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REVIEW ARTICLE

The Effectiveness of Radiation Protection in Medical Field- A Short Review

Nur Nabilah Faiqah Rosli[1], Siti Amira Othman[1]*, Nur Hazzanita Farizah[1]

[1]Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia, 84600, Pagoh, Johor, Malaysia.

*Corresponding author: sitiamira@uthm.edu.my

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Abstract

The growing of X-ray imaging around the world has implication towards radiationprotection of medical field. Higher usage in radiation commonly have been seen as a simple workload issue without future challenges. Unfortunately, due to improvement in technology and techniques, it caused the amount of X-ray procedures increase which requiring medical professionals in order to ensure patient who exposed to radiation has maintain their close physical contact. As many processes are complex, risk of severe occupational exposure become higher, thus necessary steps should be considered. It is important to ensure the lower effects of exposure are achievable. If the dosage limit for the lens of the eye is lowered in the near future, additional attention to eye protection may be required. There are many essential elements needed in ensuring medical field especially for X-ray imaging to be more proper and reasonably secured for exampleeducation and training in radiation protection.

Keywords: Radiation Protection; Radiation; Medical; Worker; X-Ray.

Introduction

Radiation is increasingly being used in medicinal applications around the world. Accordingto UNSCEAR estimates, roughly 4 billion X-ray exams are performed worldwide each year whichall of these procedures must be carried out by medical experts in handling occupational radiation exposure (United Nations Scientific Committee on the Effects of Atomic Radiation, 2008). The increasing usage may be considered as merely a workload issue which providing no new challenges. Moreover, procedures for types of X-ray imaging has been changed includingthe procedures that necessitate personnel being closed to the patient. These kind of procedures pose a difficulty in terms of ensuring proper radiation protection for medical professionals.

Justifying, efficiency and limitation dosage are the ICRP concepts that has been used in order to provide occupational radiation protection (International Commission on Radiological Protection, 2007). In fact, the implementation of efficiency and limitation dosage is likely the most critical aspect of providing radiation safety for medical workers in X-ray imaging. Therefore, it should be noted that a lack of strict adherence to the justification principle leads to the administration of a large number of unneeded examinations in X-ray imaging, which increases occupational exposure. This review paper focuses on the occupational radiation protection including factors in determining level of exposure especially in X-ray imaging, implications of X-ray imaging and the effective ways of radiation protection for medical staff due to recent trend in X-ray imaging.

The immediate aim of radiation protection is to offer an adequate level of protection for humans while not unreasonably restricting the beneficial practice of exposing people to radiation. Ionizing radiation, such as X-rays and gamma rays, may now infiltrate the human body, making radiation shielding critical in the medical field. Radiology is a discipline of medicine that employs x-rays to diagnose and treat disorders in humans. In most hospitals, the diagnostic imaging department is in charge of providing radiation services. Besides, the used of radiation in medical can affected the workers and patient based on how much the human being exposure to the radiation. The patient's radiation consequences were not evaluated until much later. until the 1950s that scientific findings emerged linking diagnostic radiology's modest levels of radiation exposure to late radiation reactions in patients. As a result, today's radiation-protection standards are based on concerns about the long-termconsequences of radiation on patients and radiation workers (Engel-Hills, 2006). However, radiation is very important in medical field such as radiation can detect cancers in human body but there is also have the disadvantages to human body that we have to take care of it.

Radiation protection is handled by several hospital departments. The fluoroscopy method emits a significant amount of radiation. Diagnostic imaging procedures such as computed tomography, mammography, and nuclear imaging, in general, add a relatively modest amount of radiation to the cumulative dose exposures of healthcare professionals. Both patients and healthcare staff are at danger from radiation exposure.

Radiation protection is important in medicine, but not as important as medical practice. When planning good management of ionizing radiation, the two most important key factors are to ensure that health professionals (including medical physicists) work together and convince them that radiation protection is an important part of their clinical practice quality management system (Vano, 2011). The most important international and national organizations have dedicated significant effort to improve radiation safety in medicine in the past number of years.

Justification, optimization, and dosage limit are three important phrases proposed by the International Commission on Radiation Protection (ICRP). It is not suitable to impose dose limits or dosage limitations because medical exposure of patients involves specialconcerns. Dose limitations are irrelevant since ionizing radiation, when utilized at the right dose for the job, is a valuable instrument that will help rather than hurt. As a result, there are no dosage restrictions for medical radiation, and the diagnostic reference level (DRL) is commonly employed as a standard (Do, 2016).

Acute health effects can be caused by exposure to very high levels of radiation, suchas being close to an atomic blast, such as skin burns and acute radiation syndrome radiation sickness. It can also have long-term health effects such as cancer and cardiovascular disease. Radiation exposure of low levels does not typically cause immediate health effects, but it does increase the risk of cancer over an entire lifetime. There are studies that help to track groups of people who have been exposed to radiation, including atomic bomb survivors and radiation industry workers. These studies show that exposure to radiation increases the chance of developing cancer, and the risk increases with increasing dose: the higher the dose, the higher the risk. Conversely, the risk of cancer from radiation exposure decreases with lower doses. The lower the dose, the lower the risk (EPA, 2018).

Accidental radiation exposure is no longer exclusive to industrial settings or after occupational medicine exposure. Since September 11, 2001, the risk of unintentional radiation exposure as a result of terrorist attacks has become more apparent. Scenarios usinga dirty bomb are becoming increasingly common. There are few options for coping with a large range of accidental radiation exposure scenarios. Many aspects of the dynamics of radiation response are uncertain, particularly at the cellular level as a function of time and dose, as well as at the organ level. To effectively respond to the effects of any inadvertent radiation exposure, knowledge must be updated on a regular basis. (Meineke & Fliedner, 2005).

Occupational Exposure in Medical Field (X-Ray Imaging)

The procedures in X-ray imaging consumes higher occupational exposure level which may ranging from simple insignificant cases such as chest X-rays to the major in the complicated cases such as interventional treatments. There are commonly two sources of radiation exposure from thestandpoint in X-ray imaging. Obviously, X-ray tube known as one of the source of radiation, thusduring the operation, the probability for workers to directly exposed to the incident beam should be minimized.

During the X-ray imaging, production of dispersed radiation will happen when incident beam of X-ray interacts with patient's body and cause the it radiates outward in through all angles. So, in most circumstances, the proximity of workers to the patient when exposures are made is thekey predictor of occupational exposure. On the other hand, the amount of radiation dose that received by the patient highly determined by the scatter level. This is importing since limiting the patient dose to the bare minimum able to achieve the desired medical goal including reduces potential occupational exposures especially in medical field.

There is usually no need for professionals to be physically close to the patient in many instances, such as radiography, mammography, and general computed tomography (CT). This gives two options for getting good occupational radiation protection. Firstly, when medical staff being far away from the patient, it able to minimizes the amount of dispersion and cause the radiation intensities fall down fast with distance due to divergence X-rays scattered from the patient. The second aspect is placement of shielding between the patient and medical staff which resulting in very low amounts of scatter reaching the staff. The shielding might be built into the control room barrier's wall and window by a medical physicist or person who expert in radiation protection in order to ensure the occupational exposure for X-ray imaging will be essentially zero.

Moreover, when radiation is utilized, it is vital to keep close physical contact with the patient in particular instances, such as fluoroscopic examinations and image-guided interventional procedures. Protective clothing worn by medical staff, such as aprons, spectacles, and thyroid shields, able to reduce the scattered radiation as well as barrier protection such as ceiling mountedprotective screens that can be placed between the patient and personnel, can reduce scattered radiation. An apron will attenuate 90% or more of incident dispersed radiation, depending on its lead equivalence and the energy of the X-rays.

Doses to the eyes can become excessively high for those working close to the patient. Therefore, protective eyewear can minimize about 90% of the dose towards the eyes, but to obtain optimal performance in order to ensure it intercepts the scattered radiation from the patient, the placement of the viewing monitor must be carefully considered as a serious issue. More attention will be received if the dosage limit for the eye lens is lowered as a result of current scientific findings (Stoeckelhuber et al. 2005). Ceiling mounted protective screens also offer great protection which commonly depends on their placement to ensure their usefulness is contingent.

Implications X-ray Imaging in Medical Field

Nowadays, digital technologies are used in medical field such as radiography compared to film-based. Generally, implications in medical field have been discovered as well. For example, multi-detector CT (MDCT) scanners have revolutionized CT imaging. Patient doses are relativelysimilar to their single slice predecessors which depends on how well imaging techniques have been improved. Due to continuous manufacturers introducing more feature in dose-saving cause the future trend is predicted to reduce the radiation doses in patient. Since CT usage is on the rise andacquisition of the image is much faster resulting increased of workloads in CT room. This has frequently necessitated the use of more structural shielding in order to maintain reasonable limits of occupational radiation protection.

In computed tomography fluoroscopy it able to generate live images of tomographic which makes biopsies easier. Yet, since interventionalist is so close to the patient, the hands may be exposed to the scattered beam, cause the doses of radiation at hand about 0.6 mSv due to 20 seconds of exposure. In addition, the major operators in interventional radiology and cardiology stay extremely close to the patient table, where it will cause the intensity of dispersed radiation increased. For example, in a cardiology treatment, when the X-ray tube is placed under the table, the probability of incident beam of the radiation to scatter operator's position can commonly range from 0.5 to 10 mSv per hour. If protective precautions are not adopted, cumulative doses can easily surpass the dosage limits and approach hundreds of mSv per year (Miller et al., 2010).

Effectiveness of Radiation Protection in Medical Field

Method that has been used in implementing radiation protection in medical field known as radiation protection programme (RPP) which has ability to established successful management either in structures, policies, procedures including structures of organization (Food and Agricultural Organization of the United Nations, 1996). In medical field,workers under X- ray imaging need to follow the rules and procedures, ensure the medical staff wearing personal protective equipment, has certificate in education and training programme in radiation protection including follow the methods in order to audit and review performance of RPP (International Atomic Energy Agency, 2006).

The implementation of radiation protection in practical is based on education and training, and most of nations regularly required a training (John, 2010). Medical staff in the field of X-ray imaging mustbe well-trained not only in radiation protection, but including radiation protection in patient due tothe effect of occupational exposure. The European Commission has produced guidance on what medical staff should include in their training (European Commission, 2000). Several training resources are available for free,including IAEA material that suitable for field of radiology and cardiology as well, including project of multimedia tool interventional training in radiology that important for effectiveness of learning (MARTIR, 2002). Due to circumstances stated above, it is critical that radiation safety training programmes at hospitals include medical workers who are not affiliated from the radiology department but involved in processes of X-ray imaging.

There are numerous publications that provide occupational doses per procedure in X-ray imaging in a specific facility, as well as others that estimate anticipated annual doses. For example, UNSCEAR gives information on occupational doses around the world, and over 80% of CT radiographers does not get the significant doses due to its 2010 report. It also including the confirmation that shielding structure has ability to low the doses of radiation for those who are exposed. Only a few nations were able to provide data that discriminated between traditional diagnostic radiology techniques and interventional procedures, according to the research of the report. According to restricted data, the reported mean yearly effective dosage for monitored workers in traditional diagnostic radiology was around 0.5 mSv, while it was around 1.6 mSv for interventional procedures. Based on data from 23 nations found that interventional cardiologists receive an average median effective dose of 0.7 mSv per country as well.

Effect of Radiation to Human

Radiation can interact with DNA, breaking bonds in the DNA or breaking the water molecules surrounding the DNA. When water molecules are broken, they become free radical unstable oxygen molecules that can damage cells and organs. Radiation may have a profound effect on the reproductive function of an individual (Ray & Choudhuri, 2011). According to Hello Doctor blog, natural radiation is produced by a number of sources, including over 60 radioactive compounds found in soil, water, and the atmosphere. Radon is a naturally occurring gas that may be found in rocks and soil and is a source of natural radiation.

Every day, radionuclides are inhaled and swallowed from the air, food, and water. High-dose radiation is still one of the most effective weapons in the battle against cancer, andsoaking in a radioactive spa is thought to be therapeutic. The amount of radiation that damages tissues and organs is determined by the dosage of radiation that is received or absorbed. The absorbed dose's potential for harm is determined by the type of radiation used and the sensitivity of various tissues and organs. Radiation can alter the function of tissuesand organs beyond specific thresholds, resulting in acute symptoms such as skin redness, hairloss, radiation burns, or acute radiation syndrome.

Radiation Protection for Workers

Radiation protection is part of the ILO's action on the protection of workers against sickness, disease and injury arising out of employment, as mandated by the Organization's Constitution. (Malone, n.d.). Radiation can be used in test equipment, to sterilize items, to measure soil moisture levels, to manufacture weapons, and to power nuclear power plants in industrial settings. Radiation is also applied in diagnostic instruments like CT scanners in the healthcare industry, and it is focused for the treatment of tumor and cancer. Those who deal with radiation must be aware of safety measures, the implications of not following them, and what to do if an accident occurs.

Figure 1. Protection equipment from radiation (Tuan Solawati, 2015)

According to Safety Management Group, the effective radiation safety training emphasizes three methods for minimizing worker exposure to radiation: keeping a safe distance from sources, limiting time spent near sources, and employing shields to reduce exposure. Other safety precautions may be necessary depending on the working environment and the type of radioactive material.

A dosimeter, for example, measures radiation andsounds an alert when a specified threshold is exceeded. They suggested that employees who are exposed to radioactive dust use respirators to avoid inhaling the dust. Gloves and other personal protection equipment could be needed as well. Radiation, like fire, is both a useful tool and a potential threat. There's no need to be terrified of radiation, but it's a good idea to have a healthy regard for its strength and utilize tactics that reduce possible harm, just as it's agood idea to build a healthy respect for fire.

Radiation Protection for Patients

Radiation protection is based on lowering the predicted dosage of exposure andmeasuring the radiation dose experienced by the human body. There are three main principlesof radiation protection. The first is period. The duration is related to the short-term exposure with reduced dose. The second is the distance, the farther the distance, the lower the dose. The last is the shield. The protective cover is the use of protective equipment, such as gowns, aprons and radiation shields, which will reduce the amount of unnecessary radiation reaching the patient, thereby reducing the radiation dose.

When the patient is exposed to radiation during an examination, how is he or she protected? Radiation devices ensure a very low dose of radiation for patients during x-ray examinations. Radiation protective devices are available in all imaging departments. Protective devices in the imaging department are available in the form of lead aprons, thyroidshields, gonadal shields, and portable lead screens.

Each radiation protection device will be provided during the inspection. The use of radiation protection equipment depends on the type of inspection performed. In addition, the appropriate exposure factor such as the X-ray Interpreter will select the appropriate exposure factor to produce an optimal image. In addition, ensure no screening uses radiation unless the benefits produced outweigh the disadvantages. Patients should not undergo repeated examinations.

Important Of Radiation Protection

A type of electromagnetic radiation is electromagnetic waves. Radio waves, microwaves, infrared, visible light, ultraviolet (UV) rays, X-rays, and gamma rays are all examples of electromagnetic radiation. The naked eye can perceive all wavelengths of light, but only the shorter wavelengths are visible. Ionizing radiation is anything that has enough energy to knock an electron out of its location in the nucleus of an atom, whereas non- ionizing radiation does not.

X-rays are a form of electromagnetic radiation that may penetratethrough solid objects and produce images of bones, organs, and injuries. An X-Ray is the name for the image. A photograph of an X-ray image of a colorless object is called an X-ray. There are various forms of x-ray machine radiation, each of which is used to producedifferent images.

General radiography is used to provide X-ray exams that don't involve any specific procedures like ingesting, injecting, or inserting contrast into the patient's body. Abnormalities in the lungs, fractures or fissures in the bones, ingestion of hard and solid foreign things such as coins, and many more diagnoses can be determined with general radiography. General radiography cannot offer a clear image if the patient's discomfort includes soft tissue organs such as the kidneys, bladder, or intestines. As a result, a chemical known as a contrast agent is employed. It is radio-opaque, which means it can be seen through radio waves. The term "radio-opaque paint" refers to paint that is not visible to x-rays.

Figure 2. A modern CT Scan machine (Al-Ameen & Sulong, 2016)

Conclusion

The number of X-ray operations in which medical staff must keep close physical contact with the patient during radiation exposures has increased astechnology and techniques have progressed. Because many processes are complex, there is a highrisk of considerable occupational exposure, and necessary precautions must be taken to ensure realoccupational exposures are optimized to be lower as possible. If the dosage limit for the lens of the eye is lowered in the near future, additional attention to eye protection may be required. To ensure medical field are safe, thus education and training especially in radiation protection must be considered as necessary elements including procedures during working in radiation, wear a suitable protective equipment, and efficiency of monitoring system.

Finally, radiation protection is a concern for patients, clinicians, and employees in a variety of departments, including Radiology, Interventional Cardiology, and Surgery. The radiation released during fluoroscopy operations causes the highest dosage of radiation for medical professionals.

Radiation from diagnostic imaging technologies such as computed tomography, mammography, and nuclear imaging is a minimal component to health care worker cumulative dose exposure. Radiation exposure poses a potential risk for both patients and healthcare professionals alike. Radiation protection tries to reduce the harmful effects of ionizing radiation by avoiding unnecessary exposure. Ionizing radiation is an unavoidable aspect of the diagnosis and treatment of a wide range of medical disorders in the medical field.

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