

Radiation Safety in the Catheterization Lab: *Time to Take a Step Back*

Introduction

Invasive cardiac diagnostic and interventional procedures can contribute significantly to a patient's overall radiation exposure (Figure 1).¹ Although the main goal of clinicians in the cath lab is to minimize patients' radiation exposure, it is also important for cath lab staff to take the highest degree of precautions for themselves given the cumulative amounts of exposure they also receive.

Figure 1: Estimated Effective Dose of Common Examinations*

Procedure	Effective Dose (mSv)	Equivalent CXRs**
Conventional diagnostic radiology		
Mammography	1	50
Barium swallow	1.5	75
CT		
Head	2.3	115
Chest	8	400
Nuclear medicine		
Perfusion cardiac rest/stress Tc-99m sestamibi	10	500
Cardiac PET 18F-FDG	3.5	175
Invasive diagnostic & interventional procedures		
Coronary angiography and ventriculography	7	350
Length (Navvus Interface to processing unit cables)	21	1050

*Adapted from Bedetti G, et al. *BJR*. 2008;81:699.

**Chest X-rays.

Background

Clinicians working long hours in busy cardiac catheterization labs (CCL) have been shown to have the highest registered dose among medical staff using x-rays.² Effective doses to operators in the cath lab have been shown to range from 0.02 to 38 μ Sv for diagnostic catheterization (DC) procedures, and from 0.17 to 31.2 μ Sv for percutaneous coronary interventions (PCI).³ Although doses for DC have been shown to be reduced over time, attributed to various technology improvements, this downward trend has not been the case for PCI. The increased complexity of these procedures appears to have offset any reduction in radiation dose associated with improvements in technology.³ For the most experienced cath lab staff, who can have a range of exposure between 2 and 5 mSv per year, 15 years of exposure is associated with a lifetime attributable risk (LAR) of 1 cancer in 200 exposed subjects.² Therefore, the need for operators and staff in the CCL to find practical ways to minimize their exposure in every case, to a level that is as low as reasonably achievable (ALARA), cannot be overstated.

Best Practices

It is important to take the time to evaluate what additional measures can be taken to reduce radiation exposure for the cath lab staff. There are more tools available today than ever before for simply and effectively reducing exposure.

Radiation scatter from the patient is the greatest source of radiation exposure for the operator and staff.⁴ The distance between the operator and the source of radiation has a dramatic effect on exposure from both scatter and direct sources.⁵

Figures 2–4 illustrate these two important factors and demonstrate how X-rays traverse the patient (Figure 2), and also show the effect of operator distance from the radiation source (e.g., the inverse square law) (Figures 3 & 4). Both factors can be mitigated in order to reduce radiation exposure for the operator.

As an example (shown in Figure 4), during CCL procedures, the typical distance between the operator and the center of the patient's scatter volume is approximately 30 inches (0.75 meters).⁶ Using the inverse square law, increasing the distance between the operator and patient an additional 12 inches (to just over 1 meter) can decrease radiation exposure by almost half; adding another 12 inches (for 24 more inches) could further reduce exposure by almost 70%. These theoretical calculations are supported by a 2011 study that showed radiation exposure can be reduced by over 78% when increasing operator distance from the source.⁷ Utilizing the ACIST I CVi[®] Contrast Delivery System (with its hand controller or X-ray sync option) makes it easy to take a step back and to simply move one's hand farther away from the radiation source

during the imaging acquisition—a task more difficult to do with a hand manifold. This standard feature of the system is another important tool clinicians should utilize to stay as far away from the X-ray beam as possible during imaging.⁴

Important measures that can be taken to reduce radiation exposure specific to the X-ray imaging system are listed below (Courtesy of Dr. Larry Dean, University of Washington, WA).

- Stay off the pedal
- Maximize table height and source to intensifier distance (SID)
- Use the appropriate image size
- Use collimation and filters
- Balance kVp and mA
- Use pulsed fluoro
- Use the lowest frame rate possible
- Use the tools provided to determine dose
- Think about the angles used for the procedure
- Use fluoroscopy storage

Figure 2: How X-rays Traverse the Patient*

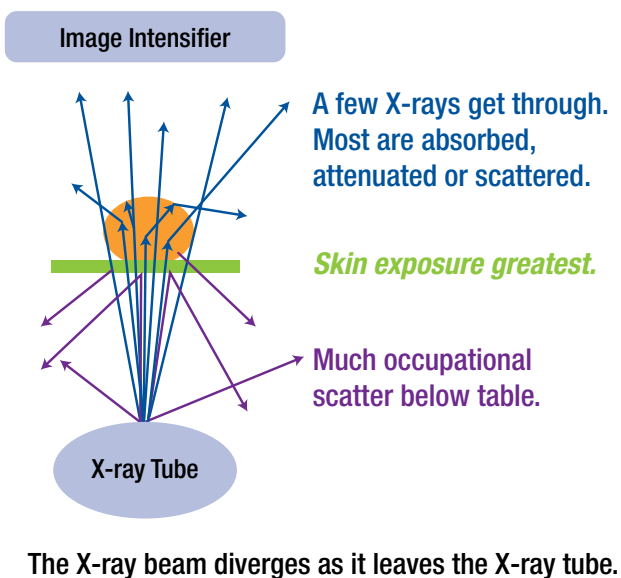
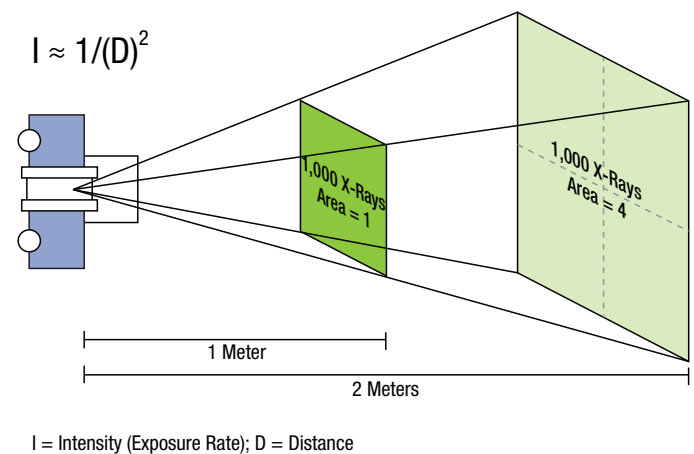


Figure 3: Illustration of Inverse Square Law*



*Courtesy of Dr. Larry Dean, University of Washington, WA.

*Figure adapted from Scott Sorenson, 2000; refer to http://www.e-radiography.net/radsafety/rad_physics.htm

Two other practices that can help minimize staff exposure are rotational angiography and the use of protective, disposable, radiation-absorbing pads. Rotational angiography has been shown to reduce total, whole-body radiation exposure to the operator by 15%.⁸ The use of the radiation-absorption pads has also been shown to greatly reduce exposure for the operator with data showing a 12-fold reduction to the eyes, a 26-fold reduction for the thyroid and a 29-fold reduction for the hands.⁹

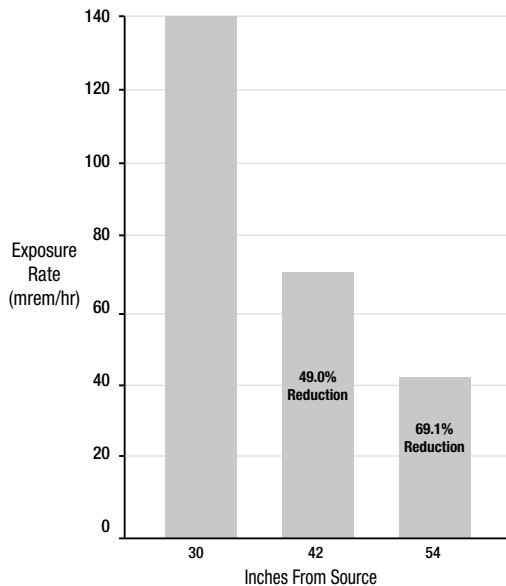
Conclusion

Taking practical actions toward greater radiation safety in the cath lab can be easily implemented in today's cardiac cath lab environment. Significant reductions in radiation exposure can be achieved by utilizing the ACIST CVi system (Figure 5), which allows the operator to simply "take a step back" from the radiation source and scatter. Use of the ACIST CVi system, as well as other measures, can effectively help reduce radiation exposure to levels as low as reasonably achievable.

References

1. Bedetti G, Botto N, Andreassi MG, et al. Cumulative patient effective dose in cardiology. *Br J Radiol.* 2008 Sep;81(969):699-705.
2. Venneri L, Rossi F, Botto N, et al. Cancer risk from professional exposure in staff working in cardiac catheterization laboratory: insights from the National Research Council's Biological Effects of Ionizing Radiation VII Report. *Am Heart J.* 2009;157:118-124.
3. Kim KP, Miller DL, Balter S, et al. Occupational radiation doses to operators performing cardiac catheterization procedures. *Health Physics.* 2008;94(3):211-227.
4. Miller DL, Vañó E, Bartal G, 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. *Cardiovasc Intervent Radiol.* 2010;33:230-239.
5. Chambers CE, Fetterly KA, Holzer R, et al. Radiation safety program for the cardiac catheterization laboratory. *Catheter Cardiovasc Interv.* 2011;77:546-556.
6. Vano E, Gonzalez L, Guibelalde E, et al. Radiation exposure to medical staff in interventional and cardiac radiology. *Br J Radiol.* 1998;71:954-960.
7. TCT-516: Impact of increased distance on operator radiation exposure during transradial catheterization. Abstract. *Journal of the American College of Cardiology.* 2011 Nov;58(20):B140-B141.
8. Maddux JT, Wink O, Messenger JC, et al. Randomized study of the safety and clinical utility of rotational angiography versus standard angiography in the diagnosis of coronary artery disease. *Catheter Cardiovasc Interv.* 2004 Jun;62(2):167-174.
9. King JN, Champlin AM, Kelsey CA, et al. Using a sterile disposable protective surgical drape for reduction of radiation exposure to interventionalists. *Am J Roentgenol.* 2002;178:153-157.

Figure 4: Increasing Distance Benefits



The spread of X-rays increases with distance from the X-ray origin, as described by the inverse square law. The calculation shown in this figure:

$$X_B = X_A \cdot (D_A/D_B)^2$$

where X_B is the radiation exposure rate (intensity) at distance D_B , and X_A is the radiation exposure rate (intensity) at distance D_A .

Figure 5: ACIST CVi® Injection System With Hand Controller



Radiation exposure can be significantly reduced by increasing operator distance from the source through the use of the ACIST CVi system and AngioTouch® hand controller.^{4,6}

This publication is not intended as a substitute for proper training or consideration of individual patient risk.

Important Product Information:

The ACIST I CVi[®] Contrast Delivery System is intended to be used for the controlled infusion of radiopaque contrast media for angiographic procedures. For additional product information, visit **www.acist.com**.

To learn more about ACIST technologies, contact us at
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