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Principles of Radiation Protection for Patients and Medical Staff

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ABSTRACT

Patients and healthcare professionals in numerous fields, such as radiology, interventional cardiology, and surgery, are concerned about radiation safety. Healthcare workers' cumulative radiation exposures from diagnostic imaging modalities such computed tomography, mammography, and nuclear imaging are negligible. However, patients and medical staff alike are at danger from any radiation exposure. This research aimed to explore the principles of radiation protection and the current issues in radiation protection for both patients and medical staff. It is shown that the purpose of radiation protection is to limit exposure to ionizing radiation where it may do the least amount of damage. Despite the many positive outcomes from medical irradiation, there is a need to safeguard patients against the hazards posed by stochastic and deterministic effects. The rising cumulative dose to individuals from medical exposure is just one of the current issues in radiation protection of patients, which also includes the fact that a large percentage of diagnostic imaging examinations are unnecessary. Conclusions for Radiation Protection Include Enhanced Justification, Patient Radiation History Tracking, Collaborative Education on Serious Safety Incidents, and Thorough Quality Audits in the Clinical Setting.

Keywords: Radiation; Protection; Principles; Safety; Patients; Clinical Staff

Introduction

Radiation protection has emerged as a key issue in healthcare settings since it has a tremendous impact on the patients and the medical staff (Martin, et al. [1]). While radiation is a highly significant diagnostic tool, it has been associated with severe risks to both patients and healthcare workers if it is not well managed and educated (Salah Eldeen NG, et al. [2,3]). It is reported that cancer, cataracts, infertility and blood dyscrasias, inherited illness, developmental abnormalities, and degenerative illnesses are only some of the health hazards associated with radiation exposure, and these risks vary depending on the amount and length of time an individual is exposed to radiation (Alotaibi, et al. [4,5]). Radiation ward staff should be well-versed on the dangers and preventative measures of radiation exposure in order to safeguard their own health and that of their patients (Morishima, et al. [6]). Radioactivity is the process by which radioactive atoms release ionizing radiation (Erkan, et al. [7]). Electromagnetic radiation (such as gamma or X-rays) and particulate radiation (such as neutrons, beta or alpha particles) make up ionizing radiation (Goula, et al. [8]). Globally, the percentage of people exposed to radiation as a result of medical procedures is expected to rise to 20% by 2020 (Della Vecchia, et al. [9]). More than 3600 million radiological exams, 37 million nuclear medicine operations, and 7.5 million radiation treatments are done annually over the globe (WHO, [10]).

The purpose of radiation protection is to limit exposure to radiation so that the risks associated with ionizing rays are reduced as much as possible (Alotaibi et al. [11]). Ionizing radiation is now routinely utilized in the medical industry for a wide range of purposes, including diagnosis and therapy. The cumulative doses of radiation that patients and doctors are exposed to over the course of a lifetime have increased as its usage has expanded. Fluoroscopic imaging, which employs x-rays to achieve dynamic and cinematic functional imaging (Hansson Mild, et al. [12]), is the primary source of radiation exposure in medical settings. Staff and patients are less likely to be harmed by radiation if they have had formal radiation protection training (Ljungberg, [13]). However, many interventionalists do not get formal training on radiation dose reduction during residency or fellowship (Malone, et al. [14,15]), making it difficult to enforce radiation safety requirements. In particular, there is poor adherence to radiation safety recommendations among doctors or medical professionals who employ fluoroscopic imaging outside of specialized radiology or interventional departments (Michel, et al. [16]). Understanding the hazards of radiation exposure and how to reduce doses is crucial as the frequency with which people are exposed to radiation rises (Chiu, et al. [17]).

Ljungberg (2022) [13] identifies justification, optimization, and dosage restriction as the three cornerstones of radiation protection. Understanding the potential upsides and downsides of radiation use is essential for making a case for it. Educating patients on the risks of radiation exposure is an important responsibility shared by physicians, surgeons, and radiologic staff. The advantages of exposure should be widely understood and acknowledged by doctors. treatments like interventional vascular treatments, which expose patients to comparatively greater doses of radiation, are often medically required. Recognizing that radiation is essential for diagnosis and treatment, the As Low as Reasonably Achievable (ALARA) concept was developed to guarantee that all steps to decrease radiation exposure have been taken. According to Vano (2011) [18], the probability of acquiring cancer after exposure to radiation is increased due to stochastic effects. It is believed that these effects proceed according to a linear model in which there is no clear threshold at which the onset of malignancy can be reliably predicted. The radiation protection for both patients and medical is closely associated with Radiation Protection Culture (RPC) (Moores, et al. [19,13,20]). Radiation dangers, safety regulations, and stakeholder involvement are all essential for establishing an RPC in a Radiology Department. The development of an RPC is mostly the responsibility of experts. Slechta and Reagan (2008) [21] found that having a solid RPC allowed for better diagnosis and treatment, increased staff and patient safety, and decreased radiation exposure.

The principles of radiation protection are essential for developing a sound RPC and for enhancing radiation protection for both the patients and medical staff (Ljungberg, [13,22]). This is also associated with understanding the current issues in radiation protection which could give deeper insights into the proper management of the radiation protection process (Johnson, [23]). So, the goal of this research is to overview the principles of radiation protection and to understand the current issues and actions for radiation protection. By realizing the governing principles and involved issues, a plausible set of recommendations can be obtained that allow radiologists, healthcare facilities, healthcare leaders, medical staff, and patients to be well protected from radiation.

Statement of the Problem

X-ray was discovered in 1895 and has since become an essential tool in medical diagnosis and treatment. Single frame radiographs, CT scans, radiation, and interventional fluoroscopy are all possible with the use of X-rays (Brusin, [24]). More than 2500 million diagnostic radiological exams, 32 million nuclear medicine examinations, and 5.5 million radiation sessions are conducted annually around the globe, according to estimates (Lakhwani, et al. [25]). Even at modest dosages, there might be a cumulative impact. There is a danger of occupational overexposure to radiation for both patients and medical staff during interventional procedures using fluoroscopy image intensifier (C-Arm) technology, such as those used in Orthopaedic surgery (Bhatt, et al. [26]). To keep radiation as low as reasonably attainable (ALARA) (Bolton, [27]) it is essential to be aware of preventative actions and to utilize protective equipment. The biological consequences of radiation exposure are dose-dependent both in terms of their severity and their likelihood of occurring (Ljungberg, [13]). Radiation-induced thyroiditis, dermatitis, and hair loss are examples of deterministic consequences that have been described in interventional radiology, cardiology, and radiation therapy. Stochastic consequences, such as cancer growth, are often identified decades after radiation exposure (Martin, et al. [1]). The cumulative dose an organ or tissue receives over time is the determining factor in the development of deterministic consequences (Salah Eldeen NG, et al. [2]).

The literature is based on epidemiologic data from huge radiation exposures at doses far greater than is employed in the medical context, making it difficult to research the consequences of long-term low-dose exposure to ionizing radiation (Vassileva, et al. [3]). Evidence from recent studies shows that medical radiation may raise the incidence of cataracts, cancer, and perhaps genetic illnesses by a small amount (Alotaibi, et al. [11,8]). Ionizing radiation is emitted when patients are examined with x-rays or radiopharmaceuticals for diagnostic purposes (Erkan, et al. [7,9]). Therapy for cancer or benign lesions, as well as interventional treatments using fluoroscopy, make use of radiation emitted by radioisotopes or radiation generators (Hansson Mild et al. [12]). The usage of ionizing radiation in medicine has skyrocketed in recent decades, raising serious safety concerns among both doctors and patients (Malone et al. [14]).

Research Questions

This research attempts to answer the following questions:

1. What are the principles of radiation protection for patients and medical staff?

2. What are the current issues and actions in radiation protection for patients and medical staff?

3. What are the recommendations to enhance radiation protection for patients and medical staff?

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Research Objectives

This research tries to achieve the following objectives:

1. To explore the principles of radiation protection for patients and medical staff.

2. To demonstrate the current issues and actions in radiation protection for patients and medical staff.

3. To present recommendations that can enhance radiation protection for patients and medical staff.

Research Significance

Radiation protection culture (RPC) should be established in every Radiology Department due to the increased use of ionization radiation for diagnostic and therapeutic purposes, the rapid advancements in computed tomography, and the high radiation doses delivered by interventional procedures (Ploussi, et al. [28]). More often than not, the task at hand is one of enhancement rather than the construction of an RPC. Quality assurance programs must be implemented, and personnel and professionals must engage in ongoing education to ensure radiation safety (Biso, et al. [15]). The RPC creation is being driven from understanding the principles of radiation protection and the actions that govern it (Chiu, et al. [17]). The understanding of the principles or radiation protection and the current issues that enhance radiation protection enable the reduction of the radiation risks, strengthen radiation risk awareness, minimize unsafe practices, and improve the quality of a radiation protection program. The purpose of this review paper is to describe the principles of radiation protection for patients and medical staff and the current actions that govern the movement towards more enhanced radiation protection with the intervening role of building a strong radiation protection culture.

Literature Review

In diagnostic and interventional radiology, radiation shielding is essential for patient safety. Justification, optimization, and dosage application are the three pillars of patient radiation protection (Ljungberg, [13]). Other researchers have introduced several principles which are followed to minimize their exposure and ensure their safety during medical procedures involving radiation (Bolton, [27,1,18]) and these principles include:

Justification

The use of radiation in medical procedures should be justified, meaning that the potential benefits of the procedure should outweigh the potential risks. The procedure should only be performed if it provides valuable diagnostic or therapeutic information that cannot be obtained through alternative, non-radiation methods.

Optimization

The radiation dose delivered to the patient should be optimized to achieve the necessary diagnostic or therapeutic outcome while keeping the radiation exposure as low as reasonably achievable (ALARA). This involves using appropriate imaging or treatment techniques, protocols, and equipment to minimize the radiation dose without compromising the quality of the results.

Dose Limitation

The radiation dose to the patient should be limited to prevent unnecessary radiation exposure. There are established dose limits and reference levels for various medical procedures, and medical staff should adhere to these guidelines to ensure that radiation doses are within safe limits.

Individualization

Radiation protection measures should be tailored to the individual patient. Factors such as age, size, clinical condition, and reproductive status should be considered to determine the appropriate radiation dose and shielding requirements for each patient.

Shielding

Shielding measures should be employed to protect the patient from unnecessary radiation exposure. This may include the use of lead aprons, thyroid shields, leaded glasses, or gonadal shielding, depending on the specific procedure and the area of the body being irradiated.

Image Quality

The quality of diagnostic images should be optimized to ensure that the required information is obtained with minimal repetition or need for additional exposure. This helps reduce the overall radiation dose received by the patient.

Informed Consent

Patients should be fully informed about the benefits, risks, and alternatives of radiation procedures before giving their consent. They should be provided with clear and understandable information to make informed decisions about their healthcare.

Pediatric Considerations

Special attention should be given to radiation protection for pediatric patients due to their increased sensitivity to radiation. Imaging techniques and protocols should be adjusted to minimize radiation doses in children, and alternative imaging methods that do not involve radiation should be considered whenever possible.

Follow-up and Documentation

Patient radiation exposure should be documented and tracked over time. This helps ensure that cumulative doses are monitored, and unnecessary repetition of procedures or excessive radiation exposure is avoided.

On the other hand, Kim (2018) [29] demonstrated three major principles for reducing radiation exposure which include time, distance, and shielding.

Time

Over the course of prolonged exposure to radiation, cumulative effects may develop. The amount of time spent verifying the C-arm fluoroscopy during radiation-guided operations is directly proportional to the amount of radiation received. The pain doctor will be subjected to a higher dose of radiation the longer the exposure lasts. As a result, limiting how often C-arm fluoroscopy is performed is crucial (Moores, [19]). Time savings may be achieved by trained intervention by the doctor and careful X-ray inspection by the radiographer at the proper time and place to avoid blurring of the picture (Brusin, [24]).

Distance

Radiation safety may be improved by moving away from the source. As opposed to decreasing with distance, radiation exposure instead decreases with the square of the distance from the radiation source (Bolton, 2008). This suggests that a reduction in radiation exposure of not 1/2 but 1/4 may be achieved by moving twice as far away from the source. As a result, the best way to protect yourself from the X-ray generator is to keep your distance. Two steps behind the moveable support structure has been shown in a prior research of radiographers to reduce exposure by roughly 80% (Johnson, [23]). Another research found that X-ray exposure may be reduced by 73% just by moving 20 centimeters away from the centre of the field (Vassileva, et al. [3]).

Shielding

For radiation safety during C-arm fluoroscopy-guided procedures, several shielding equipment are available, including hats, lead glasses, thyroid protectors, aprons, radiation-reducing gloves, and so on. The protective effect is sufficient for radiation safety, but the doctor is still at risk if they utilize the equipment. Over 80% of pain doctors in Korea wear an apron and thyroid protection (Ljungberg, [13]). However, only around 40% of people used lead glasses, and only about 35% used radiation-reducing gloves (Martin, et al. [1]). Radiation shielding equipment is costly, and it's not always easy to get used to wearing one. However, doctors may avoid radiation hazards by using shielding gear. Exposure may be minimized by limiting time spent in radiation fields, moving away from radiation generators, and using physical shields (Goula, et al. [8]). There are a number of strategies available to shorten the time spent exposed. Before putting a patient through radiation exposure, a technician or doctor should carefully plan out the necessary pictures. Therefore, care should be used while using magnification, since doing so dramatically increases patient exposure (Erkan, et al. [7]). To better comprehend anatomy during treatments, continuous or live fluoroscopy may be useful, although ordinary fluoroscopy devices only take around 35 pictures per second. Instead, pulsed fluoroscopy, which gets around five pictures per second without compromising imaging quality, may be used to reduce exposure. Finally, it's important to reduce exposure time whenever you can (Della Vecchia, et al. [9]).

Another technique to reduce radiation exposure is to increase the distance between the x-ray source and the area to be scanned. When taking an x-ray of a patient, it's best to place the image intensifier or x-ray plate as near to the patient as feasible and the x-ray tube as far away as possible while still getting a clear picture (Malone, et al. [14]). To reduce contact with doctors and nurses, a similar strategy might be utilized. During fluoroscopy operations, surgeons, interventionalists, and operating room personnel are often exposed to scattered radiation, which follows an inverse square law. As one moves further away from an x-ray source, one is exposed to less radiation due to scattering. By moving twice as far away from the radiation source, workers' exposure will be cut in half. This simple idea may significantly cut workers' exposure to radiation on the job (Chiu, et al. [17]). Personal protection equipment (PPE) comes in a variety of forms and may be used to physically shield radiation (Martin, et al. [1]). Doses to the head and neck may be decreased by a factor of 10 thanks to lead acrylic shields that hang from the ceiling in certain fluoroscopy rooms. Those working in operating rooms and interventional settings may benefit from portable rolling shields, which don't have to be permanently installed. When utilized properly, these portable shields reduce employees' effective radiation dosage by more than 90 percent (Biso, et al. [15]). When it's not possible to put up a physical barrier, workers should wear leaded aprons as an added layer of safety. Thicknesses of 0.25 mm, 0.35 mm, and 0.5 mm are most frequent for the legally mandated lead apron widths in the United States (Ljungberg, [13]). Since they cover more of the wearer's body, apron designs that wrap around the back and sides are favored over those that just cover the front. The average amount of radiation that gets through leaded apron is between 0.5 and 5%. It is recommended that a thyroid shield be used in conjunction with a lead apron at all times (Tzelves, et al. [30]).

Patients are additionally safeguarded by the use of personal protective equipment. Patients should wear protective gowns during plain radiography, fluoroscopy, and CT scans for regions that are not being scanned. To adequately shield the lens of the eye, leaded eyewear must have a lead equivalent of at least 0.25 mm. Multiple studies have shown that lead glasses are the least worn component of PPE, with compliance rates between 2.5% and 5% (Moores, [19]). Occupational radiation doses have been linked to early onset of cataracts, especially in the posterior lens, in a large cohort of radiation technicians (e.g., Goula, et al. [8,9]). Interestingly, radiation exposure mostly causes opacification at the back of the eye's lens rather than elsewhere. When worn routinely, leaded eyeglasses may cut the amount of radiation hitting your lens by as much as 90 percent. The low incidence of people actually using their leaded eyewear is indicative of a

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problem. The efficacy of the equipment relies on more than just wearing the right kind of leaded apron. Alotaibi and Muhyi (2019) [11] recommend checking lead clothing for integrity every six months and recommending that leaded aprons be hanging rather than folded to avoid cracking. Dosimeters are instruments for monitoring long-term exposure to radiation (Johnson, [23]). All medical personnel who will be exposed to scheduled ionizing radiation should wear these shields. Unfortunately, in many healthcare facilities, monitoring is inadequate, leading to a dearth of trustworthy data. Half or more of doctors, according to a study by Erkan et al. [7], either don't use dosimeters or wear them inappropriately. It is recommended that dosimeters be worn both within and outside of the leaded apron so that the facility's radiation safety staff may compare the results. Dosimetry education and public awareness should be top priorities for health systems' occupational safety and radiation safety divisions (Martin, [20]). When employees use dosimeters as required, they may get information about their radiation exposure that can be used to audit their actions and raise safety consciousness (Vano, [18]).

Methodology

This research used the narrative review approach. This review involves researching, reading, analyzing, assessing, and summarizing relevant journals and articles about radiation protection for patients and medical staff. The conventional approach to assessing the literature is the narrative review, which leans more heavily on a qualitative interpretation of existing knowledge (Sylvester, et al. [31]). Simply said, a narrative review is an effort to summarize or synthesize the existing literature on a certain subject without the goal of drawing broad conclusions or amassing extensive information (Davies, et al. [32,33]). Here, the researcher undertook the task of accumulating and synthesizing the literature to demonstrate the value of radiation protection for patients and medical staff.

Results & Discussion

Since this review attempted to explore the key principles of radiation protection and the current issues in radiation protection for patients and medical staff, below are the results of the review:

The Principles of Radiation Protection for Patients & Medical Staff

The results of this review have shown that there are key principles of radiation protection for both patients and medical staff. These results have been well evidenced in the literature since varying principles of radiation protection have been well elicited. It has been shown that medical professionals and their patients may benefit from formal radiation protection training (Ljungberg, et al. [13,3]). Enforcement of radiation safety regulations, however, may be time-consuming and difficult, and many interventionalists do not get instruction on radiation dose reduction during residency or fellowship (Salah Eldeen NG, [2]). Radiation safety requirements are not often followed, especially by physicians or medical professionals that employ fluoroscopic imaging outside of specialised radiology or interventional departments. Numerous medical fields make use of fluoroscopy, including gastrointestinal surgery, vascular intervention, vascular surgery, vascular radiography, orthopaedics, and urology. Understanding the dangers of radiation and how to minimise exposure to it will be crucial as exposure to radiation increases. Justification, optimisation, and dosage restriction are the three pillars of radiation protection. As stated by Ljungberg (2022) [13]. By adhering to the aforementioned guidelines, medical professionals may reduce their patients' radiation exposure without sacrificing the quality of the diagnostic or therapeutic data they need. For complete radiation safety in medical practise, it is essential that these guidelines be used in tandem with principles of radiation protection for medical professionals (Tzelves, et al. [30]).

In order to evaluate the many measures to safeguard medical workers and patients from radiation, a fundamental grasp of the science underpinning the detrimental effects of radiation is essential. High-energy photons in the electromagnetic spectrum are what make up X-rays. X-rays stand out from other types of light because they may ionise atoms and destroy chemical bonds (Martin, [20]). The chemically active molecules created by this ionisation are called free radicals, and they have been shown to cause indirect DNA damage (Moores, [19]). Scattered x-rays and direct exposure to the x-ray beam both pose risks to medical personnel and patients (Vano, [18]). Energy deposited in tissues from dispersed x-rays is less than from direct x-rays because of the loss of energy during the scattering process. There are three common approaches to quantify radiation exposure. The amount of radiation that is deposited in an item is called its "absorbed dose," and it is expressed in milliGray (mGy). Millisieverts (mSv) are used to indicate the equivalent dose, which is derived by factoring in the organ-specific radiation exposure and the organ's susceptibility to radiation (Martin, et al. [1]). The effective dose, measured in millisieverts (mSv) (Chiu, et al. [17]), is the total of the doses received by all of the body's organs. Dosage recommendations can only be understood with a firm grasp of these terms. The ICRP's dose recommendations are shown in Figure 1 [34].

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Type of Dose Limit	Limit on Dose from Occupational Exposure	Limit on Dose from Public Exposure
Effective Dose	20 mSv/yr, averaged over defined five-year periods, with no single year exceeding 50 mSv	1 mSv/yr
Effective Dose	Once employee declares pregnancy, the dose to embryo/fetus should not exceed 1mSv during remainder of pregancy	-
Equivalent Dose: Lens of the Eye	20 mSv/yr, averaged over defined five-year periods, with no single year exceeding 50 mSv	15 mSv/yr
Equivalent Dose: Skin	500 mSv/yr	50 mSv/yr
Equivalent Dose: Hands and Feet	500 mSv/yr	-

Figure 1: ICRP Dose recommendations. Source (Frane, et al. [34]).

It is also shown that protection for medical staff is crucial to minimize occupational radiation exposure and ensure their safety in healthcare settings where radiation-emitting procedures are performed. The below key principles of radiation protection for medical staff are also elicited from the findings (Michel, et al. [16,21,22,11]):

Awareness and Training: Medical staff should be educated and trained on radiation safety principles, including the potential risks of radiation exposure, proper use of radiation equipment, and adherence to safety protocols. They should have a good understanding of radiation protection measures and be aware of the specific risks associated with their work.

Time, Distance, and Shielding: The "time, distance, and shielding" concept should be consistently applied. Medical staff should minimize the time spent in close proximity to the radiation source, maintain a safe distance from the radiation source whenever possible, and utilize appropriate shielding measures to reduce their exposure. This may include wearing lead aprons, thyroid shields, leaded glasses, and other protective devices.

Personal Protective Equipment (PPE): Medical staff should wear appropriate personal protective equipment to minimize radiation exposure. This may include lead aprons, gloves, and other shielding devices that provide adequate protection for the specific radiation procedures being performed.

Monitoring and Dosimetry: Regular monitoring of radiation doses received by medical staff is essential. Personal dosimeters should be worn to measure their radiation exposure accurately. This data helps identify any potential overexposure and allows for appropriate corrective actions.

Equipment and Facility Design: Medical facilities should be designed to minimize radiation exposure to staff. This includes the proper installation and maintenance of radiation-emitting equipment, adherence to shielding requirements, and the implementation of safety features to prevent unnecessary radiation exposure.

Work Practices and Procedures: Medical staff should follow established work practices and procedures to minimize radiation exposure. This includes proper positioning of patients, using appropriate technique factors, collimation, and image optimization to reduce radiation doses. Adherence to safety protocols and guidelines is crucial in maintaining a safe working environment.

Quality Assurance and Quality Control: Regular quality assurance programs should be implemented to ensure that imaging and treatment equipment are functioning correctly and delivering appropriate radiation doses. Quality control measures help maintain the accuracy and reliability of radiation-emitting devices, reducing the risk of excessive radiation exposure.

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Communication and Collaboration: Effective communication and collaboration among medical staff are vital to ensure radiation safety. Staff should communicate relevant information about radiation procedures, patient conditions, and safety concerns to minimize errors and promote a culture of safety.

Emergency Preparedness: Medical facilities should have emergency protocols in place to handle accidental radiation exposure or equipment malfunctions. Staff should be trained on emergency procedures to minimize the potential impact of such incidents and ensure prompt response and appropriate management.

Current Issues in Radiation Protection for Patients & Medical Staff

Several emerging tendencies in the medical use of radiation are highlighted, all of which contribute to pressing problems in radiation safety for both patients and healthcare providers.

Justification of Medical Exposures: Medical procedures that are not justified for a specified objective, application of procedures to individuals that are not justified based on their conditions, and medical exposures that are not appropriately optimized for the situation in which they are used can all lead to unnecessary exposure of patients (Martin, et al. [1]). Because of random factors, this might increase the likelihood of undesirable outcomes. Patients may be exposed to harmful levels of radiation or lose control of their tumors due to deterministic effects caused by poorly designed or used medical equipment. Protecting patients from radiation exposure entails preventing both intentional and unintentional harm (Salah Eldeen NG, et al. [2]). The goals of the exposure and the patient's unique features should be carefully considered before any medical exposure is administered (Goula, et al. [8]). At this stage, the justification process often includes both the referring physician or surgeon and the radiologist who will be doing the evaluation. Alternative methods that do not include the use of ionizing radiation (such as ultrasonic and magnetic resonance imaging) should also be examined (Chiu, et al. [17]). Justification relies heavily on the knowledge and training of referring doctors and radiologists, but research reveals that this training is often lacking in practical settings (Vano, et al. [18,19]). Patients' rights and autonomy must be respected, and more care must be taken to ensure that they are fully informed before giving their permission (Martin, [20]).

Tracking Radiation Exposure of Patients: It was rare to encounter a patient who had undergone dozens of CT scans within a few years only a decade ago. Patients getting many CT scans within a year or even within a few years have lately been reported (Martin, 2014). There have been reports of cumulative effective doses more than 100 mSv, and even 1 Sv in extreme circumstances (Tzelves, et al. [30]). In 2005, reports of radiation-induced skin injury (erythema or hair loss) from a clinical CT protocol or accidental excess exposure emerged, and by 2012, the U.S. Food and Drug Administration (FDA) had intervened to prevent this from happening to more than 200 patients undergoing perfusion CT protocols (Ljungberg, [13]). An attractive solution to this issue would be to centre attention on a patient's total radiation dose (Ljungberg, [13]). It is important to keep track of each patient's radiation exposure (radiation history), including the number of exams and estimated radiation doses. Patients' radiation protection efforts have traditionally been motivated by the rising national average dosage from medical procedures. However, there is a growing demand to consider the cumulative dosage (exposure history) of particular individuals (Vano, [18]).

Keeping Up with Technology with Comprehensive Quality Audits: Increasing dialogue between physicians in radiological practice and health professionals versed in efficient dose reduction measures is crucial if we are to see a shift in the collective dose to the public from diagnostic radiology (Ljungberg, [13]). It is evident that the establishment of regulatory frameworks outside the clinical setting aids in the implementation of standards for patient protection. Patients' radiation exposure may be kept at safe levels with the help of a well-designed clinical infrastructure that prioritizes radiation safety. Perhaps the finest illustration of this is found in the creation of a methodical strategy for justifying medical radiological exams (Martin, [20]). Another effort to systematically enhance awareness of patient dosage and include the integration of this data into the considerations for patient treatment is the use of novel tools to measure patient exposure. Both of these examples need intricate integration to be really useful in a busy clinical setting. Here, clinical audit may help by using helpful peer review techniques that are neither intimidating nor counterproductive (Vano, [18]).

Shared Learning of Safety Important Events: Improving radiotherapy patient safety is also a major focus right now. While the risk of damage or death from documented side events is minimal, this sophisticated treatment technique has lately attracted extensive focus on safety related problems in the public press (Chiu, et al. [17]) despite this. It is widely acknowledged that the establishment of a comprehensive global safety reporting and learning system is a necessary step towards achieving safety improvement in radiotherapy, as accidents and incidents that are repeat occurrences are sometimes seen in radiotherapy (Johnson, [23]). Radiation treatment incidents must be reported to national authorities in several countries. The results of inquiries into severe occurrences are typically kept under wraps (Goula, et al. [8]) because they include the reporting of substantial dosage mistakes or effects on several patients. In addition to these national and mandated reporting systems, open and volunteer reporting systems may allow learning on a broader scale by capturing near-incidents and other safety-related occurrences (Della Vecchia, et al. [9]).

Conclusion and Recommendations

This research discussed how to properly use the principles of radiation protection in the context of medical exposure to patients and medical staff. Three key principles have been reported which include

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justification, optimization of protection, and application of dose limits, in addition to other important principles. Current challenges in radiation protection of patients are a direct result of recent developments in the medical use of ionizing radiation. A significant contributor to the rising collective dosage to the world's population from medical exposure is the continuous fast expansion of CT-scanning. Considering recent findings that a sizeable fraction of diagnostic imaging exams are unneeded, this is a field in which patients may be better protected from radiation exposure. There is a window of opportunity to implement voluntary systems for shared learning of safety-critical events as the public becomes more aware of the risk of deterministic harm from ionizing radiation in medicine. Last but not least, clinical audit is a useful tool for encouraging sustained patient safety initiatives in healthcare facilities. The medical community's knowledge of how to shield patients from radiation exposure has improved with the development of medical imaging. Educating hospital workers on radiation best practices is the first step towards optimizing safe radiation practices. Radiation safety is the responsibility of each individual institution's radiation safety office. Multiple fields of medicine have found success through educational and protocol-development initiatives. Radiation dosage optimization may benefit greatly from even the simplest of measures. Adherence to dosage limits, together with justification and optimization, may greatly reduce exposure. In accordance with the ALARA principle, medical professionals must ascertain that the potential advantages of radiation exposure exceed the potential disadvantages, and they must endeavor to keep their exposure levels as low as reasonably achievable.

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