White paper

Real-time staff dose radiation monitoring: Immediate and long-term solutions for reducing medical radiation risks

Exposure to radiation due to the increasing use of minimally invasive image-guided diagnosis and treatment of disease, continues to grow rapidly. The sheer volume and length of interventional radiology (IR) procedures is placing medical professionals–as well as their patients–in greater jeopardy than they might imagine. In one example of the expansion of these practices, the total number of imaging and radio diagnostic tests performed in England during the decade from 2002-2003 to 2012-2013 grew at an average annual rate ranging from 12.0 percent for MRIs, 10.3 percent for CT scans, 5.2 percent for ultrasounds and 1.5 percent for x-rays[1]. In particular, radiation monitoring is an issue. Thankfully, there are solutions that can keep radiation exposure to a minimum for those who are frequently exposed during both diagnostic and interventional procedures. These require changes to education and tradition and current thinking, but they are invaluable to the long-term health of the medical staff and patients and beneficial to the overall health of the institution.

Time to mandate awareness and build a strong radiation safety culture

Medical institutions must embrace the fact that proactive management of occupational radiation exposure is necessary to achieve the goal of radiation reduction for all individuals working in interventional and diagnostic labs. The adoption of real-time staff dosimetry (RTSD) can jump-start meaningful change. Used in conjunction with other tools and techniques available today, such as personal, equipment-mounted and architectural radiation shielding, RTSD can be a critical component in building a safe environment.

RTSD is easy to use, set up, install, and implement by digitally assigning a dosimeter badge to each participant. Active dosimetry provides all exposed medical personnel with real-time feedback on their personal exposure and an opportunity to immediately evaluate and/or adjust their behaviors.

The RaySafe i3 Real-Time Personal Dosimeter

In the longer term, real-time radiation dosimetry systems save dose data enabling medical facilities to conduct thorough post-procedure reviews and analysis, and incorporate new or better practices where indicated.

A recent study by Dr. Peter Drescher, Davina Winandy and Tracey Marshall on real-time staff dosimetry during vertebral augmentation at Aurora West Allis Medical Center revealed a significant reduction in staff radiation dose due to RTSD. RTSD measured radiation exposure for the attending physician, scrub technologist, circulating technologist and anesthesiologist. The X-ray system measured and provided information about the fluoroscopic time and dose area product while the RTSD system provided dose and dose rate readings for the staff during the procedure to immediately evaluate and/or adjust their behaviors. After this study, under the guidance of Dr. Drescher, new processes and procedures were implemented to increase radiation awareness, the stringent use of radiation protective devices, resulting in the complete revision of the entire workflow.[2]

In another example of positive changes generated by RTSD, University of Rochester Medical Center (URMC) was having difficulty managing staff radiation dose in high-dose labs (such as interventional cardiology, interventional radiology and hybrid surgical suites)–with high radiation exposures. Some physicians had annual radiation doses just under the 5 rem legal limit. “With a high level of ALARA letters and suboptimal radiation work practices, we knew that we needed to further the URMC radiation safety program to reduce radiation dose and improve staff safety,” explains Frederic J. Mis, Ph.D., CHP, who was URMC’s new Director of Radiation Safety and Radiology Quality Assurance at the time. The URMC administration supported Dr. Mis’s request for additional personnel radiation safety training and tools to improve the radiation safety culture. The medical center added and repaired shielding and modified training programs. At the same time, Dr. Mis and his team implemented RTSD for their high dose interventional labs. “We immediately implemented this new system in two labs to reinforce to physicians and staff how their radiation practices were affecting their dose exposure,” Dr. Mis notes. “The RTSD provided staff the ability to ‘see’ their radiation dose during patient cases. Radiation exposure quickly decreased, even during training, because the ‘red cloud’ became easier to conceptualize.” The medical center feared that the benefits of its aggressive dose reduction plan would not be apparent for several years. Instead, its collective radiation dose began to drop very quickly, leading the hospital administration to equip an additional four rooms with real-time dose monitoring. “In our first full year of implementing this new dose reduction program, we noted a 50 percent reduction in staff dose,” concludes Dr. Mis. “Real-time dose monitoring has become part of the culture at URMC and is mandatory, although well accepted and appreciated by staff.”

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Dr. Frederic J. Mis

Another case of radiation improvements with RTSD use comes from a pilot study analyzing potential changes in the occupational radiation exposure to the interventional radiology staff at Lawrence General Hospital, Lawrence, MA. Badge dosimetry records for the eight months prior to the adoption of RTSD were normalized, then the process was repeated for the eight-month period post-RTSD implementation. The testing was performed on three groups: interventional radiologists, nursing staff and technologists. The study results demonstrated an overall dose reduction per procedure of 43.1 ± 16.7% over the entire nursing staff ($p = 0.04$); a reduction of 65.8 ± 33.6% to the radiologist group ($p=0.01$); and a 45.0 ± 14.4% dose reduction per procedure to the technologist group level ($p=0.03$).[3]

Benefits of interventional radiology are readily apparent, but add a layer of complexity for medical professionals

Let’s look at the advancement that has led to this need for increased radiation safety. IR procedures apply cutting-edge technology to accurately diagnose and treat conditions in the heart and vascular system, abdomen, central nervous system, chest, musculoskeletal and genitourinary systems. There is no doubt that patient benefits stemming from the use of interventional radiology

treatment versus surgical intervention, including minimal discomfort and shorter recover time, are significant. Interventional procedures can often also be used where surgery would be unjustified or contraindicated.[4]

As a result of the proliferation of image guided interventional procedures, a growing number of medical providers besides radiologists–such as cardiologists, vascular surgeons, anesthesiology staff, nurses and medical students–are exposed to larger doses of radiation on a regular basis. In addition, hybrid rooms incorporating multiple imaging modalities used by multidisciplinary teams present additional radiation protection challenges.[5]

Radiation exposure statistics are concerning

"Since radiation is a known risk factor for brain tumors, ... studies have shown an increased risk of brain tumors in radiologists and others with occupational radiation exposure."

Medical radiation is one of the fastest growing sources of radiation exposure. This is a global health concern as evidenced by the Biological Effects of Ionizing Radiation (BEIR) VII report. This report is the seventh in a series of publications from the National Academies concerning radiation health effects. According to this study, interventional radiology operators receive the highest doses of radiation, primarily from patient scatter. Interventionalists who have performed procedures for a number of years are reportedly developing radiation-induced cataracts. Recent studies have demonstrated that if radiological protection devices are not used and radiological protection principles are not followed, radiation doses to the eye lens may exceed the current threshold for tissue reactions after several years at typical reported interventional workloads. Some studies have shown an increased risk of brain tumors in radiologists and others with occupational radiation exposure.[6]

Numerous organizations offer radiation exposure education, guidelines and enforcement

Both nationally and internationally, agencies are working tirelessly to protect people from harmful doses of radiation, such as the International Commission on Radiological Protection (ICRP) and the

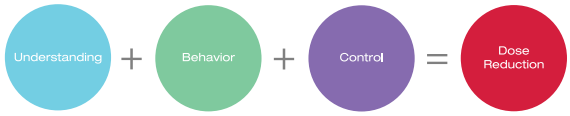
NRC, which developed the International System of Radiological Protection, as well as professional societies such as the Cardiovascular and Interventional Radiological Society of Europe (CIRSE), and the Society of Interventional Radiology (SIR). The list of professional and scientific groups also includes the American College of Radiology, the American Association of Physicists in Medicine, and the American Society of Radiologic Technologists, just to name a few.

From a national perspective, the U.S. Food and Drug Administration (FDA) began policing medical devices with the Federal Food, Drug, and Cosmetic Act of 1938. Today, the FDA holds direct authority to determine the safety and effectiveness, and to approve the marketing, of all radiation products used in medicine. However, individual states have varying mandates that differ from state to state, have "the greatest share of regulatory responsibility" when it comes to using radiation in medicine.[7]

Traditional methods exist to minimize radiation dose

Education has always been at the top of the list when it comes to safe radiation practices. There's no doubt that appropriate training for all healthcare professionals who have the potential for radiation exposure can lead to a reduced dose.

There are many other steps that medical institutions should also take to lower radiation risks:



- Institute a comprehensive dose management program with quality assurance
- Review radiation exposure on regular basis
- Imaging techniques without radiation when it is clinically appropriate

- Position all personnel in low-scatter areas
- Insist that all exposed staff wear dosimeters and know their doses
- Enforce the use of protective equipment and personal shielding
- Reduce fluoroscopy time and the number of image acquisitions whenever possible
- Use collimation and try to avoid oblique lateral projection angles
- Examine all safety equipment (such as shields) annually
- Create staff and patient radiation databases

None of these measures succeed without enforcement. Management must commit to applying sufficient resources and decisive leadership to maintain and enhance an effective radiation safety program.[8]

Despite the increase in education and awareness, there is still a lot of work to be done

There continues to be considerable discourse and debate around the subject of radiation safety, but greater adoption is needed. Organizations like URMC, Lawrence General Hospital and Aurora West Allis Medical Center are helping pave the way with their proactive, holistic approach to safety. By layering the tools currently available, like shields, RTSD's, etc., they are models of what successful radiation safety programs look like.

As part of their efforts to lower radiation exposure during procedures, some 300 hospitals, including Aurora West Allis Medical Center, are using RTSD technology to help physicians and technicians adjust their behavior in real-time. If Dosimeters alone are used, the dose is measured primarily on a monthly or quarterly basis. Such infrequent periodic measurement can extend overexposure, as well as risky practices, much longer than necessary.[9]

The benefits of real-time dosimetry are real and measurable

Compliance with state and national radiation regulations is no longer sufficient. For the sake of patients, staff and the environment of our planet, all hospitals should be working to reduce radiation. By committing to this goal, then creating a blueprint for attaining it, medical centers will lower risks while still using state-of-the-art technology for procedures. RTSD is a vital component in this process of achieving radiation reduction by helping to instill awareness and create a safer working environment. Active dosimetry provides medical personnel with real-time feedback concerning their personal radiation exposure, whereby allowing them to immediately evaluate their risk and adjust accordingly.

[1]The Royal Collge of Radiologistis, Clinical Radiology UK Workforce Census Report 2012, pg. 28 (2014)

[2] Drescher et al., "Real-time radiation dosimetry during vertebral augmentation - Initial experience, education and radiation reduction," Abstract CIRSE 2017.

[3]Poudel et al., "Changes in Occupational Radiation Exposures after Incorporation of a Real-time Dosimetry System in the Interventional Radiology Suite" (2014).

[4]Cardiovascular and Interventional Radiological Society of Europe, Patients Information, www.cirse.org.

[5]Bartal et al., "Management of Patient and Staff Radiation Dose in Interventional Radiology: Current Concepts" (2014), CardioVascular and Interventional Radiology, 37:289-298.

[6]Bartal et al., "Management of Patient and Staff Radiation Dose in Interventional Radiology: Current Concepts" (2014), CardioVascular and Interventional Radiology, 37:289-298.

[7]Kate-Louise D. Gottfried and Gary Penn, Editors, Radiation in Medicine: A Need for Regulatory Reform (1996), Ch. 3, "Regulation and Radiation Medicine".

[8]Donald L. Miller et al., "Occupational Radiation Protection in Interventional Radiology: A Joint Guideline of the Cardiovascular and Interventional Radiology Society of Europe and the Society of Interventional Radiology" (2010), Cardiovascular and Interventional Radiology, 33:230–239.

[9]Bartal et al., "Management of Patient and Staff Radiation Dose in Interventional Radiology: Current Concepts" (2014), CardioVascular and Interventional Radiology, 37:289-298.

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Fluke Biomedical
6045 Cochran Road
Cleveland, OH 44139-3303 U.S.A.

For more information, contact us at:

(800) 850-4608 or Fax (440) 349-2307
Email: sales@flukebiomedical.com
Web access: www.flukebiomedical.com