CIG into clinical practice, initially starting with pilot projects in each of these countries, and chose to use the ESR IGUIDE because of its availability.

Methods

This was a clinical audit at Mengo Hospital which is a 350-bed Faith-Based Private Not-For-Profit hospital, located in Kampala city. It has general and specialized services for general surgery, internal medicine, obstetrics and gynecology and pediatrics. It has specialist neurosurgeon and orthopedic surgeons. The CT scan at the time of the study was a 16-slice CT Philips-Brilliance CT scanner. There are 4 radiologists, two of which are part-time. The CT unit has an average throughput of up to 7 patients daily.

During this audit, a baseline review of 262 head CT requisitions for the months of October, November and December 2018 was done to determine the level of appropriateness for imaging requisitions. Head CT was considered because it is the commonest indication for which majority of CT examinations are done. Appropriateness was determined using the iGUIDE which is a CIG application software for the European Society of Radiology. Two radiologists with over 20 years of practice and teaching medical imaging assessed the appropriateness.

We determined the baseline knowledge level on CIG use among 15 referrers practicing at Mengo Hospital. These included intern doctors, medical officers and specialist doctors**.** Assessment was done by administering a paper-based copy questionnaire to the participants. The questionnaire had multiple choice answers for every question, and the participant had to choose the most correct answer. Every correct answer was awarded 1 mark. We developed a scale of 0–15 for which all referrers who scored < 10 as low level of knowledge and > 10 as high level of knowledge. The level of knowledge was determined by total individual scores from 3 thematic areas (radiation protection, CIGs and patient work flow) each consisting of 5 questions including;

Radiation protection

1. What is the principle of "optimization" with reference to radiation protection of patients?
2. What is the principle of "justification" with reference to radiation protection of patients?
3. How do clinical imaging guidelines differ from clinical practice guidelines?
4. What are clinical imaging guidelines/clinical referral guideline (CIGs)?
5. Who is responsible for the justification of imaging procedures?

CIGs

1. Why is it important to use the best evidence available when writing clinical imaging guidelines?
2. Why is it important to regularly update the guidelines?
3. In what format are guidelines availed to the user?
4. What are the key components of a clinical imaging guideline?
5. Why is it important that a relative radiation level for every type of examination is shown for each guideline?

Patient workflow

1. In which circumstances would you use clinical referral guidelines?
2. If the best option imaging for a given clinical condition is not available in your hospital, should you take the next best option or should you refer the patient abroad for the best option?
3. Who is supposed to use the clinical imaging guidelines?
4. At what point in the patients care cycle should one first refer to the clinical imaging guidelines?
5. When would one ignore using the guidelines?

An intervention involving the training on use, awareness of CIGs and implementation of the iGUIDE for the 15 referring clinicians was done in the months of January, February, March and April 2019 through CMEs. The iGUIDE application software was uploaded onto the referrers smart phones and computer work stations for use. The training was physically conducted by the 2 practicing and teaching radiologists over a 4-month period. Such a period was determined by the frequency (2 CMEs per month) of CMEs as scheduled by the hospital. All participants attended the same session as a group each time it was done.

This was followed by a post-intervention assessment which involved a review of 154 requisitions for June, July and August 2019 to determine the level of appropriateness. We determined the post-intervention knowledge level on radiation protection (RP) and CIG use among the same referring clinicians.

Ethical clearance and approval for this study was obtained from Mengo Hospital Research Ethics Committee and the Uganda National Council for Science and Technology.

Results

Results from our study indicated that pre-intervention, out of the 262 head CT requisitions, 53% were inappropriate as shown in Fig. 1.

Post-intervention, we found that 47% of all the reviewed head CT requisitions were inappropriate as shown in Fig. 2. This implied that there was a 11.32% decrease in the inappropriateness level following CIG training and utilization by referring clinicians (Table 1).

Our results indicated that there was a 73% level of knowledge pre-intervention assessment and over 93% level post-intervention CIGs among the referring clinicians.

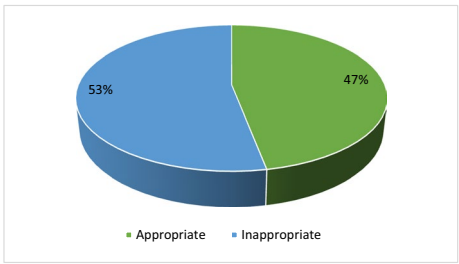

Fig. 1 Pre-intervention level of appropriateness at Mengo Hospital

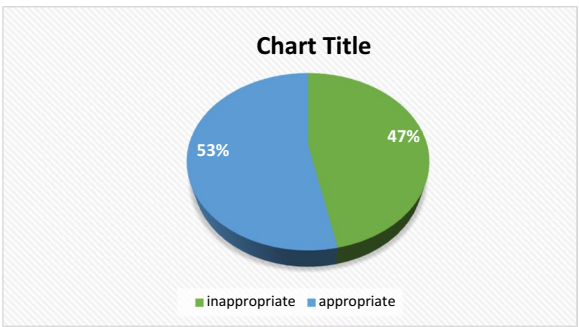

Fig. 2 Post-intervention level of appropriateness

Table 1 Table showing referrers scores at Mengo Hospital

Participant ID	Pre-intervention scores	Post-intervention scores
1	12	12
2	8	10
3	11	12
4	10	13
5	8	12
6	7	10
7	11	16
8	6	9
9	13	14
10	10	14
11	10	14
12	12	15
13	12	14
14	5	11
15	12	15

Discussion

Since the starting point for application of CIGs in the entire patient workflow is with the referring clinician at the point of care, he should be familiar with basic principles of radiation protection and how these relate to good clinical practice. By being adequately informed on radiation protection, the referring clinician should also know about CIGs, what they are, how they are formulated, where they are applied during patient workflow, why they are applied and how they are applied. This knowledge can hopefully motivate the referring clinicians to use CIGs without being compelled and can hopefully infer a positive attitude and work culture with regard to radiation protection and CIG application.

The initial pre-intervention scores indicated that there was a lower level of CIG knowledge among referral clinicians but with the intervention the level of knowledge increased. It is anticipated that this increase in knowledge translated into attitude and practice change. A number of studies have been done to show similar findings of low level of RP knowledge and CIG use among clinicians. Lars and Erling in their comparison study found that referral clinicians had a low level of knowledge in relation to radiation protection and CIG use. In addition, a study done by P Singh et al. to assess clinician's attitude and knowledge on radiation exposure in India indicated that only 30% of all clinicians that had participated in their study had knowledge of referral guidelines [17, 18]. Our findings may be explained by the fact that in Uganda, medical students rarely get targeted education or learning on RP and CIGs use. Introduction of such education has been suggested to improve their knowledge which translates later into practice. Lee et al. found that there is little radiation safety and protection education in Irish medical schools, resulting in knowledge gaps regarding radiation doses accruing from common imaging examinations. From this study, they recommended a formal radiation safety curriculum for Irish medical schools to ensure patient and health workers' safety of the doctors and patients. Further still, Razieh et al. also recommended education of healthcare workers in RP following their systematic review which indicated that more than 50% of health workers had just an average level of RP knowledge [19, 20].

Our results also indicate that the pre-intervention level inappropriateness was 53%. This finding is slightly higher than in other studies in the world. Malone J et al estimated that 20–50% of imaging requisitions in various parts of the world may be inappropriate [13]. In addition, studies done elsewhere; Europe 5%, Sweden 20% and USA 44% showed a lower level of inappropriateness compared to that found in Uganda [21–23]. Our finding may be explained by the fact that for our study we considered requisitions with inadequate clinical information and had missing key data like patients age as inappropriate requisitions.

Important to note is that during our intervention, we also introduced and implemented the iGUIDE to the referrers. This decision aiding tool is thought to have contributed to the reduction of the inappropriateness level in addition to the training on Radiation protection and CIGs. This is because, before its introduction and implementation, no CIGs existed in Uganda and thus were not being used. This finding is similar to others elsewhere which indicate that introduction, training and implementation of CIGs increases appropriateness of medical imaging requisitions. A study done in France by Mathieu et al. evidenced that during their comparison of the level of appropriateness pre- and post-intervention, results indicated that there was a decrease in inappropriateness when imaging guidelines were activated during practice [24]. Furthermore, results from 2 multicenter studies done in USA by Leonid et al. and Hussey et al. indicated that implementing and increasing provider exposure to CIGs is associated with improved appropriateness for imaging requisitions [25, 26].

Important to note is that even with application of the stand-alone web-based version of the IGUIDE, the 47% level of inappropriateness is high and other approaches must be devised to bring this down. One way is to embed the CIGs into the hospital health information system (HIS) in form of a computerized decision support (CDS) for some hospitals that have the compatible information technology (IT) infrastructure. The second option, which has proved to work in many centers and requires far less resources and IT infrastructure, is to vet each request form within the radiology department and reject those that are inappropriate. This can be followed by a dialog between the radiologist and the referrer so as to arrive at the most appropriate imaging option [23].

Limitations

This study was done in a single center, and so, these results may not be generalizable to other CT centers. Nevertheless, these findings will give insight into the general quality and safety of imaging situation in Uganda bearing in mind that majority of these referrers also work in other facilities. In addition, this study being an audit, the sample size of audited requisition forms seems small. However, it is important to note that that was all the available number of brain CT requisitions at the time.

Conclusions

CIGs are effective to reduce inappropriate brain CT imaging requisitions. Referring clinicians require a basic knowledge of radiation protection and CIG usage, if they are to ably and willingly use CIG. Training and awareness through CMEs can improve referrers RP knowledge.

CIGs are necessary for Uganda if the principle of justification is to be applied to promote radiation safety and good clinical practice.

There remains a significant proportion of imaging requisition inappropriateness which may have to be tackled through introduction of radiation protection and CIGs curriculum into medical courses for medical students while on job training of the same should be done for the already practicing referrers.

Abbreviations

CDS: Computerized decision support; CIGS: Clinical imaging guidelines; CME: Continuing medical education; CT: Computed tomography; ICRP: International commission on radiation protection; IT: Information technology; MRI: Magnetic resonance imaging; RP: Radiation protection; UNSCEAR: The United Nations Scientific Committee on the Effects of Atomic Radiation.

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Author contributions

MGK contributed to idea conception, study PI and manuscript writing. HK contributed to study implementation and manuscript writing. RM contributed to coordination of the study, manuscript writing and review. EN contributed to study implementation and review of manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical clearance and approval for this study was obtained from Mengo Hospital Research Ethics Committee (MHREC) and the Uganda National Council for science and Technology(UNCST). Referrers were issued with informed consent form before participating in the study. A waiver of consent was also obtained to use patient secondary records for this study.

Consent for publication

This was provided by Ernest Cook Ultrasound Research and Education Institute (ECUREI). In addition, the authors consented to publication of this study.

Competing interests

The authors declared that they have no competing interests.

Author details

[1]Ernest Cook Ultrasound Research and Education Institute, Kampala, Uganda. [2]Department of Radiology, Mulago National Referral Hospital, Kampala, Uganda.

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