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Radiation exposure, the forgotten enemy: Toward implementation of national safety program

Tarek A.N. Ahmed *, **Salma Taha**

Interventional Cardiology, Department of Cardiovascular Medicine, Asyut University Hospital, Egypt

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Abstract Radiation safety is an important counterpart in all facilities utilizing ionizing radiations. The concept of radiation safety has always been a hot topic, especially with the late reports pointing to increased hazards with chronic radiation exposure. Adopting a nationwide radiation safety program is considered one of the most urging topics, and is a conjoint responsibility of multiple disciplines within the health facility.

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* Corresponding author at: Lecturer of Cardiovascular Medicine, Asyut University, 71526 Asyut, Egypt.
E-mail address: tarkaf76@yahoo.com (T.A.N. Ahmed).

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1. Introduction

The medical use of ionizing radiations for diagnostic and interventional cardiac procedures has been exponentially increasing over the last few years. With the uprising concept of multimodality imaging, a considerable number of patients undergo multiple procedures that have relatively high radiation exposure within a short period of time. This may result in higher cumulative exposure.[1–3]

Moreover, cardiac interventional procedures are getting more and more complex, which entail higher patient, physician and staff exposures. This renders radiation safety education and implementation a priority, not a privilege. Currently, radiation safety education is a defined requirement for the cardiology fellowship, with 15% of the interventional cardiology board examination questions pertaining to radiation safety and physics.[4]

Over the past few years, great advances have been accomplished in both equipment and application of radiation safety protocols, which were reflected on reducing both patient and operator exposures, fulfilling the "as low as reasonably achievable" (ALARA) principle. This principle dictates that exposure to radiation should produce sufficient benefit to the exposed individual to offset the radiation risk it causes.[5]

In this review, we are trying to highlight some of the important issues of radiation exposure and its hazards, as well as to shed some light on radiation safety concepts. Finally we will try to adjust a multi-disciplinary protocol to be adopted by our prestigious Egyptian society of Cardiology, toward implementing a comprehensive radiation safety program, and establishing a solid concept of "Safety comes first".

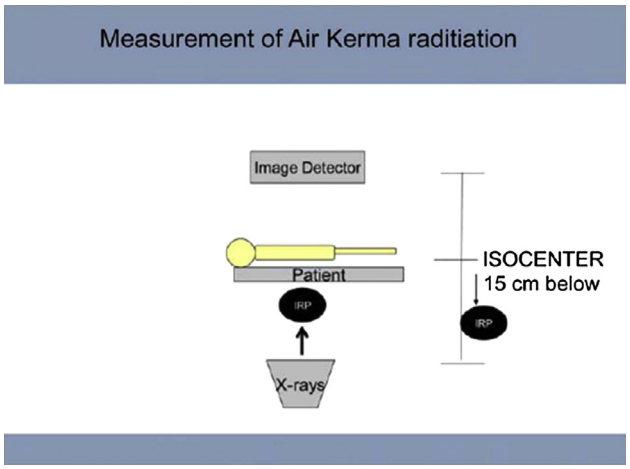

Figure 1 Definition of Air Kerma Radiation. IRP: Interventional reference point. Adapted from Christopoulos et al.[9]

2. Radiation dose estimation

2.1. Fluoroscopy time (FT, min)

It is the most commonly used parameter for radiation dose estimation. It represents the time fluoroscopy is used during a procedure, not including cine acquisition imaging. As documented in previous studies,[6,7] the assessment of radiation dose requires more than fluoroscopy time. Steeper angulations, larger patients, varying frame rate, ignoring store fluoroscopy mode, and patient extremities in the field of view all will significantly increase the radiation dose without affecting fluoroscopy time.[8] Up-to-date fluoroscopic equipment provides measures and displays of more sophisticated and reliable radiation dose estimates.

2.2. Total air kerma at the interventional reference point ($(K_{a,r}$, Gy))

It is also known as cumulative air kerma (Kinetic Energy Released in MAtter). It represents the X-ray energy delivered

Table 1 Dose limits for occupational exposure according to the International Commission on Radiological Protection (ICRP).[a]

Dose quantity	Potential dose risk	Occupational dose limit
Effective dose	Stochastic effect throughout The body (Likelihood of cancer and birth defects)	20 mSv per year averaged over five consecutive years (i.e. a limit of 100 mSv in 5 years), and 50 mSv in any single year
Equivalent doses in	Deterministic effect in specific tissues	
Eye lens	Cataract	20 mSv in a year, averaged over defined periods of five years, with no single year exceeding 50 mSv
Skin	Skin lesions ranging from mild erythema to skin necrosis mandating surgical repair	500 mSv for the skin (average dose over 1 cm2 of the most highly irradiated area of the skin)
Extremities (Hands and feet)		500 mSv in a year

[a] International Commission on Radiological Protection, 2011. Statement on Tissue Reactions, April 21, 2011. Available at: http://www.icrp.org/page.asp?id=123.