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EDITORIAL COMMENT

# A Practical Approach to Radiation Protection for Cardiac Catheterization Laboratory Staff*

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X-ray angiography and fluoroscopy contribute substantially to diagnosing and treating heart disease. The contributions of x-ray imaging to patient care are immeasurable. However, x-ray imaging includes exposure to ionizing radiation with associated health risks to the patient and to staff. High radiation doses to the skin of patients is known to cause skin injury. Epidemiological studies have demonstrated that, if the short-term effective dose is sufficiently high (100 mSv), then radiation is known to be potentially carcinogenic (1). Fortunately, radiation dose levels to patients undergoing procedures in the cardiac catheterization laboratory and to laboratory workers is typically well below the levels known to increase cancer risk. Increased cancer incidence associated with modern medical use of radiation is not readily measurable in groups of patients or hospital workers due the approximately 20% to 30% natural "background" lifetime cancer rate. From an epidemiological perspective, the large number of cancers in an occupationally exposed population that are not associated with radiation overwhelms the small number of additional cancers that may have been caused by medical or occupational radiation. However, that radiation dose at any level includes a commensurate cancer risk is one of the primary tenets of radiation safety (1). Therefore, reasonable methods to reduce radiation dose to both patients and radiation workers should be incorporated into the routine practice of all cardiac catheterization laboratories.

Interest and concern about occupational radiation exposure to interventional cardiologists have increased in recent years, and equipment modifications, shielding, and behavioral strategies to reduce radiation exposure have increasingly been introduced and emphasized in daily practice. Occupational exposure to ancillary staff, including technologists and nurses, has received somewhat less attention. These staff, although generally farther away from the source of radiation exposure than the physician, are exposed to radiation on a daily basis. The current paper by Madder et al. (2) in this issue of *JACC: Cardiovascular Interventions* describes the potential for accessory shields to reduce the occupational radiation dose to cardiovascular technologists and nurses assisting with cardiac catheterization procedures. For these procedures, scatter of the primary x-ray beam within the patient represents the primary source of occupational radiation dose. The technologists were scrubbed into the procedure and standing adjacent to the performing physician. Their position in the room as compared with the physician is relatively farther from the patient. The nursing staff work near and around the patient head end of the procedure room. Their proximity to the patient can be expected to be variable depending upon the immediate patient care needs.

The accessory radiation shielding device tested for both the technologists and nurses was a portable leaded glass barrier that was 1.8 m tall and 0.7 m wide. The shield was sufficiently large to fully protect a person standing behind it. The study found that integration of the shield into routine practice reduced occupational radiation dose to these staff by as much as ~66%. Given that the shield can be expected to

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absorb ~98% of the scatter radiation incident upon it, the utility of the shield is limited only by the ability of the technologists and nurses to remain behind the shield while still assisting the procedure and caring for the patient. That such accessory shielding can and does contribute to lower occupational dose for technologists and nurses supports their efficacy. All interventional cardiology labs should be equipped with these shields to support comprehensive radiation safety practices. An additional and important observation from this study was the substantial increase in radiation dose to nurses during PCI. This finding should serve to remind cardiac catheterization workers to be aware of their proximity to radiation in relation to their patient-care duties and remind physicians to be cognizant of safe radiation practice, including awareness of the position and proximity of their coworkers whenever they are using fluoroscopy.

In the work by Madder et al. (2), occupational effective dose (μSv) was estimated from electronic personal dosimeter readings and patient dose burden was characterized by the dose-area product (DAP) as reported by the x-ray system. Occupational dose measurements were divided by patient DAP to provide a DAP-normalized occupational dose metric (μSv/mGy $cm^2$). On the basis of μSv/(mGy $cm^2$) quotients and typical single-procedure patient DAP values reported (53,408 mGy $cm^2$), it is straightforward to estimate that, without the use of the accessory shield, per procedure occupational dose to technologists and nurses is approximately 1.3 and 0.6 μSv, respectively. It is then straightforward to estimate that technologists and nurses would participate in approximately 770 and 1,700 procedures, respectively, to accrue a 1-mSv occupational radiation dose. By comparison, the natural background radiation dose level in the United States is ~3 mSv. Maximum annual occupational dose limits in Europe and the United States are 20 mSv and 50 mSv, respectively. For purposes of radiation safety, the fatal cancer risk coefficient for radiation-induced cancer is assumed to be 5%/Sv, or 0.005%/mSv (1). Compared with a natural cancer incidence of ~30% and fatal cancer incidence of ~20%, the potential cancer risk to technologists and nurses assisting with invasive cardiac procedures is expected to be small without the accessory shields, and even smaller with the shields.

Madder et al. (2) should be congratulated on conducting a well-planned and executed study made more challenging because of the uncontrolled work environment and lack of blinding. They appropriately acknowledge other limitations of their study. In summary, their study reports that an accessory radiation shield can be integrated into the clinical practice and can contribute to reduced radiation dose to technologists and nurses during cardiac interventional procedures. Because they are effective and can be expected to provide reliable service for several years, these shields should be made available as part of a comprehensive radiation safety program. Also, the findings of this work should provide technologists and nurses confidence that their occupational radiation doses and related health risk can be expected to be low.

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## REFERENCES

**1.** International Commission on Radiological Protection. The 2007 recommendations of the International Commission on Radiological Protection. ICRP Publication No. 103. Ann ICRP 2007;37:1–332.

**2.** Madder RD, LaCombe A, VanOosterhout S, et al. Radiation exposure among scrub technologists and nurse circulators during cardiac catheterization: the impact of accessory lead shields. J Am Coll Cardiol Intv 2017;XX:xx–xx.

**KEY WORDS** occupational radiation dose, radiation shield