EDITORIAL

A paradigm shift to address occupational health risks in the EP laboratory

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The electrophysiology (EP) laboratory has long been recognized as an environment for delivery of sophisticated health care to patients with arrhythmias that are often complex and found in the setting of complex cardiac conditions. While advances in our field have improved patient outcomes, significant health hazards still endure for the EP physicians and laboratory staff. In particular, repeated exposure to ionizing radiation, even at low levels, may increase the lifetime risk of malignant neoplasm.[1] At the same time, wearing radiation protective garments exposes laboratory personnel to orthopedic risks associated with carrying the extra weight added by those garments.[2] Despite identification of occupational health challenges and publication of a "call to action" to address the challenge of making the interventional EP laboratory a safer environment,[3] safety in the EP laboratory has advanced too slowly. For this reason, the Heart Rhythm Society, in conjunction with the American College of Cardiology, the American Society of Echocardiography, and the Society for Cardiovascular Angiography and Interventions, has endorsed the document titled "SCAI multisociety position statement on occupational health hazards of the catheterization laboratory: shifting the paradigm for healthcare workers' protection."[4]

Klein et al[4] state the simple premise that cumulative low level radiation exposure in the EP laboratory over the duration of one's career leads to insidious adverse health effects including cataracts and cancer, but also a progressive risk of serious orthopedic maladies attributable to bearing the weight of radiation protective garments. The full scope of occupational health issues related to our work environment is not completely defined. We know that low level radiation exposure increases lifetime cancer risk.[1] A reported increased risk of cancer in those with occupational exposure to radiation[5] and anecdotal reports of brain cancer in interventional cardiologists[6] have fueled concerns about our occupational exposure to radiation. Since no dose of radiation exposure has been deemed to be safe, the ALARA (As Low As Reasonably Achievable) standard has been widely applied in the fluoroscopy suite. The consequence is that despite improvements in fluoroscopy technologies with reductions in radiation doses, physicians and laboratory staff are obliged to shield themselves with radiation protective garments and barriers. In turn, wearing lead aprons has been associated with cervical and lumbar spine maladies in particular, and with chronic work-related pain.[7] These have been reported in almost half of interventional cardiologists responding to a survey, of whom one-third missed work because of spine problems.[8] Devices have been developed to support the weight of protective garments and barriers, but the desire for unfettered movement in the laboratory has prevented their wide adoption.

As our procedures have increased in complexity and duration, so have the occupational health risks. But despite these real threats to our health and well-being, technological development aimed at improving the health of operators and staff has lagged behind. Therefore, we believe that it is time for clinical and industry partners in this field to focus attention and resources on improving our occupational health. Hospitals and industries that benefit from the hard work and dedication of the EP laboratory workers commit to support the health and well-being of these employees. But how can this goal be achieved?

Operators have become adept at catheter manipulation in the heart using nonfluoroscopic imaging technologies including intracardiac echocardiography and electroanatomic mapping systems.[9,10] While experienced operators can perform safe and successful catheter ablation procedures in a near-zero fluoroscopy environment, transition to zero fluoroscopy and freedom to remove protective lead apparel altogether is a difficult step that has not been widely adopted. Even if only 1 minute of fluoroscopy is used during a procedure, protective radiation shielding garments must be worn. Robotic catheter manipulation allows the operator to be seated in the shielded control room and avoid fluoroscopy exposure altogether.[11] Although these technologies have been promoted for 2 decades, resulting in substantial hospital

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1547-5271/$-see front matter https://doi.org/10.1016/j.hrthm.2019.12.018

investments in robotic infrastructure, robotic catheter ablation represents only a small segment of today's market. Speed, convenience, and efficacy supersede the desire to avoid radiation exposure and wearing lead. Real-time magnetic resonance imaging to guide catheter movement during catheter ablation procedures may be a promising alternative to the use of ionizing radiation. First-in-man studies have demonstrated the proof of concept,[12] but further development is needed before this becomes a viable alternative to fluoroscopic guidance.

Improvements in image train technology have yielded significant radiation dose reduction. Behavioral changes to reduce radiation exposure include using best practices in positioning of mobile shielding, choosing table height, close positioning of the image intensifier to the patient, reducing aperture with shutters as much as possible, limiting imaging at steep oblique angles, reducing frame rates, and most importantly reducing pedal time. Unfortunately, bad habits are hard to break, and some operators are resistant to changes, even when it benefits all parties. Therefore, accurate radiation monitoring of the operator and laboratory personnel is paramount. Conventional radiation badges do not provide immediate feedback and as a result are not effective in altering operator behavior. Real-time radiation dosimetry monitoring is now available and provides the operator with immediate feedback. This encourages close attention to dosing and can result in a significant reduction in radiation exposure.[13]

The *Multisociety Position Statement* proposes that each stakeholder has an important role in improving occupational health and safety in the EP laboratory.[4] *Physicians* must set improvement of occupational health and safety as a high priority goal, use excellent fluoroscopy techniques, monitor radiation exposure, and use nonfluoroscopic imaging whenever possible. The *Heart Rhythm Society* must redouble education efforts for physicians and EP laboratory staff regarding best practices in the EP laboratory. Programs promoting good ergonomics and orthopedic health should be developed and made available to hospitals and clinicians. *Hospitals* should promote and enforce wellness in the EP laboratory by training staff in proper processes, purchasing appropriate shielding equipment, optimally calibrating existing fluoroscopy machines, and upgrading to the most advanced imaging systems to take advantage of the lower radiation doses generated by the newer systems. Hospital participation in EP laboratory accreditation will ultimately raise the standards of physician and EP laboratory staff safety in the workplace.[14] Finally, *industry* can continue to work to further reduce radiation dosing. Ultimately, a zero radiation exposure fluoroscopy suite should be the goal, accomplished through alternate imaging modalities and/or total radiation shielding so that the operator can perform his or her procedures without wearing additional radiation protective garments, thus mitigating the risks of orthopedic injury.

Radiation safety and occupational health and safety are not glamorous topics, but may be more relevant to our long-term success as interventional electrophysiologists than most of what we choose to focus on. Solutions to this challenge are at hand, but ongoing elevation of this topic as a priority in our field will improve our health and well-being in the decades ahead.

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