

MINI REVIEW ABOUT RISKS OF RADIATION IN MEDICINE**Fatema Sattar, Ali Razzaq Amer, Dhay Kazem Jabbar, Zahraa Ayed Raziq, Shahad yousif Mahdi**

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Abstract: Radiation is currently widely used and routinely applied in medicine. Diagnostic radiology, nuclear medicine, and radiation treatment have grown from their primitive beginnings 100 years ago to modern methods that are regarded as critical tools across all fields and specializations of medicine today. Ionizing radiation's inherent qualities give numerous benefits, but they can also be harmful. Its usage in medical practice requires an informed decision on the risk-benefit ratio. This choice requires knowledge of radiation in general as well as medical skill in specific. This review investigated the risks associated with radiation, their connection to medicine, and the advancements in diagnostic and therapeutic technologies. Radioactive substances and radiation are used in medicine, research, and diagnosis. The forms of radiation and their varied impacts on medicine, particularly in the treatment and diagnosis of disorders like cancer, were disclosed by our review's conclusions. It has been demonstrated that mistakes in radiation dosage can result in health issues, hence managing radiation must be done carefully both during research and in practice.

Keywords: Radiation Risks, X-rays, Computed Tomography (CT), Magnetic Resonance Imaging (MRI).

This is an open-access article under the [CC-BY 4.0](https://creativecommons.org/licenses/by/4.0/) license**Introduction**

Radiation is frequently categorized according to the energy of the emitted particles as either ionizing or non-ionizing. More than 10 eV of ionizing radiation is present, and this is enough to ionize atoms and molecules and disrupt chemical bonds (Gupta & Gupta, 2020). Given the wide variation in toxicity to living things, this is an important distinction. Radioactive materials emitting α , β , or γ radiation, including helium nuclei, electrons or positrons, and photons, are a typical source of ionizing radiation. Additional sources include medical radiography test X-rays,

as well as the particles that make up secondary cosmic rays (which are created when primary cosmic rays collide with the atmosphere) such as muons, mesons, positrons, neutrons, and other particles (Reed, 2011). The ionizing region of the electromagnetic spectrum includes gamma rays, X-rays, and ultraviolet light with higher energy levels (Norgard & Best, 2017). The term "ionize" refers to the separation of one or more electrons from an atom, which needs the relatively high energy supplied by these electromagnetic waves (Goodman, 1995). A good example of this is sunburn, which is brought on by long-wavelength solar ultraviolet light. Further down the spectrum, the non-ionizing lower energies of the lower ultraviolet spectrum cannot ionize atoms, but they can disrupt the interatomic connections that form molecules, breaking them down instead of atoms (Feng et al., 2006). Longer wavelengths than UV in visible light, infrared, and microwave frequencies can cause vibrations that are sensed as heat but cannot dissolve bonds. Biological systems are generally not thought to be negatively impacted by wavelengths shorter than radio waves. The effects of some frequency overlap, therefore they are not precise separations of the energies (Glasser, 1995). This mini review aims to review some of the health risks of radiation.

Naturally occurring (background) radiation

More than half of the radiation that humans are exposed to comes from the environment. Radioactive elements found in the earth's crust include potassium, uranium, radium, polonium, thorium, and polonium (Shahbazi-Gahrouei et al., 2013). The amount of exposure will change based on the rocks and soil in the area. Cosmic radiation represents another natural source. Radiation from processes taking place in the sun, other stars, and the universe is continuously exposed to Earth (Melott & Thomas, 2011). Arguably the most dangerous kind of natural radiation is radon, a colorless, odorless gas produced by the breakdown of radium, an element present in nearly all rocks and soils. Cracks and other openings in walls and floors allow radon gas to enter structures. Because radon gas emits alpha particles, breathing in radon that has accumulated within buildings can be extremely dangerous (Thorne, 2003). After smoking, radon is the second most common cause of lung cancer death, accounting for an estimated 20,000 cases of the disease annually. Those who smoke and reside in houses with elevated radon levels are more vulnerable (Numann & Doege, 1991).

Artificial sources of radiation

From the end of World War II until 1980, atomic weapons were tested in the atmosphere, releasing radioactive particles known as fallout. As the fallout settled, it became part of the ecosystem. Although some of the debris is still degrading today, the majority had brief half-lives and are no longer present (Diffey, 2002). The amount of fallout that affects people and the environment decreases yearly. Radiation has numerous applications in medicine (Sharipova, 2022). The most well-known use is in X-ray equipment, which employ radiation to diagnose illnesses and find shattered bones. Province and Health Canada are in charge of X-ray machines. Nuclear medicine is another example, which diagnoses and treats illnesses like cancer using radioactive isotopes. The CNSC regulates certain nuclear medical applications and the equipment associated with them. Reactors and particle accelerators that produce isotopes for use in industry and medicine are also licensed by the CNSC (Fundarek, 2022).

Radiation in medicine

In countries with a robust clinical sector, medical sources can account for up to 50% of our total radiation exposure. The majority of this stems from the use of ordinary x-ray and CT scan equipment to detect injuries and diseases. Other techniques, such as radiation therapy, employ radiation to treat patients (Hricak et al., 2011).

Radiation Risks and Children

Both adults and children need to be concerned about radiation control. But there are three specific issues that affect kids and fetuses that need to direct our actions: Numerous epidemiological studies on populations exposed to radiation have shown that children are much more vulnerable to radiation exposure (Paolicchi et al., 2014). Radiation damage has a longer window of opportunity to appear in children due to their longer life expectancy than adults. Children may get

more radiation than is necessary if dosages and equipment settings are not adjusted for their smaller bodies. It is unlikely that a growing fetus or child may experience radiation-induced malformations or intellectual impairment from routine diagnostic radiography or nuclear medicine procedures. Nevertheless, even at standard diagnostic radiation dosages (>50 M Gy), there is a small but significant risk of cancer induction, which needs to be taken into account (Bosch de Basea Gomez et al., 2023). A young child undergoing similar diagnostic or interventional treatments has a considerably higher chance of developing radiation-related cancer than an adult. Therefore, minimizing radiation dosages must be a primary goal, particularly for treatments given to minors or during pregnancy. Dosage reduction for pediatric use is mostly accomplished through child-specific technical factors. Briefly, Children are more susceptible to the harmful effects of radiation due to their smaller size and developing bodies (Mettler et al., 2013; Mohammed & Hadi, 2022). Research has indicated that children who are exposed to ionizing radiation, such as through diagnostic imaging techniques like CT scans, have a higher chance of developing cancer (Linnet et al., 2018; Hammer et al., 2009; Kutanzi et al., 2016) Radiation exposure in early childhood or during pregnancy increases the chance of childhood cancer. It's critical that medical professionals understand the dangers of radiation exposure and take the necessary precautions to reduce exposure in young patients (Angel et al., 2008).

Reducing fetal radiation in pregnancy

Any time throughout pregnancy can be a safe time to do medically needed distant diagnostic procedures (such as lung scans or x-rays of the chest or extremities) as long as the equipment is in excellent operating order. Most of the time, the benefits of a precise diagnosis outweigh any possible risks associated with radiation (Michalet et al., 2022). When a fetus is in or close to a radiation beam during an examination that is at the higher end of the diagnostic dosage range, the risk-benefit equation requires limiting procedures and doses as much as practical while maintaining enough information to provide a correct diagnosis (Blommaert et al., 2024). This can be achieved by tailoring the examination to minimize the number of radiographs needed or, in the case of nuclear medicine, by promoting hydration and prompt radiopharmaceutical voiding through the urinary tract to minimize exposure to the fetus (Lowe, 2004). However, Radiation during pregnancy poses risks to the fetus, especially during organogenesis and the first trimester. Effects vary with gestational age and radiation dose. High doses (above 100-200 mGy) can cause serious effects, but doses under 50 mGy are generally safe [15,16]. Most diagnostic procedures don't reach concerning levels. For cancer treatment, minimizing fetal exposure through advanced techniques is key. Decisions on radiation use should balance fetal risks with maternal benefits (Gomes et al., 2015).

Radiation risk and CT (computed tomography) use in pediatrics

Radiation risk and the use of computed tomography (CT) in pediatrics can save children's lives by detecting illnesses and injuries. In the United States alone, 5 to 9 million CT examinations are conducted on children each year, and the usage of this treatment is gradually expanding, owing to its value in common disorders as well as technological progress (Wang et al., 2023). However, despite its many obvious benefits, CT has a considerable disadvantage in terms of radiation exposure. Even while CT scans make up only 12% of diagnostic radiological procedures performed in the US, they account for over 49% of the nation's total radiation exposure from medical procedures (MacNevin et al., 2024). The first study to specifically look at the risk of pediatric cancer following CT scans found a robust dose-response relationship for brain tumors and leukemia, with the risk rising with cumulative radiation absorption. It has been observed that a cumulative exposure of roughly 50–60 mGy to the skull triples a child's risk of developing brain cancer. Similarly, it was shown that the risk of leukemia increased proportionately with identical radiation exposure to bone marrow (Andrade et al., 2012). The two results were contrasted with those of a control group that was exposed to less than 5 mGy of radiation in the pertinent body regions. These findings resembled estimates from investigations following the nuclear disasters in Japan (Brenner et al., 2001).

Magnetic resonance imaging

Magnetic resonance imaging (MRI), sometimes known as MR, is a different imaging technique that has developed within the past 40 years. As previously seen, this utilizes radio frequency energy from the far left end of the electromagnetic spectrum. Because of its low energy, tissue or DNA cannot be directly harmed by this radiation (Chen et al., 2023). It is important to note, though, that exposure to excessive amounts of radiation can heat tissues, which can result in harm. To avoid this, the amount of radio frequency radiation that can be employed in an MRI scanner is strictly limited (Schramm et al., 2023).

The general Principles for Reducing Radiation Risk in Medical

The most efficient strategy to limit patient risk during radiological examinations is to perform suitable tests and optimize radiation protection for the patient. In essence, radiologists, nuclear medicine physicians, and health physicists are responsible for these (Mainprize et al., 2023). Procedures must, according to the fundamental concept of patient protection, aim to obtain diagnostic data with acceptable clinical quality at the lowest feasible dose. Data from several nations show that entrance doses that is, doses measured at the place where the x-ray beam enters the body vary significantly when given to patients; in certain situations, these differences can reach a factor of 100 (Fogtman et al., 2023). Higher-end entrance dosages (beyond the 70th or 80th centile, for example) are clearly difficult to defend as sticking to an ideal risk/benefit ratio, as the majority of the doses in these studies cluster around the lower end of the distribution (Dorr, 2010). A helpful first step toward radiation risk reduction for patients would be an established protocol of diagnostic reference tables of appropriate radiation for various procedures and patient types (e.g., children vs. adults) at an institutional, regional, or national level, based on observed international best practice (Gray et al., 2005). In addition to being an excellent teaching or counseling tool, this kind of work can help with quality control by quickly identifying facilities or equipment that need to be fixed in order to reduce patient hazards. Radiation dose reduction for patients can be significantly impacted by actions that improve transparency, communication, and execution between radiologists, health physicists, and audit teams (McCollough et al., 2011). These actions can also improve diagnosis efficacy. It is policy to gradually phase out some approaches when better ones come along. Fluoroscopy and photofluorography, for instance, are no longer advised for the screening of tuberculosis in children (normal radiography is a less harmful alternative for this age group), and when compared to alternatives, fluoroscopy without electronic image intensification exposes patients to unacceptable high doses of radiation. At the moment, the majority of wealthy nations have outlawed these operations (Wesenberg & Amundson, 1984). In parallel, during the past 20 years, the number of interventional procedures guided by fluoroscopic imaging has increased dramatically. Across fields, both the number and diversity of such processes are still increasing. A basic coronary intervention exposes patients (and personnel) to an average of 15 mSv, whereas complex electrophysiological treatments expose them to an average of 50 mSv. These radiation doses are comparable to 750 and 2500 post-anterior chest X-rays, respectively. Usually, the direct advantages of these procedures outweigh the dangers posed by such large radiation dosages. Even with this favorable risk-benefit ratio, risk-minimization measures still need to be taken. It is impossible to overstate the importance of quality assurance and improvement programs that minimize radiation exposure to patients and staff, promote ongoing learning, monitor doses, ensure proper use of equipment and protective clothing/shields, and adhere to radiation safety guidelines published by various professional societies (Milder et al., 2024).

The radiation and cancer risks

Exposure to ionizing radiation is a known risk factor for cancer development. Studies have shown that moderate to high doses of radiation can increase the risk of various types of cancer, including leukemia, lymphoma, breast, brain, and thyroid cancers (Canet & Harbron 2022). The effects of radiation on cancer cells include DNA damage, cell death, chromosome aberrations, and gene

mutations (Liu et al., 2020). However, the relationship between radiation and cancer is complex, and factors such as genetic predisposition, dose, and timing of exposure, as well as interactions with other carcinogens, can influence the risk (Martin et al., 2016). It is significant to remember that greater radiation doses, such those used in radiotherapy, are typically linked to a higher risk of radiation-induced cancer than low-dose exposures. Advances in radiation therapy techniques aim to minimize exposure to normal tissues and reduce the risk of radiation-induced malignancies (Kim et al., 2015). Overall, while radiation can increase the risk of cancer, the benefits of radiation therapy in treating cancer often outweigh the potential risks (Baskar et al., 2012).

The radiation and genetic risks

The development of genetic diseases and the likelihood of genetic abnormalities can both be heightened by exposure to ionizing radiation (Canet & Harbron, 2015). Research has demonstrated that mutations caused by radiation are stochastic events, which means that the amount of radiation received determines how frequently they occur (da Cruz et al., 2015). Extrapolation from animal trials and comparisons with observed incidence in exposed populations serve as the foundation for the estimate of radiation-induced genetic risk (Sankaranarayanan & Chakraborty, 2000). Depending on the approach taken to estimate the risk, the risk of radiation-induced genetic damage might vary, although overall it is modest when compared to the population's baseline frequency of genetic illnesses. Genetic predispositions and other genetic factors may also impact the risk of radiation-induced cancer. To properly comprehend the influence of genetic variables on the risk of radiation-induced cancer, more research is necessary (Sankaranarayanan & Nikjoo, 2011; Sankaranarayanan & Chakraborty, 2001).

Conclusion

The nature of radiation, its types, and the extent of the effect of each type, and thus the extent of the effect of this radiation or its risks in the field of medicine, were discovered in this study due to the frequent use of radiation as a treatment and diagnosis of several diseases, the most important of which are cases of cancer, where it was discovered that any error in the proportion of giving these doses may cause health problems and diseases. It was concluded or concluded that radiation must be studied and dealt with.

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