EMERGING TECHNOLOGY AND FUTURISTIC PRACTICE: ISSUES OF CONCERN FOR PAEDIATRIC RADIATION PROTECTION IN LIMITED RESOURCE SETTINGS

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Abstract

Background: emerging trends in radiography practice over the years occasioned by the rapid technological developments in the field of medical imaging makes it difficult for the radiography community to stay ahead of the technology train. These have present and future implications for the radiation protection of paediatric patients. Hence, this paper intends to explore current emerging technologies and the challenges of paediatric radiation in limited resource settings.

Methods: authors reviewed relevant literature for current and updated information on the subject. Key words such as radiation protection, paediatric radiography, paediatric radiation protection, emerging technology, current trends in paediatric radiography, and digital imaging were used to search the internet. Major search engines and websites related to radiation protection such as Google, Google Scholar, and International Commission on Radiological Protection (ICRP), International Atomic Energy Agency (IAEA), World Health Organization (WHO), Image Gently and the International Society for Radiology websites were consulted. Only literature related to paediatric radiation protection were used.

Results: findings from this review show that a lot has happened in the field of radiation protection with emerging technological advances which has implications for radiation protection in limited resource settings. Issues of concern are lack of awareness of radiation protection among health professionals and patients, lack of specialized training and facilities in paediatric radiation protection.

Conclusion: based on this review we observe that a lot has happened in the field of radiation protection and is still happening. However numerous issues of concern such as lack of awareness of radiation protection and specialized training exists in limited resource settings Nigeria inclusive. These can be improved by increase awareness, appropriateness and audit of paediatric imaging among others.

Keywords: Modern radiology, radiation protection, exposure tracking, paediatric radiography, challenges

Introduction

Historically, Rehani [1] categorized the timeline of radiation protection into three; the early 20th century before the advent of radiation protection measures marked by skin injuries; 1920s to 1980's during which skin injuries largely decreased due to innovations in radiation protection measures such as x-ray tube shielding; 1990s resurgence of skin injuries in patients undergoing interventional procedures and other high dose procedures; presently, we are in an era of increased and increasing patient exposure due to emerging technological advances in medical imaging. He concluded by saying that “overall this may not be a bad thing as the medical benefits still outweigh the harm”. But there is growing concern about cumulative radiation doses to patients.

Patient exposure remains the largest exposure to the human population from man-made radiation sources [2]. Emerging technological advances in diagnostic and interventional radiology have influenced the practice of radiology within the past few decades. While these advances in technology have reduced patient doses for low dose procedures such as plain film radiography, high dose procedures such as computed tomography has led to increase patient doses [1]. In many developing countries even if these technologies are available, it cannot be guaranteed that they are being used effectively and safely for paediatric patients. In fact there are reported cases of inadequate awareness of radiation protection among health professionals and patients, and situations where adult protocols are used for paediatric patients during CT scans [3,4].

Therefore this paper intends to explore current issues relating to emerging technology and futuristic practice with a view to highlight challenges of paediatric radiation protection in limited resource settings and recommend ways forward.

Current Trends in Radiation Protection of Patients

There have been growing concerns on the radiation protection of patients over the past few decades. This led to the development of a dedicated website on the radiation protection of patients in 2001 by the International Atomic Energy Agency (IAEA) [1]. Currently there are numerous patient advocacy campaigns worldwide for radiation protection of patients some of which are; Image gently campaign, Eurosafe, Afrosafe, Latinsafe, and Arabsafe, with renewed emphasis on use of referral guidelines and diagnostic reference levels among others [5,6]. Patient radiation dose tracking for relatively high dose radiological procedures (Computed radiography/direct digital radiography, advanced dose saving techniques in computed tomography and use of radiation smart cards) [1]. Mechanistic and orthomolecular approaches to radiation protection are also being reviewed in futuristic context [7].

Radiation protection of patients’ advocacy campaigns

To advance the cause of radiation protection of patients worldwide, there was a recent call for strengthening radiation protection in medicine for the next decade organized by the IAEA, hosted by the government of Germany and co-sponsored by the World Health Organization (WHO) tagged the “Bon call for action” held in 2012. A follow-up conference was held in Vienna by December last year, 2017 which appraised and consolidated on the gains and successes recorded since the previous conference in Germany [8].

Relevant stakeholders such as the IAEA, WHO, International Society for Radiographers and Radiologic Technologist (ISRRT), European Society of Radiology (ESR), American College of radiology (ACR) among others are at the forefront of patients’ advocacy campaigns for radiation protection [6]. There is also renewed emphasis on the need for justification at all levels and optimization of medical exposures [5]. Several consultations and guidelines have been developed on the use of referral guidelines or clinical imaging guidelines to aid justification of medical exposures worldwide taking into cognizance differences in technology and practice [9, 10,11]. The need to establish diagnostic reference level as a tool for optimization of radiation protection has equally gained recognition globally with the European Union being at the forefront of the paediatric Diagnostic Reference Level project (PiDRL) [12, 6].

Patient radiation dose tracking

Occupational and public radiation protection have been the focus of most radiation protection measures over the years at the expense of patient radiation protection on the basis that exposure to patient is justified; `the benefit to the patient from the procedure far outweigh the minimal potential risk. This does not take into cognizance the cumulative effect of such minimal doses [1]. It is estimated that the average life time dose to a patient is 200 times higher than the average life time dose to the staff [2, 13]. Hence, the conventional dictum that staff protection is more important than patient protection does not longer hold [1]. This calls for prompt action and thinking about the future hence, the need for this paper.

Radiation dose to patients have not been the focus of most manufacturers of medical imaging equipment (CT in particular) over the years because clients rarely asked of it [1]. Image quality and speed of the examination were the focus of buyers rather than radiation dose to patients. For example every year CT manufacturers will announce an improvement in scan time from the previous year without any mention of the dose implication. Some professionals instinctively equate faster scan time with lower radiation dose. Since there are no dose limit, many incorrectly assume there are no controls to patient exposures [1].

Current research trends are focused towards patient radiation exposure dose tracking with the recent IAEA radiation smart card project that is on-going [14,15]. The new International Basic Safety Standards, General Safety Requirement Part 3 (GSR part 3) developed by the IAEA in collaboration with Food and Agricultural Organisation (FAO), International Labour Organisation (ILO), Pan-American Health Organisation (PAHO), WHO, among others clearly stipulates with renewed emphasis the requirements of patient protection that involve justification and optimization of radiation doses [5]. The increasing use of high radiation dose procedures such as CT is a need for the cumulative record of patient doses similar to that of staff, though voluntary [1].The patient-friendly nature of CT machines and ease with which scans are performed make it susceptible to overcautious ordering related to medico-legal reasons in paediatric patients [16]. Current emphasis of radiation protection in CT has shifted from "management of patient doses" to "avoidance of overexposure". Manufacturers also on their parts have shifted focus from "slice war to dose war" with safety mechanisms incorporated into CT machines directly rather than leaving it as an option for the operator with a view to reduce patient dose [17].

Fig 1. Specimen of the proposed radiation smart card to contain patient radiation history (Source: Rehani [1])

CHALLENGES OF PAEDIATRIC RADIATION PROTECTION IN LIMITED RESOURCE SETTINGS

Major challenges of paediatric radiation protection in limited resource settings borders on a number of issues ranging from awareness of radiation protection to paucity of dedicated paediatric equipment and trained personnel in these settings [18, 19, 20].

Awareness and utilization of ionising radiation among health professionals;

Empirical research findings in most limited resource settings have shown low awareness of ionising radiation among health professionals [18, 19 ,20]. This results in under-or over utilization ionising radiation emitting devices or modalities as well as a communication gap between health professionals and patients. These further results in;

- Unjustified patient exposure; Current findings show that 33-50 % of paediatric CT examinations have questionable indications [16]
- Increased radiation dose to patients
- Poor communication of radiation risk and benefits to patients and/or relations

Awareness of risks and benefits of ionising radiation among patients

Low awareness of risk and benefits of ionising radiation among patients results in general dislike for radiological procedures that could be beneficial to them. This situation is further complicated by the influence of social media and exaggerated public media reportage on radiation risks and hazards [1].

Patient-friendly radiological equipment and specialized staff training

Most radiology departments and equipment as well as staff training is largely tailored towards adult patients. This is even more serious in limited resource setting and crisis ridden regions [19] where the interest of the paediatric patient compete with other adult patients amidst the meagre resources available. Common challenges encountered in limited resource settings relating to paediatric radiation protection are;

Apparent lack of dedicated paediatric radiology equipment which ultimately affect patient dose since most equipment are built with adult specification. There are also reported cases where adult protocols are used for paediatric patients even for high dose procedures such as CT [3, 4].
Inadequate paediatric positioning aids and immobilization devices lead to poor quality images and increase radiation dose to patients [19]
Absence of specialized training in paediatric radiography and radiology result in sub-optimal practice with a cumulative negative effect on the radiation protection of patients as paediatric protection requires child-specific care [18,19,20].

Recommended Ways Forward

The following are recommended ways forward to counter the challenges of paediatric radiation protection in limited resource settings;

- Concerted effort is required to increase Awareness, Appropriateness and Audit of ionising radiation in line with the 'triple A" initiative of the IAEA for paediatric imaging.
- Management of hospitals should include paediatric imaging equipment as part of their procurement
- Specialized education and training of radiographers, radiologist and medical physicists with relevant update courses as part of continuous professional development are recommended.

Conclusion

Three things to bear in mind as we conclude this paper are the facts that; A lot has happen in radiation protection of patients over the years and there is need to strengthen radiation protection in the next decade; It is obvious that there are challenges of radiation protection in limited resource settings but these challenges are surmountable; Hence, to have a healthy population that will succeed the present generation in the next decades, radiographers, radiologists, medical physicists, and relevant stakeholders need to promote awareness, appropriateness and audit of ionising radiation in paediatric medicine in order to achieve the desired change in practice.

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