

Controversies and Safety in Radiotherapy- A Short Review

Luqman Nur Hakim Mustafa Kamal, Siti Amira Othman* and Nur Amirah Elias

Department of Physics and Chemistry, Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia, 84600, Pagoh, Johor

*Corresponding author: sitiamira@uthm.edu.my

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Abstract: Nuclear medicine's development during the last 50 years illustrates a significant relationship between government investments in research and technology and breakthroughs in health care in the United States and throughout the world. As a result of these efforts, novel nuclear medicine methods have been created that may non-invasively detect illnesses, provide information that other imaging technologies cannot provide, and administer tailored therapies. In the United States alone, almost 20 million nuclear medicine treatments including radiopharmaceuticals and imaging equipment are performed each year. Overall, the use of nuclear medicine procedures is increasing rapidly, particularly as new imaging technologies such as positron emission tomography/computed tomography (PET/CT) and single photon emission computed tomography/computed tomography (SPECT/CT) improve the accuracy of disease detection, localization, and characterization, and as cyclotron automation and miniaturization, as well as advances in radiochemistry, make radiotracer production more practical. Besides that, this paper summarizes the safety issues from the radiographer's perspective. While radiology departments have the potential to present harmful consequences owing to ionizing radiations, radiology technicians' awareness and understanding of application protection standards and tools play a vital role in ensuring safe working conditions in these environments.

The current supplement discusses topical concerns and conflicts. Several of these are the consequence of fast advancing hybrid imaging technology. PET/CT has become the gold standard in diagnostic cancer; SPECT/CT is rapidly being utilized in numerous disciplines of nuclear medicine and a new hybrid imaging method, PET/MRI, is entering preliminary clinical trials. The introduction and use of hybrid imaging techniques necessitate major changes in nuclear medicine training curriculum for both physicians and technicians, as well as influencing nuclear

medicine practice in the United States and developing nations, respectively.

Nuclear medicine imaging employs radiotracers, which are tiny quantities of radioactive material that are commonly injected into the circulation, breathed, or eaten. The radiotracer moves across the region being studied and emits energy in the form of gamma rays, which are detected by a special camera and computer to produce pictures of the inside of your body. Nuclear medicine imaging gives information that conventional imaging methods cannot always provide, and it has the ability to detect disease in its early stages. Nuclear medicine is often used by doctors to diagnose, assess, and treat a variety of disorders. Cancer, heart illness, gastrointestinal, endocrine, or neurological diseases, and other ailments are examples. Nuclear medicine examinations identify molecular activity. This provides them the ability to detect sickness in its early stages.

Radiographers, also known as radiologic technologists. They are medical experts who use sophisticated scanning machines to create images for medical purposes. They use X-ray machines, CT scanners, and modern technology like digital fluoroscopy in their work. Radiographers are responsible for operating medical x-ray machines in healthcare settings in order to offer crucial and frequently life-saving diagnostic information. Radiographers' primary responsibilities are to provide services to patients while ensuring their safety at all times. In radiology, there are various safety concerns that must be addressed. These include safeguards against direct harm caused by the procedures and technologies they employ. Assuring the physical and psychological well-being of patients while they are in their care, as well as maintaining the best possible level of service delivery and, finally, protecting the employees so that they can provide safe services. But this profession entails more than simply setting a machine and pressing a button.

Radiographers should be aware of and prepared for the risks associated with their varied job duties. Because of the ionizing radiation exposure, this job is regarded to be dangerous. Radioactive materials and radiation-generating equipment are both sources of ionizing radiation. Although it is thought that the relationship between radiation dose and the risk of adverse biological effects is a linear, no-threshold model, the risk of injury is also influenced by dose rate,

age at exposure, radiation type, and organ exposed. Radioactive materials can be found naturally in the soil, such as uranium and radium, or they can be created artificially in a reactor or accelerator. Ionizing radiation in medical imaging is one of the powerful diagnostic tools in medicine [1]. Ionizing radiation causes harm that is incurable and has long-term consequences. Ionized atoms can make free radicals, break or form new chemical bonds, or harm components that control cell activities like DNA, RNA, and cell proteins [2]. Cell death, repair, or mutation can all occur as a result of these processes.

In an accuracy study, PET/CT is compared to a current conventional method using a third procedure or follow-up information as the gold standard. Generally, accuracy is measured using the estimated sensitivities and specificities of the two methods. When PET/CT is explored as a treatment option for cancer patients, accuracy studies are often conducted as population studies.

Positron Emission Tomography/Computed Tomography, generally known as a PET/CT scan, is a sophisticated imaging technology that combines functional imaging from PET with anatomical information from CT. It is an excellent method for distinguishing between healthy and damaged tissue [3]. While PET/CT imaging has become obligatory in the first assessment of lymphoma or lung nodules, its use in other indications such as prostate cancer, where tracers other than glucose should be utilized, is less obvious. As a consequence, nuclear medicine is being promoted to undertake high-quality diagnostic imaging in order to enhance patient management. Image fusion has a high diagnostic utility since it allows for the identification and localization of hypermetabolic or fluorodeoxyglucose (FDG)-avid lesions while also ensuring the efficiency of PET imaging without introducing any extra artefacts. By allowing two exams to be completed in a single session, this procedure saves a significant amount of time.

PET demands some effort to understand since it applies classic nuclear medicine ideas to a new radioactive element, fluorine-18, as well as innovative concepts integrating traditional nuclear medicine in terms of whole body scintigraphy and the distribution of ^{18}F -labelled glucose in the body. These nuclear medicine difficulties are then matched with computed tomography with or without contrast delivery, connecting the two imaging processes, nuclear medicine and radiology, together.

A SPECT-CT scan is a form of nuclear medicine scan that integrates images or photos from two different types of scans. The combined scan can offer accurate information on how various areas of the body work and help to pinpoint abnormalities more precisely. Following an injection of a nuclear medicine radiopharmaceutical, SPECT images are obtained. Depending on the radiopharmaceutical utilized and the type of scan, the injected medication “sticks” to certain parts of the body. It can, for example, reveal bone in a bone scan and the gall bladder and bile ducts in a hepatobiliary scan. Nuclear medicine gamma cameras detect the radiopharmaceutical. The camera or cameras spin in a 360-degree arc around the patient, allowing three-dimensional pictures to be reconstructed.

The patient is initially positioned on a bed that slides inside a ring- or 'donut'-shaped X-ray machine to collect CT pictures. The X-ray equipment spins around the patient in a 360-degree arc, allowing pictures to be rebuilt in three dimensions. Because the CT scanner's X-ray machine rotates considerably quicker than the gamma camera, the CT scan takes less time than the SPECT scan.

A tiny dosage of ionizing radiation is used in the scan, both from the radiopharmaceutical injected into your vein and from the CT scan. Importantly, the SPECT scan does not need any more radiopharmaceutical injections beyond what you would have received for a typical nuclear medicine scan without SPECT. The CT is often performed using a low-dose radiation approach, which exposes the patient to around 20–25 percent of the radiation exposure of a standard CT scan.

Simultaneous positron emission tomography and MRI (PET/MRI) is a technology that combines the anatomic and quantitative strengths of MR imaging with physiologic information obtained from PET. PET and computed tomography (PET/CT) performed in a single scanning session is an established technology already in widespread and accepted use worldwide. PET/CT systems that use 18F-fluorodeoxyglucose (FDG) PET to monitor metabolic activity are both advantageous to patients and cost efficient for a variety of oncologic reasons and they show promise in the evaluation of a variety of other disorders, including infection/inflammation.

The integration of PET and MRI is a new technology that intends to leverage on the inherent

benefits of MRI, such as improved soft tissue contrast and the absence of ionising radiation exposure. Despite the availability of PET/MRI, there have been some early concerns about which indications are best suited for its usage, considering the higher expense and complexity of the operation when compared to PET/CT.

In today's medicine, imaging is extremely significant. Radiology is another term for imaging. X-rays, ultrasound, CT scans, PET scans, and MRI are examples of modern imaging techniques. To create an image, each imaging kind employs a different technology. Imaging is a term that refers to a set of procedures that are used to make images of bodily parts. This can help in screening for prospective health diseases before symptoms appear, diagnosing the likely source of current symptoms, and monitoring health conditions or treatment effects for people who have been diagnosed. When it comes to illustrating what is going on inside the body, health providers now have a larger number of imaging types to choose from.

Table 1: Strengths and limitation [4]

	Strengths	Limitation
PET/CT	<ul style="list-style-type: none"> • Widely available • Established imaging protocols • Evidence proven indications • Familiarity among ordering providers • Quantitative accuracy well established • Imaging of small pulmonary nodules • Exams performed in as little as 30 minutes 	<ul style="list-style-type: none"> • Limited soft tissue contrast • Fast CT exam does not provide extra time for PET acquisition • IV contrast not routinely used • If focused MRI needed, must be additional exam • Ionizing radiation from CT component
PET/MRI	<ul style="list-style-type: none"> • Improved soft tissue contrast • Added value of DWI • Increased available time to collect 	<ul style="list-style-type: none"> • Limited availability • Protocols and indications still in development

PET data	<ul style="list-style-type: none"> • Better motion correction • Convenience and time savings with combined exams • Use of MRI specific contrast agents • No ionizing radiation from MRI component 	<ul style="list-style-type: none"> • Require technologist knowledgeable in both nuclear medicine and MRI • Quantitative accuracy still being determined • Exams may take 1 hour or longer • Limited evaluation of pulmonary parenchyma
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Table 2: Types of medical images.[5]

Types of medical imaging	Imaging method	Used to diagnose
Computed tomography(CT) scan	Ionizing radiation	Injuries from trauma, bonefractures, tumors, cancers, infections
X-Ray	Ionizing radiation	Bone fractures, arthritis,osteoporosis, breast cancer and digestive tract problems.
MRI	Magnetic waves	Multiples sclerosis (MS),spinal cord disorder, blood vessel issue
Ultrasound	Sound waves	Gallbladder disease, breast lumps, joint inflammation,blood flow problems
PET Scan	Radiotracers	Cancer, heart disease,coronary artery disease, Alzheimer disease.

Clinical radiology, like any other medical technique, carries some risk. Medical professionals, on the other hand, believe that the benefits of enhanced diagnosis and early treatment much outweigh any hazards. Radiation used in X-rays, whether in the form of simple radiography, CT scanning, or fluoroscopy, raises the risk of cancer later in life by a modest amount. Radiation sensitivity varies by age with children being more vulnerable than adults.

Radiation from these materials has a great effect on the cell structure in our body if exposed to repeatedexposure and the impact of this radiation will be felt after 5 to 10 years later and the most

feared impact or effect of exposure to radiation is genetic dysfunction which is immune function body and offspring but keep in mind that the health impacts arising from radiation exposure are dermatitis or disorders of the liver, burns on the skin, anemia, cataracts, bone cancer, skin cancer and changes in the genetics or heredity of the body.

The radiographer plays numerous essential responsibilities in reducing ionizing radiation exposure to patients and staff: (6) implementing a quality control model and developing optimized protocols with the medical physicist and interventionist; (7) accurately identifying the type of procedure and imaging protocol for an individual patient; and (8) maintaining a good safety culture to protect patients and staff in the daily routine.

Radiation protection and safety measures have been designed to ensure the protection and safety of department workers so that they are not accidentally or unintentionally exposed to radiation. The work conditions of radiographers are designed to be as safe as possible. "The X-ray room's walls have led in them to ensure that the radiation doesn't escape," Frey explains. "In the X-ray rooms, there is a shielded operator's booth where they can stand at the operator's control panel without being exposed to radiation." Through the use of suitable techniques, equipment, and shielding materials, radiation safety is maintained to ensure that radiation health professionals are not exposed to unnecessary radiation.

The ALARA radiation safety principle is based on using all "reasonable techniques" to reduce radiation doses and limit the release of radioactive elements into the environment. ALARA is a regulatory necessity for all "radiation protection programmer," as well as a basic radiation safety philosophy. The ALARA concept is applied in all activities involving radiation or radioactive materials, and it can help to reduce both unnecessary and excessive exposure. The three key factors that can help keep dosages "As Low as Reasonably Achievable" are time, distance, and shielding.

The amount of time you spend near a radioactive source is simply referred to as time. Limit your time spent near a radioactive source to only what is necessary to complete the task. If you're working in a location with high radiation levels, finish your work as fast as possible and then leave. There's no reason to spend any more time in its vicinity than is absolutely essential. One of

the finest things you can do in the event of a radiation emergency is to go inside a safe place as soon as possible.

The term "distance" refers to the distance between you and a radioactive source. As much as possible, keep your distance from a radioactive source. Because distance and dose are inversely related, this is a simple strategy to protect yourself. You can reduce your dose by increasing your distance. The length of time you must remain inside will be determined by the nature of the catastrophe and the extent of damage to essential infrastructure such as highways and bridges. Emergency personnel may tell you to evacuate the area after the roads and bridges have been cleared.

To protect yourself from a radiation source, you must put something between you and the radiation source. The type of radiation emitted by the source will determine the most effective shielding. Some radionuclides emit a variety of radiation. If you're in a multi-story building, head to the centre floors. Stay away from windows, doors, and external walls if you're in a single-story building. You could even be able to find refuge in a cellar.

Radiation that comes from outside the body and interacts with us is referred to as external exposure. Radiation that comes from inside the body and interacts with us is referred to as internal exposure.

Internal radiation dangers posed by radionuclides can be effectively mitigated by excellent hygiene and housekeeping routines. Internal radiation exposure can be decreased by removing food and drink from areas where radioactive materials are used or kept, as well as regulating "hand to mouth" practices.

Contamination can be avoided by using labels to indicate radioactive and possibly radioactive areas and items. Contamination should be contained with absorbent papers and spill trays, and contaminated things should be disposed of in a properly labelled container. It is vital to disinfect the area as soon as possible once a contamination occurs to prevent the infection from spreading. The risk of inhaling radioactive compounds can be reduced by using fume hoods and minimizing the generation of dust, aerosol, or volatile gas.

You have personal protection equipment as a radiation worker that you can employ to reduce your exposure. The radiographer's respirator will be protected from inhalation dangers as a result of this. Finally, wearing protective gear keeps radioactive particles away from the skin and hair. Finally, in a region with high radiation levels, alerting dosimeters can help you limit your stay time and track your collected doses. If radioactive material comes into contact with skin, clothing, or hair, it must be removed as soon as possible. Disposable gloves, safety glasses, lab coats, and other personal protective equipment (PPE) can help to reduce the risk of radioactive materials being ingested or absorbed. When working with high-frequency radiation, it's vital to understand how to protect your medical personnel and patients, as well as how to reduce the quantity of radiation they are exposed..

Conclusion: Medical radiation has had a huge positive and negative impact on society. Although the danger of side effects from diagnostic radiology techniques, such as cancer, is low, the usage of medical radiation, particularly CT, is gradually increasing. Before sending a patient for an ionizing radiation medical imaging test, the GP should make sure that the procedure is justified and that other tests that do not utilize ionizing radiation are not acceptable. General practitioners should feel comfortable informing their patients about the relative risk of cancer induction from medical radiation so that they can make an informed decision. In general, radiographer safety precautions are critical to protect their long-term safety.

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