CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

SJIF Impact Factor: 7.187

https://doi.org/10.5281/zenodo.8356589

https://www.iajps.com/volumes/volume10-august-2023/33-issue-08-august-23/

Available online at: http://www.iajps.com *Research Article*

MEASURE TO REDUCE PATIENT RADIATION DOSE WITHOUT AFFECTING IMAGE QUALITY

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Abstract:

Introduction: *Despite widespread agreement that nuclear medicine is largely beneficial to patients when used for appropriate reasons, concerns have been expressed about the possibility that cancer could be caused by it because of the exponentially growing usage of high radiation exposure in medicine. The most crucial method for reducing this potential risk is to keep radiation exposure as low as reasonably possible (ALARA) while still performing the diagnostic work.*

Aim of the study: *The common technical approaches for managing radiation exposure are outlined in this article. Future thoughts on dose reduction are discussed, along with dose-management measures.*

Methodology: *The literature review is a comprehensive research of PUBMED since the year 1999-2020*

Conclusion: *Medical imaging has numerous crucial therapeutic applications and can have a big impact. However, there are dangers associated with CT, fluoroscopy, and nuclear medicine imaging methods. A well-rounded public health strategy aims to minimise the hazards while promoting the advantages of medical imaging. The FDA, other departments of the federal government, and the medical community can all contribute to such an approach. The FDA and our partners will seek to meaningfully reduce the unnecessary radiation exposure of patients during CT, fluoroscopy, and nuclear medicine imaging exams through the Initiative to Reduce Unnecessary Radiation Exposure from Medical Imaging.*

Keywords: *Radiation exposure, measures to control radiation, nuclear medicine, CT Scan, ALARA*

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QR code

Please cite this article in press Mohamed Ahmed Sharaf et al, ***Measure To Reduce Patient Radiation Dose Without Affecting Image Quality****, Indo Am. J. P. Sci, 2023; 10 (08).*

INTRODUCTION:

Computed tomography (CT), fluoroscopy, and nuclear medicine imaging tests all have advantages and disadvantages. The diagnosis and treatment of many medical diseases have improved as a result of these imaging techniques. The ionizing radiation (hereafter "radiation") that patients are subjected to during these exams could increase their lifelong risk of developing cancer. A well-rounded public health strategy aims to minimize the hazards while promoting the advantages of these imaging tests. Two radiation protection tenets—the appropriate reason for requesting and performing each procedure and careful optimization of the radiation dosage utilized during each process—are essential for managing the dangers associated with computed tomography (CT), fluoroscopy, and nuclear medicine imaging techniques. Only when medically necessary should these imaging tests be performed. Patients should only be exposed to the ideal amount of radiation during such exams, which is neither more nor less than what is required to produce a picture of the highest quality. In other words, every patient needs to receive the appropriate imaging test at the appropriate time with the appropriate radiation dose.[1]

Types of Medical Imaging

Medical imaging processes come in a variety of forms or modalities, and each one employs a unique set of tools and methods. High-frequency sound waves are used in ultrasound imaging, also known as sonography, to observe soft tissues, including muscles and internal organs. Radio waves and magnetic fields are used in magnetic resonance imaging (MRI) to create images. Contrary to ultrasound and MRI, ionizing radiation is used to create images of the body during nuclear medicine, CT, fluoroscopy, and projection radiography (also known as standard X-ray) treatments. Ionizing radiation is a type of radiation with sufficient energy to possibly harm DNA. Every day, people are exposed to modest background levels of ionizing radiation that occur naturally.[2]

Different levels of ionizing radiation are used during these various imaging processes. Mammography and other projection radiography treatments use comparatively small doses of radiation. During these exams, a machine emits X-rays through the patient's body to create one to several radiographs, or two-dimensional photographs, of a specific location of the body. While projection radiography, which includes mammography, accounts for around 74% of the radiation-intensive imaging procedures carried out annually in the U.S., it only accounts for 11% of all yearly radiation exposure from medical imaging.[3]

During a CT scan (also called a CAT scan) a rotating source passes x-rays through a patient's body to produce several cross-sectional images of a particular area. These two-dimensional images can also be digitally combined to produce a single three-dimensional image. In a fluoroscopic procedure, a device passes X-rays through a patient's body for a brief length of time to capture a real-time moving image, which can be used to observe the movement of an object or substance in the body. During a nuclear medicine procedure, such as a positron emission tomography (PET) scan, a patient is given a small amount of a radioactive substance called a radiopharmaceutical or radiotracer. [4]

Types of Radiation Exposure in Different Fields [7]

Type of Exposure	Average Adult Effective Dose in (mSv)	Estimated Dose Equivalent (No. of Chest X-rays)
Dental X-ray	0.005-0.01 6a	0.25-0.5
Chest X-ray	0.02	1
Mammography	0.4	20
CT	2-16 6b	100-800
Nuclear Medicine	0.2-41 6c	10-2050
Interventional Fluoroscopy	5-70 6d	250-3500

Concerns about Radiation Exposure

The overall amount of ionizing radiation that the American population has been exposed to over the past two decades has roughly doubled, according to a report released in March 2009 by the National Council on Radiation Protection and Measurements (NCRP). This increase is mostly related to more exposure to interventional fluoroscopy, nuclear medicine, and CT. The authors believe that these numbers will increase. According to NCRP, 67 million CT scans, 18 million nuclear medicine treatments, and 17 million interventional fluoroscopy procedures were carried out in the United States in 2006. [5,6]

Risks connected to patients' radiation exposure through medical imaging have drawn attention. Ionizing radiation exposure can raise a person's lifetime chance of getting cancer because it can harm DNA. Although a single scan may not pose a significant risk to an individual, millions of exams are performed annually, making radiation exposure from medical imaging a significant public health concern. According to Berrington de González et al., 29,000 potential cancer cases in the future could be linked to CT scans carried out in the United States in 2007.[9]

Measures to Reduce Unnecessary Radiation Exposure from Medical Imaging

With a focus on the imaging techniques that are linked with the greatest radiation doses, CT, fluoroscopy, and nuclear medicine, the FDA is initiating a Joint Initiative to Reduce Unnecessary Radiation Exposure from Medical Imaging. Through this endeavor, the FDA will work with others and take action to reduce the elements that lead to unneeded radiation exposure from these three medical imaging modalities. These initiatives seek to minimize the hazards while promoting the advantages of medical imaging. [10]

Safe Use of Medical Imaging Devices:

Following are the steps that the FDA facilitate the secure use of medical imaging technology:

1. Incorporating additional safeguards into equipment design, labeling, and user training in CT and fluoroscopic devices.

   The FDA set specific guidelines for makers of CT and fluoroscopic systems, requiring them to build these devices with significant additional protections, create safer technologies, and offer more training to promote safe usage by practitioners. On March 30 and 31, 2010, FDA plans to convene a public meeting to get feedback on the requirements that should be set forth. The FDA may mandate that CT and fluoroscopic devices, for instance, display radiation dose, record it, report it, and notify users when it exceeds a diagnostic reference level, a peak skin-dose threshold for damage, or any other predetermined number. In order to support specific clinical applications, the FDA may additionally require manufacturers to submit extra data in their premarket submissions, as well as to include that data in product labelling and education to increase safe the use of devices. [10]

2. Partner with the Centers for Medicare and Medicaid Services (CMS) to include crucial quality assurance practices in the certification and participation standards for imaging centres and hospitals.

   The CMS is in charge of regulating the accreditation of independent medical imaging facilities under the Medicare Improvements for Patients and Providers Act (MIPPA). In addition, CMS has established hospital participation requirements as well as interpretation standards for Medicare surveyors. Ent interpretive standards for hospitals' radiologic and nuclear medicine services. In order to encourage safe usage, the FDA customarily incorporates quality assurance recommendations into product-specific labeling and training. Working with CMS will enhance quality control at user facilities and encourage the safe use of medical imaging technology even more. [11]

3. To create regionally specific diagnostic reference levels for fluoroscopy, nuclear medicine, and CT procedures as well as a national radiation dose registry.

   The FDA recommends healthcare professional organizations to keep creating nationally recognized diagnostic reference levels for radiation-using medical imaging procedures, particularly pediatric procedures, building on the work of numerous professional organizations, including the ACR and NCRP. FDA will get more involved in these initiatives. For instance, in order to enable the construction of more precise diagnostic reference values, we will work with others to create mechanisms for gathering more useful radiation dose data from user facilities. By assisting practitioners in determining whether the radiation dose utilized during a certain exam is reasonable, these levels will improve quality

assurance and the safe use of medical imaging technologies. [12]

4. Develop guidelines for the documentation of radiation dose information by CT and fluoroscopic device makers for use in patient medical records or a radiation dose registry.
   The FDA released specific guidelines for CT and fluoroscopic device manufacturers to include equipment features that will give doctors more information to inform their decision-making. FDA may mandate that certain features be built into CT and fluoroscopic devices, such as the ability to record the radiation dosage value from each exam and link it to the study image to make it easier to store that information in a patient's paper or electronic medical record.[13]

5. Recommend standards for the proper use of nuclear medicine, fluoroscopy, and other procedures utilizing these methods continue to be developed and adopted by the healthcare professional community.

   The FDA advises that the community of healthcare professionals continue to create and accept appropriate use criteria for CT, fluoroscopy, and nuclear medicine procedures, building on the work of numerous professional organizations, including ACR and ACC. These criteria could be included in electronic decision support tools for ordering imaging procedures to raise the standard and consistency of clinical decision-making. [14]

6. Provides patients access to technologies that will allow them to track their own medical imaging histories.

   The FDA, with the joint task force of the ACR and RSNA, which is in charge of overseeing Image Wisely, creates and distributes a patient medical imaging record card.This card will be made available on the FDA's website. While adding a patient's history of radiation exposure to their paper or electronic medical record will be the best way to track it in the long run, a personal record card will give patients and their carers a way to track their own medical imaging histories in the short term and share this information with their doctors. This will make it easier for patients and doctors to have important dialogues about the best healthcare alternatives available.[15]

CONCLUSION:

Medical imaging has numerous crucial therapeutic applications and can have a big impact. However, there are dangers associated with CT, fluoroscopy, and nuclear medicine imaging methods. A well-rounded public health strategy aims to minimize the hazards while promoting the advantages of medical imaging. The FDA, other departments of the federal government, and the medical community can all contribute to such an approach. The FDA and our partners will seek to meaningfully reduce the unnecessary radiation exposure of patients during CT, fluoroscopy, and nuclear medicine imaging exams through the Initiative to Reduce Unnecessary Radiation Exposure from Medical Imaging.

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