Although advances have been made in the diagnosis of and therapy for cardiovascular disease, this has not come without risks. This risk includes a 3-fold increase in patient medical radiation exposure over the past 25 years (1), with all imaging areas challenged to reduce patient dose (2). Although interventional cardiology contributes a small component to this increase, when a culture of radiation safety is practiced in the interventional suite, patient dose can be significantly reduced (3).

Society efforts have focused on establishing a radiation safety program for all cardiac catheterization laboratories, in which dose reduction for the patient has had similarly beneficial effects on the operator and staff (4).

As is often the case, unintended consequences may prove significant in the long term. Although invasive/interventional cardiology is appropriately focused on quality care/patient outcomes, the risks to the profession have received far less attention. This has resulted in the effects of radiation exposure and/or the protective attire-induced orthopedic injuries being underestimated. These risks related to the fluoroscopy suite differ significantly from other disciplines in the medical profession. Career terminating orthopedic injuries, cataract formation, or life-altering cancers are subspecialty related (5–7).

Although medical school lectures do not include discussions of chronic pain and potential career-ending disabilities, women have recognized these risks with a current underrepresentation in this subspecialty (8). Groups such as the Multi-specialty Occupational Health Group have addressed these medical concerns for operator and staff, but their voice has been limited (9).

What are the risks and are they anecdotal or quantitative? In this issue of JACC: Cardiovascular Interventions, Andreassi et al. (10) present another aspect of radiation injury that to date was previously unrecognized in interventional laboratory workers. Their findings suggest that chronic radiation exposure in the cardiac catheterization laboratory may be associated with increased subclinical carotid intima-media thickness (CIMT) and shortening of the leukocyte telomere length (LTL), suggestive of early and accelerated vascular injury. This Italian study of 223 self-selected cardiac catheterization workers, compared with a control population, identified potential concerns regarding low-dose ionizing radiation that previously were not identified.

Challenges are present with the study population. Risk factors were not uniform between the groups; male sex, smokers, and hypercholesterolemia were more common in the cath lab workers. A risk qualifier for lab radiation exposure, the occupational radiological risk score (ORRS), was used based on years of work, number of cases, and operator status during the case. The scoring system was required because dosimetry data were available in only 25 of the 131 interventional cardiologists (19%) and 32 of the 110 nurses (29%). CIMT data showed increases
on the left side in the cath lab workers compared with control subjects based on their ORRS. If the nurses in this study were not consistently at the table but also rotating throughout the room, the side variation is more challenging to interpret. However, these data in combination with the shortening of LTL is compelling as a potential marker for radiation injury.

The study population requires further comment. As a group concerned with atherosclerotic risk, the cath lab staff knows the issues of risk reduction, yet 29% smoked compared with 16% of control subjects. Additionally, 11% had hypercholesterolemia compared with 4% of control subjects. This variation in risk has a potential impact on data interpretation as well as reflects less favorably on a cath lab team that emphasizes risk modification. Finally, <20% of the physicians in this study had dosimetry data. Corrective interventions to reduce lifetime exposure should be based on personal dosimetry, not estimated ORRS. Individuals should wear dosimeters to best estimate the potential impact of radiation exposure and methods for reduction. Recent data on real-time dosimetry in the cath lab can result in not only lower operator exposure but also reduced patient dose (11).

Vascular injury from high-dose radiation therapy for cancer has been recognized for decades. Most commonly identified in young individuals receiving mantle radiation for solid tumors, the vascular changes in the endothelium resulting from radiation injury can lead to premature cardiovascular disease (12). Data from the life span study of Japanese atomic bomb survivors demonstrates that radiation exposure significantly increased the risk of the development of ischemic heart disease, particularly myocardial infarction (13). Similarly, epidemiological investigations in a very large patient population receiving radiotherapy after breast cancer surgery demonstrated a single-dose exposure of more than 2 Gy increased the risk of ischemic heart disease more than 10 years after therapy. These events suggest an endothelial component to radiation-induced vascular injury. Andreassi and colleagues present data supporting these data for potential endothelial damage in workers exposed to long-term low-dose radiation.

So what is being done to address radiation safety? As prompted by the 2010 U.S. Food and Drug Administration publication calling for radiation reduction in medical imaging, all equipment manufacturers responded with imaging modification and best practice protocols (2). Organizations such as the National Council on Radiation Protection have published recommendations on dose management in fluoroscopic imaging (14). Societies have responded with the emphasis on radiation safety in the context of quality improvement (4,15). However, the focus has been on patient safety, recognizing that protecting the patient benefits all.

With patient safety addressed, it is now appropriate to focus on protecting the cath lab workers. In addition to the potential radiation injury identified by Andreassi et al., it has been well established that orthopedic injuries are frequent in this group (5). In the setting of concerns for left-sided brain cancer in interventional cardiologists, even further protective garments may be used (7). The long-term effects regarding cancer in operators and staff will not be easily quantifiable as the incidence is low and the current reporting system limited. However, enough information is available to recognize the need for improved operator protection without orthopedic consequences.

There are options currently offered for operator/staff protection. Ceiling-suspended as well as table-mounted protective shielding is standard with more extensive options available for surrounding the operator with a weightless shield (16). Robotic systems offer a radiation-free environment for the operator in a remote/not in the procedure room/laboratory location (17). Embracing these as well as improving and developing further options will emphasize the need for improved safety in the workplace.

The importance of the problem must be realized. Occupational health risks in interventional cardiology have been recognized but often categorized as anecdotal unfortunate occurrences. Individuals entering the profession often have limited understanding of the potential long-term consequences that are often understated or ignored. It is now time to recognize the importance of preventing this personal liability. The entire health care community including equipment manufacturers, hospitals and administration, governing bodies, and the medical providers, both those exposed and not exposed, must agree that this needs to be addressed and move to address this. Without this effort, continued lost manpower, injury, and unnecessary disabilities that can be prevented will persist.

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REFERENCES


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