

Radiation Exposure in Pain Management Providers: A Systematic Review of the Current Literature

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INTRO

- Millions of interventional pain procedures are performed each year to address chronic pain. Some of these procedures include epidural steroid injections, medial branch blocks, epidurograms, radiofrequency ablation, and more. The increase in interventional pain procedures also raises the concern of health risks associated with ionizing radiation for physicians who perform fluoroscopy-guided operations.

METHODS

- A PRISMA systematic review: EMBASE and PubMed from the years 1956-2023 and 1969-2023.
- “radiation exposure pain management” and “radiation exposure interventionalist.”
- 2736 articles, where we later included 24 manuscripts in our paper.
- Bias Evaluation: Cochrane Risk of Bias tool and the National Institutes of Health tool.

RESULTS

- 3,577 patients treated by 30 interventional pain physicians.
- Common areas of exposure to radiation: neck, chest, groin, hands, and eyes.
- Factors: influence the amount of radiation that physicians may receive: protective gear, work experience, type of procedures performed. For example, one common body region that is exposed to radiation is the chest, and our systematic review found that wearing lead aprons can lower the radiation dose by over 95%.
- Wearing protective equipment and managing the distance between the operator and fluoroscopy machine can both independently lower the radiation dose by over 90%
- The radiation dose to the outside (unprotected) chest ranged from 0.008 ± 27 mREM to 1345 mREM. When protective equipment was worn, the radiation exposure to the inside chest ranged from 0 mREM to 108 mREM,
- The outside neck ranged from 572 mREM to 2032 mREM. When protective equipment worn, the inside neck ranged from 0 mREM to 68 mREM,
- The outside groin ranged from 176 mREM to 1292 mREM. When protective equipment worn, the inside groin ranged from 0 mREM to 15 mREM.
- The hands ranged from 0.006 ± 27.4 mREM to 0.114 ± 269 mREM
- Eyes ranged from 40 mREM to 369 mREM.
- Fluoroscopy-guided > CT-guided operations.



How much radiation exposure are Interventional Pain Physicians exposed to?



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Radiation Definitions

Three main types of ionizing radiation exposure:

- Primary x-ray: occurs when the beams from the x-ray directly make contact with the physician’s body or extremities.
- Scatter x-ray: contributes to most of the radiation that interventional pain physicians experience. The x-ray beams first make contact with the patient and lose energy, where they then deflect and scatter throughout the room.
- Leakage x-ray: when defective equipment causes the beams to leak out of the machine and head in an unintended direction.

Radiation exposure can be quantified in terms of absorbed dose and dose equivalent. The absorbed dose is the amount of energy that is transferred from the ionizing beams to tissues whereas the dose equivalent takes into account the biological effects of tissues along with the amount of energy absorbed. The main units recognized by the International Council on Radiation Protection (ICRP) is gray (Gy) for absorbed dose and Sieverts (Sv) or roentgen equivalent-man (rem) for dose equivalent (1 Sv = 100 rem). Dosimeters are used to measure the absorbed dose and dose equivalent during operations, where the ICRP recommends that at least two of these devices are worn by providers in the operating room. Regulations are set to protect medical staff from prolonged radiation exposure throughout the year. The National Council on Radiation Protection (NCRP) recommends that the annual maximum dose limit for physicians should be 500 mSv (50,000 mREM) for the thyroid, 500 mSv (50,000 mREM) for the extremities, 500 mSv (50,000 mREM) for the gonads, 50 mSv for the lens (5000 mREM), 50 mSv (5000 mREM) for the whole body, and 5 mSv (500 mREM) for pregnant individuals.

The exact effects of low radiation exposure and its direct harm on human health is relatively unknown. Some studies have suggested that low radiation dose may lead to statistically significant increased risk for certain cancers. Pediatric patients who received a mean total thyroid dose of 50 mSv -100 mSv (5000 mREM - 10,000 mREM) were more likely to get diagnosed with thyroid cancer than those who never received radiation as well. Other studies have suggested that there is some cancer correlation in those who are exposed to 10 mSv to 100 mSv (1000 mREM - 10,000 mREM), where 1000 mSv (100,000 mREM) may lead to a 5% cancer risk in a person’s lifetime. Cheon et al shared in their review article that an accumulation of 65 µSv (6.5 mREM) per procedure elevates the likelihoods of thyroid cancer development over time. It is also important to note that as individuals age, their likelihood of developing thyroid malignancy caused by radiation exposure diminishes. For comparison, there is background radiation of 3 mSv (300 mREM) every year.