My First Lead-Free Coronary Angiogram

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[For full disclosure, I have no relationship with the Protego system (Image Diagnostics, Inc) or any other radiation reduction system company. While I express satisfaction with our recent experience, I would like to say the same positive words about any device that would permit me to work without lead and have a zero badge reading. The Protego system was our first test for the 'lead-free' cath lab concept. I do not want to sound like a commercial, just provide our story.]

Today was special. I did my first coronary angiogram without wearing my lead apron (Figure 1). It felt like I was working in my underwear. My movements were unrestrained and weightless, a strange sensation compared to my many years of traditional lead-apron procedures. My technologists and the nurses working on my side of the Protego Radiation Protection System[1] also did not need to wear their lead and expressed similar sentiments. The company representatives, Mark Hansen and Grant MacWilliams (Image Diagnostics, Inc), worked with our team during our product demonstration week using the Protego system.

Figure 1. Drs. Kern and Tungate performing coronary angiography in a 'lead-free' environment. This was our first case where the operators did not have to wear lead aprons. Our radiation exposure at the end of the case was zero millirems. The Protego shield (Image Diagnostics, Inc), while protecting the operators, does not change the exposure for personnel at the head of the bed and the left side of the table.

The biggest question for everyone in the lab was how much radiation exposure would be reduced with Protego. My RaySafe radiation badge registered zero. It was the same for all staff badges on my side of the shielding wall. Those badges on the tube side of the room had 24 millirems (mrems) exposure, a routine amount for a coronary angiogram. We performed "lead-free cases" all week and the near-zero radiation readings in the shielded zone were impressively low: near zero every case.

Since the beginning of cardiac catheterization, radiation exposure was among the highest safety concerns in every lab. Every radiology and cardiology society consensus or guideline documents on radiation addressed the many techniques that can be used to reduce radiation exposure. I have written three editor's pages on this subject since 2006.[2-5] The industry supplying our x-ray systems has been diligent and proactive in making radiographic equipment that produces excellent images at lower and lower radiation costs. In addition, other industry partners have been developing many unique designs in shielding, such as suspended hanging lead devices (Zero-Gravity [Biotronik]), and remote control of catheters using robotic manipulators (Corindus [Siemens Healthineers]) to place the operators out of the radiation environment.

While I am not the first person to enjoy a lead-free (ie, no apron) case, I felt like this was a true game-changer for our lab and likely for many others. Of course, nothing is perfect, and we should understand the limitations of all shielding systems. I thought this would be a good time to do that.

Reducing Radiation Scatter

To recap for the cardiac cath team, the x-ray beam enters the patient from below the table and some x-rays pass through the patient to the image intensifier above the patient. Much of the x-rays are scattered to the room in all directions, bouncing off the patient's bony structures (Figure 2). Currently, all personnel in the lab wear lead aprons, thyroid shields, maybe arm shields, and leaded caps and glasses. Like most labs, our room has ceiling-mounted movable shields for the operators, under-table attached lead shields and several large vertical shields on wheels to be positioned in different places depending on the procedure. But there are zones or gaps in the shield x-ray blocking areas such that x-rays still get to the operator and their team.

Lead-Free Environment?

There are several new systems of shielding and radiation protection, such as a suspensor system for the lead apron, or an encapsulated patient table shielding system (Egg Medical, Inc), which are described elsewhere.[6-8] Two extended shielding systems are now available from Rampart[9] (Figure 3)

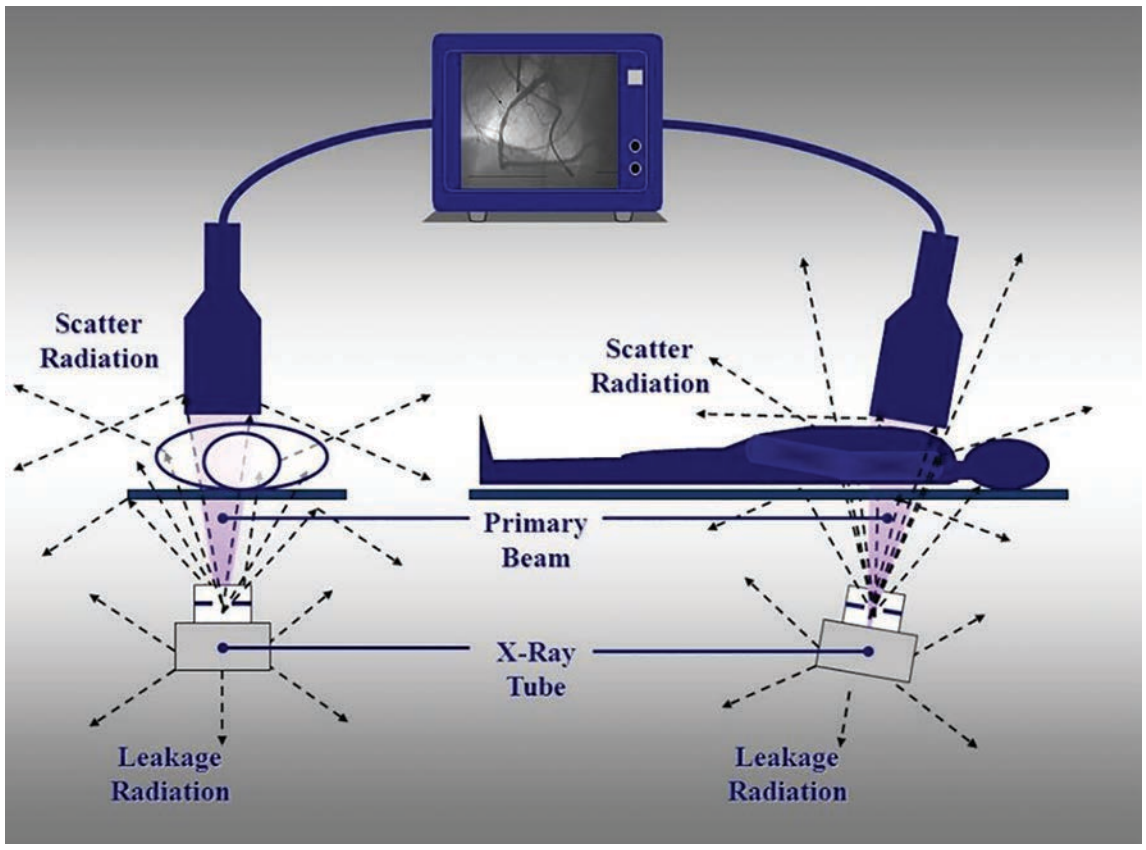

Figure 2. Diagram of radiation scatter in the cath lab. Most radiation scatter occurs through the patient's body and increases with greater angulations.

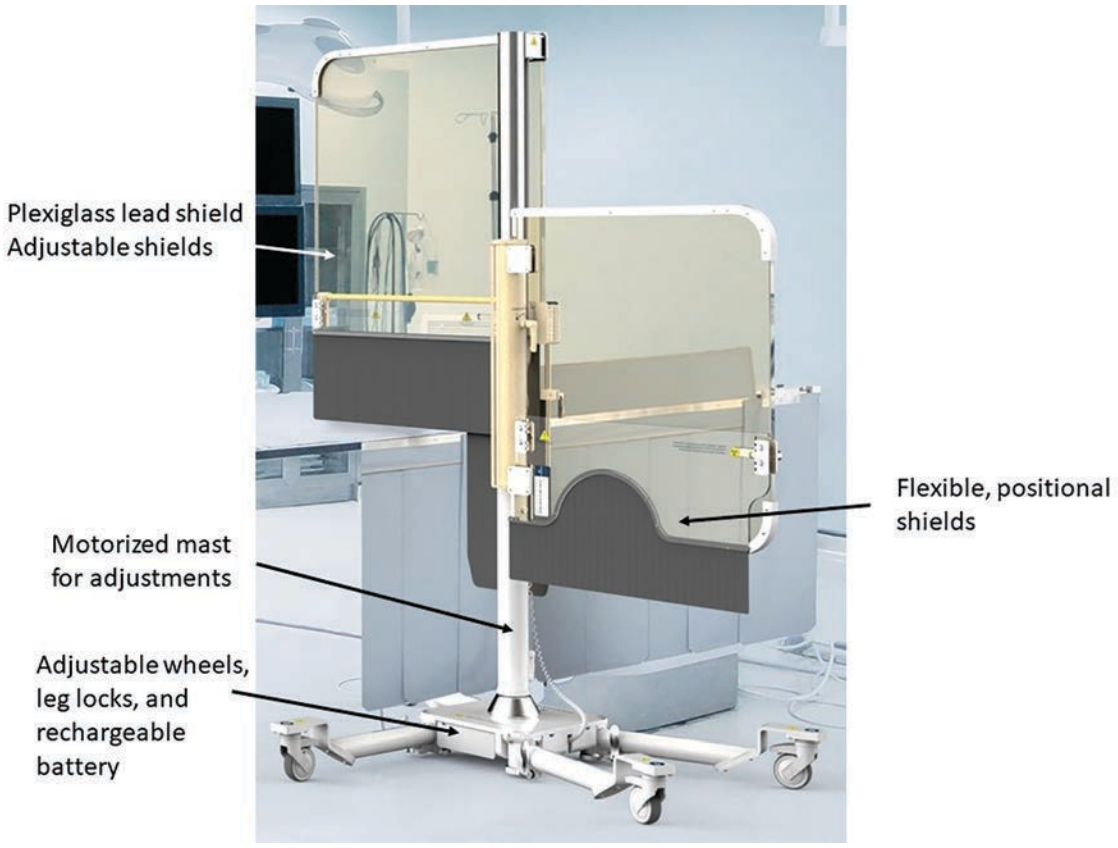

Figure 3. The Rampart IC M1128 radiation shielding system is a mobile lead radiation protection device that is designed specifically to allow operators to forego wearing lead altogether.
Image modified from RAMPART ic. https://www.rampartic.com/rampart-m1128

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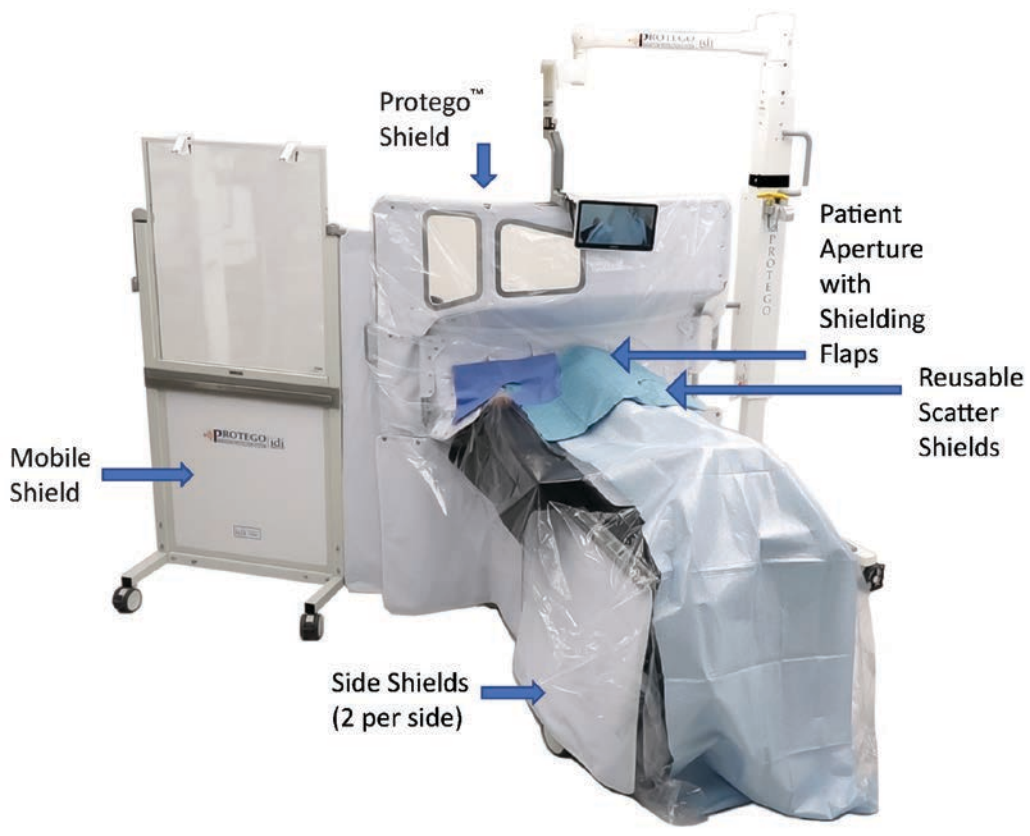

Figure 4. The Protego Radiation Protection System incorporates concepts of reducing scatter radiation with patient shield pads, lower table shields, angled radiation barrier wall, and a mobile side shield.
Modified image courtesy Image Diagnostics, Inc. https://imagediagnostics.com/

and Protego Systems[1] (Figure 4), which have large wings and several smaller shields surrounding the patient. Both of the extended shield systems significantly reduce radiation and were designed to allow operators to forgo wearing lead. The differences between the systems are minor.

The Rampart IC M1128, a mobile lead shielding device, is comprised of a configurable, floor-mounted center mast with two thick lead panels above the table and 2 lead curtains below the table. The lead panels are each 1 mm thick and are attached to either side of the center mast. Accessory soft lead shielding that are 0.5-mm thick attach to these lead panels and cover the patient. The device is positioned over the patient's torso, and can be angled at 180-degree configuration for structural and biplane cases, or at 90-degree configuration for electrophysiology and standard or complex coronary interventions. There is an ongoing clinical study to compare the efficacy of this device to conventional systems.[9]

The Protego system includes an angled radiation barrier sitting between the imaging equipment and the cath team, and a mobile side shield to the right of the table. Using a scatter radiation phantom, this system demonstrated a >94.2% reduction in scatter radiation across 20 reference points on the operator side of the table, as well as dose reduction at the location of the primary operator ranging from 97.8% to 99.8% in postero-anterior (PA) and left anterior oblique (LAO) projections.[1] In the configuration used during our demonstration, the personnel on the opposite side of the shields were exposed to standard radiation doses and were protected by their personal protective equipment. One of our team mentioned that for device procedures such as pacemakers and implantable cardioverter defibrillator implants, the shielding would have to be modified or we would have to revert to wearing lead aprons again. Future modifications will likely provide a design to cover this contingency.

Of note, for both Rampart and Protego, there is lack of extra protection for personnel at the head of the bed and the left side of the table; however, the Protego system provided 2 cameras that enable patient monitoring during the procedure (Figure 5).

The Bottom Line

I know a good thing when I see it. While it was only a demonstration and we may fall out of love when we use the system on a daily basis over time, I am having trouble seeing the downside of shielding that yields zero operator exposure. My team felt the same. And, oh yeah, did I mention my back didn't hurt at the end of the day either? A game-changer for sure. ■

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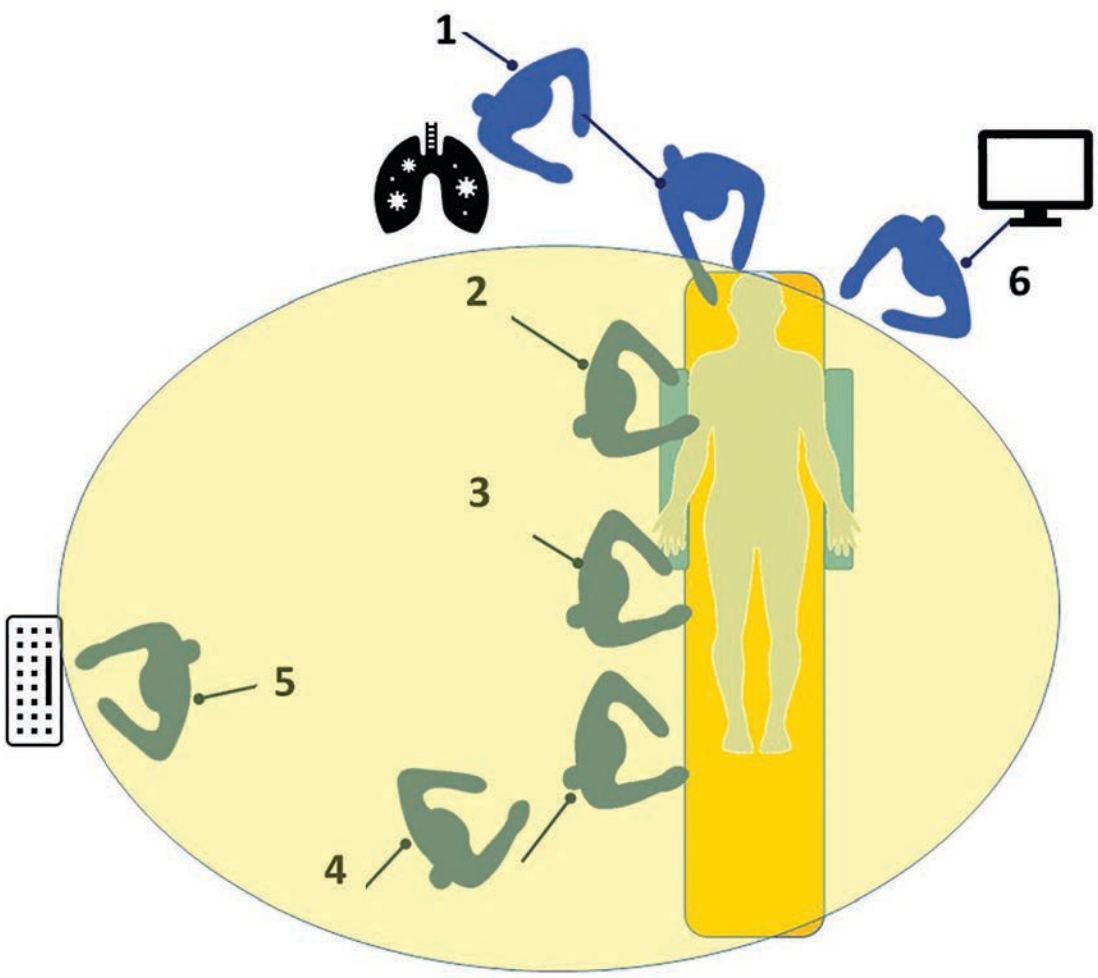

Figure 5. Diagram of locations that are protected by the Protego system. The personnel located closer to the x-ray tube for anesthesia and transesophageal echocardiography (TEE) operations. 1, respiratory therapist and anesthesiologist; 2, operator; 3, operator assistant; 4, circulating nurses; 5, recording technologist/nurse; 6, echocardiographer.

Modified figure courtesy of Dr. Robert Wilson.

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Imaging and physiology play an integral role in the cath lab. Despite data and advancements, the penetration rate is still low. We are trying to understand why, and are relying on your frank honesty and feedback, as nurses and technologists play a critical role in procedure workflow and decision making.

All survey answers will be kept anonymous and participation is voluntary. Completion of the survey implies consent to participate in the research study. The estimated time to complete this survey is 3-5 minutes. ■

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