A Physicist's Perspective on Radiation Safety: What Should Matter Most?

Advice on what clinicians should know about exposure, risk, and protection.

With Ehsan Samei, PhD

What do you think is the single most important thing clinicians and cath lab staff should understand about their personal radiation exposure and long-term risk?

Radiation risk to personnel in the cath lab is routinely so small that the likelihood of any potential harm materializing is low; however, cumulative exposure over time may increase long-term risk if proper precautions are not taken. As such, there are good practices to minimize that likelihood. These practices are worth being intelligent and literate about and worth putting into practice. Having medical physics expertise at hand is indispensable toward that goal.

What metrics should physicians pay more attention to when thinking about exposure?

Exposure time is a significant measure. The shorter the better. Likewise, narrower fields of view minimize the exposure. Low- and normal-dose settings of the equipment will also minimize the exposure.

If a cath lab wanted to meaningfully reduce radiation exposure for staff, what are the first—and most impactful—steps it should take?

Time, distance, and shielding are the bread and butter of reducing radiation exposure. First, strive to use as short an exposure-on time as possible, while, of course, never compromising patient care or quality of the procedure. Related to this, as much as able, use pulsed exposure (as opposed to continuous exposure) with as low of a frequency as possible.

Second is distance. Be as far from the x-ray system and from the patient as possible, again without compromising what you need to do for the patient to ensure a quality procedure. Remember that in cardiac catheterization, patients themselves become a source of (scattered) radiation, so maximize your distance from the patient.

Third is shielding. Personal shielding (lead aprons) is a must, but also, use as many other shielding methods as are available (eg, mobile shields, leaded curtains). If you can be outside of the room in the control area, that would be even better.

Added to this list is the sparing use of high-dose acquisitions and using as small a field of view as needed to get the job done.

What should matter most when clinicians are optimizing fluoroscopic imaging for both image quality and radiation safety?

To ensure the most effective and optimized use of x-ray equipment, there are so many factors that come into play. In technical jargon, there are too many degrees of freedom, ranging from the equipment geometry and options to its configuration, which balances dose and quality and adjusts x-ray flux and energy per patient size and position. These options not only affect the dose to the patient and the quality of the images but also the clinicians' ability and confidence to do the job and minimize exposure to themselves and other staff. Across this complex landscape, the most important matter is to have a medical physicist involved in the team, who has specialized expertise to navigate these complexities and ensure the safety of personnel and patients, as well as the overall effectiveness of the practice.

Are there any common radiation safety practices that are emphasized by physicians but ultimately have limited real-world impact?

There is a general perception (partly valid) that new equipment is always safer and better, but that is not always the case. Shinier "new" options of equipment do not necessarily mean better or safer devices. Additionally, most equipment comes with configuration settings (eg, changes in exposure per patient size); unless it is configured per user and practice preference, its appropriateness and consistency with other equipment in the fleet of a practice cannot be assured.

How can training programs better prepare physicians about the risks of radiation and how to protect themselves over the course of their career?

The principles and approaches summarized previously need to be included in an explicit training program, along with additional details, examples, visuals, videos, and hands-on training. These trainings should be designed and directed by medical physicists.

When implementing a new radiation protection technology or tool, how can clinicians evaluate whether it truly reduces radiation exposure in practice?

Medical physicists deploy specialized equipment and procedures that objectively measure exposure and exposure rate as a function of patient size and distance. As such, any new equipment should be qualified and properly commissioned to ensure optimum safety and quality.

How well are collected radiation data (fluoroscopy time, badge readings, dose area product) being used to improve practice?

Radiation data (eg, fluoroscopy time, badge readings, dose area product, patient dose records, image quality records) can and should be used to assess and improve practice patterns. However, that is currently not a universal practice. A system needs to be in place to provide such analysis, oversight, and actionability. There are commercialized products that can address this need. This responsibility lies with the practice administration to deploy such products, alongside medical physics expertise to ensure high-quality practice.

Your work has explored artificial intelligence (AI) and data-informed approaches to scientific inquiry. How might AI or advanced analytics help clinicians better understand and manage radiation exposure in the future?

AI can be helpful to systematically analyze practice and exposure patterns. However, similar to its use in medicine, this is dependent on human intelligence to set the goal and determine how the AI data analytics advantage should be deployed to achieve the priorities identified in advance.

How have trends in radiation protection strategies evolved in the last 5 years? What developments might have the greatest potential to change how we approach radiation safety?

More streamlined definition of clinical procedures, better equipment with AI-enabled image quality enhancement, and more intentional engagement of medical physicists to optimize equipment options and protocols have opened new pathways to improve not only radiation safety but also practice quality and efficiency.

If you could offer one piece of advice to clinicians and staff who work daily in the operative and interventional suite, what would it be?

Use the expertise of medical physicists. They are your strongest allies to make your practice better. ■

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