Supplement to

Sponsored by Rampart

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The Radiation Safety Revolution

The Next Generation of Interventional Team Protection

Lead Apron–Free Procedures

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Is It Time to Shed the Lead?

Why an innovative, inclusive radiation protection strategy for the cath lab must be prioritized.

By Sahil A. Parikh, MD

For decades, the lead apron has been a symbol of protection in interventional medicine: necessary, familiar, and flawed. As procedural complexity and caseloads have grown, so too has our awareness of the long-term consequences of radiation protection garments on our bodies. Interventionalists have some of the highest rates of work-related orthopedic injury in medicine.[1] At the same time, we face chronic, cumulative radiation exposure that threatens our health and that of our teams (Figure 1).[2] The time has come to ask a critical

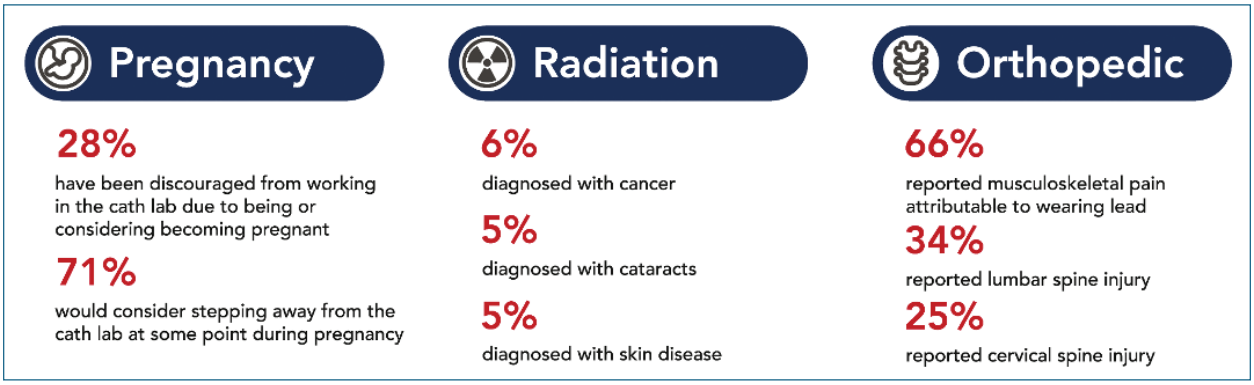

Figure 1. Occupational hazards in the cardiac catheterization lab as seen in a 2023 survey. Reprinted from JSCAI, Vol 4, Abudayyeh I, Dupont AG, Hermiller JB, et al, Occupational health hazards in the cardiac catheterization laboratory: results of the 2023 SCAI survey, Page 102493, Copyright 2025, with permission from Elsevier.

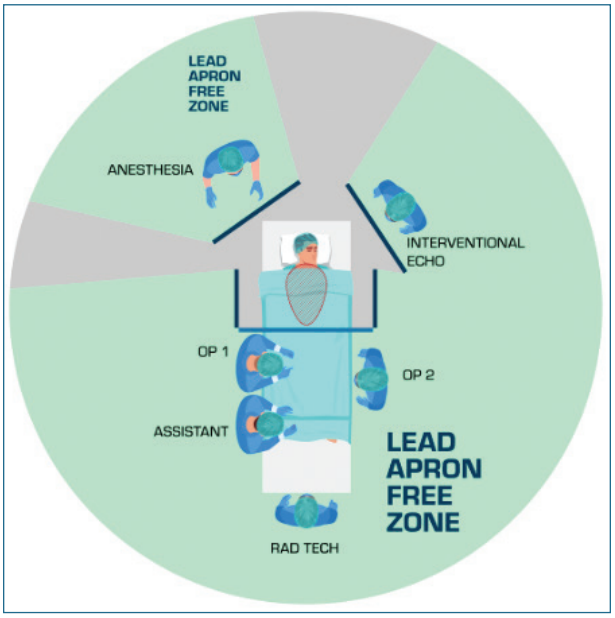

Figure 2. Rampart eliminates the need for lead aprons, offering full-body protection for the interventional team.

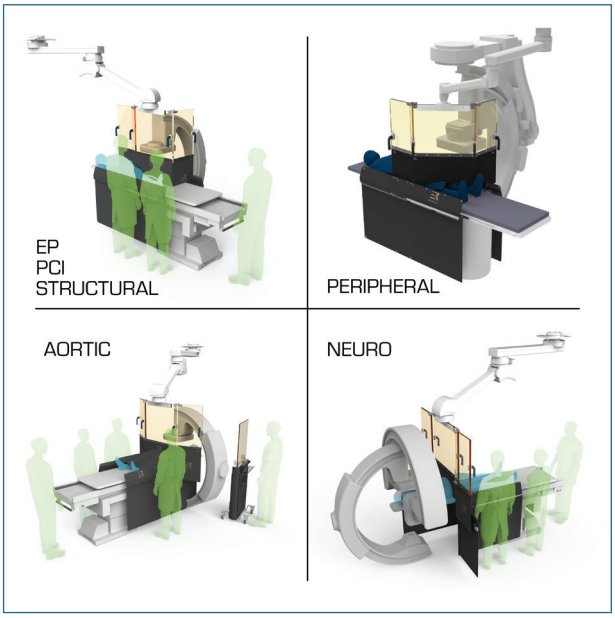

Figure 3. Rampart's portfolio of radiation shields are designed to work across the full spectrum of procedures. EP, electrophysiology; PCI, percutaneous coronary intervention.

question: **Is it time to shed the lead?** The answer is yes, but only if we can replace it with something proven to be equal or better at radiation protection.

Radiation safety has traditionally focused on shielding the primary operator at the table, often overlooking team members at the head, foot, and left side of the patient. Nurses, techs, anesthesiologists, and trainees remain vulnerable. Today's procedures are no longer limited to straightforward coronary interventions from a femoral approach. They span peripheral, structural, venous, and cerebrovascular therapies. In this evolving landscape, our radiation protection strategy must adapt, **protecting everyone, in every room, at every position.**

After 100 years of the lead apron, there is a new class of radiation protection solutions. Mobile and suspended shielding systems—like those developed by Rampart—are transforming how we think about cath lab safety. These systems eliminate the need for wearable lead by offering full-body protection for multiple staff members, including those at positions previously left exposed (Figure 2). Rampart's configurations are designed to work across the full spectrum of procedures, allowing teams to perform complex interventions without compromising access or workflow (Figure 3).

A particularly important advance is the integration of **real-time dosimetry** into modern cath lab workflows. By "visualizing" exposure as it happens, we gain unprecedented insight into radiation risk and the effectiveness of protective strategies. It empowers every team member to make safer choices and reinforces accountability in radiation protection.

Recent data have underscored just how effective these innovations can be. Clinical trials and large real-world studies demonstrate that Rampart's shielding system can reduce total body radiation exposure by **greater than 99%** for operators and staff, without requiring anyone to wear a lead apron.[3-8] That kind of impact isn't just ergonomic—it's transformative.

Radiation and orthopedic protection are no longer overlooked concerns. This is a matter of occupational health, sustained personal wellness, staff retention, and talent recruitment. As leaders in interventional medicine, we must set the standard, not only for how we treat our patients but also for how we protect ourselves and our teams. Our tools must reflect our commitment to innovation, safety, and long-term health. ALARA (as low as reasonably achievable) should be mandated and enforced, as what is now achievable has changed. In addition, it should include protection systems that could mitigate the risk of orthopedic injury to all team members.

The question is not whether we can afford to shed the lead. It's whether we can afford not to! ■

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Disclosures: None.

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Confidence in the Data

Redefining radiation safety in the cath lab.

By Karim Al-Azizi, MD

As interventionalists, we constantly make high-stakes decisions about devices, access, strategy, etc., all in the name of improving patient outcomes. These decisions are guided by data, clinical evidence, and experience. Radiation protection should be no different. The same level of clinical scrutiny we apply to patient care must extend to how we protect ourselves and our teams. The future of radiation depends on evidence-based solutions. And as with anything else in our field, the data should lead.

THE DATA

The Rampart system (Rampart) distinguishes itself with rigorous clinical validation. Among six published studies to date, two stand out—"**Radiation Exposure Using Rampart vs Standard Lead Aprons and Shields During Invasive Cardiovascular Procedures**" and "**Real-World Reductions in Lead-Free Radiation Exposure With the Rampart System During Endovascular Procedures.**"[1,2]

The results are not just measurable but also clinically significant. Rampart consistently demonstrates substantial

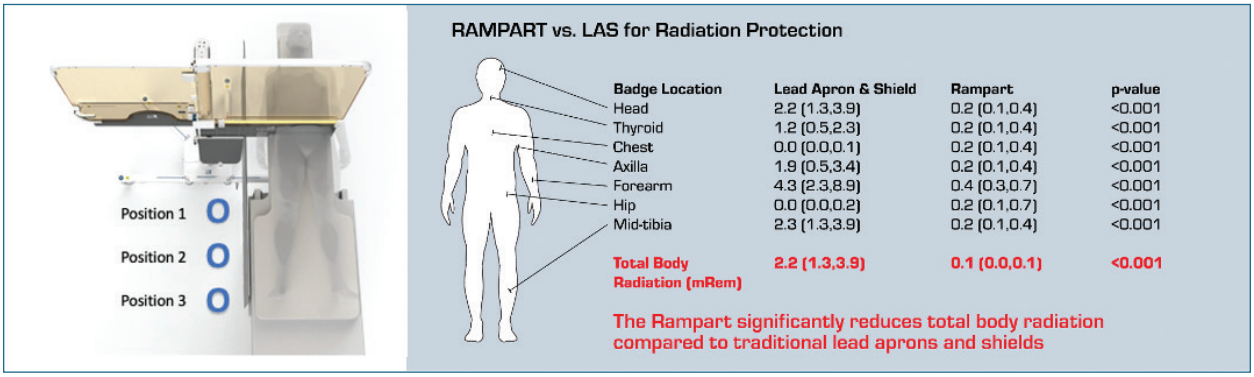

Figure 1. Rampart reduced total body radiation by > 99% compared to traditional lead aprons and shields. Adapted with permission from Lisko JC, Shekiladze N, Chamoun J, et al. Radiation exposure using Rampart vs standard lead aprons and shields during invasive cardiovascular procedures. J Soc Cardiovasc Angiogr Interv. 2023;3:101184.

TABLE 1. RAMPART RADIATION EXPOSURE REDUCTION PER PROCEDURE

- 1,712 procedures from 671 operators at 153 sites (19% OUS)
- Median fluoroscopy time 7.7 min (IQR, 3.9-15.3 min)
- Average reduction of 99%+, regardless of procedure type

Procedure	Control (mGy)	Main Operator (mGy)	Radiation Reduction (%)
All (N = 1,712)	0.955	0.002	99.8
Coronary procedure (n = 1,340)	1.030	0.002	99.8
Diagnostic angiogram (n = 750)	0.643	0.002	99.7
Non-CTO PCI (n = 474)	1.80	0.003	99.8
CTO PCI (n = 115)	2.92	0.008	99.8
Peripheral (n = 27)	0.298	< 0.001	100.0
Structural (n = 139)	0.923	0.001	99.9
Electrophysiology (n = 68)	0.300	< 0.001	100.0

Note: Results are presented as median values.
Abbreviations: CTO, chronic total occlusion; mGy, milligray; OUS, outside the United States; PCI, percutaneous coronary intervention.
Data from Herzig MS, Kochar A, Hermiller JB, et al. Real-world reductions in lead-free radiation exposure with the Rampart system during endovascular procedures. Am J Cardiol. 2025;243:59-64. doi: 10.1016/j.amjcard.2025.02.019

TABLE 2. EARLY FIELD DATA FOR RAMPART GUARDIAN COMPARED TO RAMPART DEFENDER

Parameter	Emory RCT[1]	Real-World Study[2]	Guardian LMR*
Product	Defender	Defender	Guardian
Number of sites	1	153 (125 United States, 28 international)	11
Number of operators	9	671	28
Number of cases	47	1,713	156
Procedure types	Coronary (PCI, CTO PCI), structural, EP	Coronary (diagnostic angiography, PCI, CTO PCI), structural, EP, peripheral, EVAR	Coronary/structural, peripheral/vascular
Median fluoroscopy time	12.3 min	7.7 min	13.8 min
Median radiation dose (control)	38.8 mRem	95.2 mRem	140.7 mRem
Radiation reduction compared to LAS	99+%	99+%	99+%
Median operator one radiation dose	0.1 mRem	0.2 mRem	0.2 mRem
Median operator two radiation dose	0.1 mRem	0.1 mRem	0.06 mRem

Abbreviations: CTO, chronic total occlusion; EP, electrophysiology; EVAR, endovascular aneurysm repair; LMR, limited market release; mRem, millirem; LAS, lead apron and shield; PCI, percutaneous coronary intervention; RCT, randomized controlled trial. *Data on file

reductions in radiation exposure across both controlled trials and real-world procedures, without compromising workflow or access.

In the randomized controlled trial (RCT) conducted at Emory University School of Medicine, 100 consecutive cases were assigned to either standard lead aprons and shields or Rampart shielding without the use of lead aprons. Using real-time dosimetry across eight anatomical points, the results were striking:

- Rampart provided 99.7% radiation attenuation, resulting in 20 times more total body protection than traditional lead aprons and shields (Figure 1).[1]
- Fluoroscopy time and procedural access were unaffected, confirming the system's practical compatibility with coronary and structural heart interventions.[1]

Yet RCTs are just one piece of the puzzle. In practice, variability prevails—case complexity, operator technique, and cath lab layout all impact radiation exposure to staff. That is why the "**Real-World Reductions in Lead-Free Radiation Exposure With the Rampart System During Endovascular Procedures**" study, recently published in *American Journal of Cardiology* and including > **1,700 procedures across 153 sites**, is so important.[2] It demonstrated consistent, lead apron–free radiation protection in coronary, structural, peripheral, and emergency cases. Median operator radiation was just **0.2 mRem**, a level comparable to or

lower than traditional underlead dosimetry but achieved without the physical burden of wearing lead aprons. This held true across access sites (radial, femoral, combined) and was remarkably stable even with complex chronic total occlusion cases (Table 1).[2]

Rampart's strength lies in the balance between these two studies—one strictly controlled, the other completely practical. Regardless of case complexity, geography, or type of procedure, the outcomes are consistent: **significant radiation reduction without the weight of lead aprons**.

Although the published data have focused primarily on the Defender system (Rampart), early field data for Rampart's **Guardian** system are equally promising. Across **11 sites, 28 operators, and 156 procedures**, the median exposure for operator one was **0.2 mRem**, while operator two's exposure was **0.06 mRem**. These cases spanned coronary, structural, and peripheral interventions, supporting the consistent performance of the Rampart platform across product lines (Table 2).[1-3]

Overall, the safety of operators and staff is a priority; it is a work hazard that has to be taken very seriously, and systems like Rampart address two main issues: radiation attenuation and alleviating the physical burden of lead.

SUMMARY

Radiation protection is no longer a guessing game. With Rampart, there are data to practice safely and the flexibility to practice freely. In an era when operator wellness, team safety, and procedural efficiency are under increasing pressure, Rampart delivers what few solutions can: **evidence-based confidence to practice without lead aprons**. ■

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3. Rampart data on file.

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From Awareness to Action

Transforming radiation safety culture—insights from across the lab.

With Lancer Smith, MS, and Brittney Meckley, BS, RCIS

ENGAGEMENT & CULTURE

How did you approach building awareness and gaining support across the team for prioritizing radiation safety?

Ms. Meckley: Building awareness around radiation safety required a cultural shift within our team. As professionals in invasive cardiology, we are committed to ensuring the safety and well-being of our patients, often putting our own safety concerns on the back burner. We focused on providing comprehensive educational opportunities and emphasized the importance of ongoing staff training and competency. This approach not only enhanced our understanding of radiation safety but also created a strong sense of shared responsibility across the team, bringing radiation safety to the forefront of our priorities in the cath lab.

Mr. Smith: Some solutions to reduce radiation exposure in the cath lab are very simple: Reduce time near the source, increase distance, and use shielding. But because radiation is invisible and imperceptible, it's easy for staff to forget about it. That's why I advocate for using real-time dosimetry with visual or haptic feedback—it makes exposure feel "real" in the moment. Also, showing real-world data from a published article I wrote has been helpful as well.[1]

JUSTIFYING THE INVESTMENT

What factors were most important in securing buy-in or budget approval for adopting new radiation protection technology?

Mr. Smith: I wrote an article analyzing the cost-benefit of radiation protection.[2] And, a study by Engstrom et al

estimated the value of reducing exposure at $61-$162 per man.mSv.[3] For 40 staff members, a 20-mSv reduction could justify spending up to $136,000. This kind of data-driven argument resonated with leadership and helped prioritize funding for modern protection systems.

Ms. Meckley: It is essential that all healthcare workers and administrators understand how ionizing radiation may impact their workforce. When leadership understands how radiation protection may provide longevity for provider and staff careers, the investment is a no-brainer. My number one goal is to be an advocate for staff safety. In addition to the up-front cost, it is essential to understand the return on investment. While my primary focus was on staff safety, I also highlighted the financial assets of investing in radiation protection technology. Over time, minimizing staff injuries and the potential for radiation-related health problems can lead to reduced healthcare costs, fewer sick days, and fewer workers' compensation claims. Additionally, there's the indirect cost of having to replace skilled staff who might leave the institution due to health concerns.

IMPLEMENTATION & INTEGRATION

What were the most important considerations in successfully integrating the system into your clinical environment or workflow?

Ms. Meckley: The staff's education and understanding of how ionizing radiation affects them in the lab was ideal for integrating the technology into the team's workflow. Staff now have a hyperfocus on where the gaps are that radiation might sneak through and adjunct factors that could lead to unnecessary radiation. Allowing the staff to learn the technology and feel empowered to adapt to the new workflow is essential. The staff are now able to take responsibility for fully protecting themselves during these interventional procedures.

Mr. Smith: Training is the most important part of integrating the new system. Just as physicians are trained to work with traditional shielding, our staff needed similar support to adopt this new approach. By providing hands-on training and peer-led demonstrations, within weeks the new workflow can become second nature. As with any innovation, there is an adjustment period, but ultimately it will enhance safety and efficiency.

VISION FOR THE FUTURE

How do you see radiation protection evolving in the coming years, and what advancements or changes are most needed?

Mr. Smith: Many radiation protection regulations still assume that lead aprons are the only defense, even though newer technologies can offer better protection and comfort. It's a classic case of the letter versus the spirit of the law. Fortunately, more regulators are recognizing the gap and adapting to solutions like Rampart.

Ms. Meckley: We have seen vast improvements in the quality of shielding in recent years. It will be exciting to see how that continues to evolve to meet the needs of all specialties utilizing radiation. I believe we will continue to see a shift in "if" we need the protection to "how" we get the protection now! Continued research on the long-term effects of ionizing radiation will only continue to propel radiation protection technology forward. I look forward to, and see, a day when every staff member (especially in the cath lab) is lead free, with real-time feedback and essentially zero occupational radiation dose throughout their career. ■

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GUARDIAN

Floor-Mounted or
Ceiling-Mounted

DEFENDER

TOTAL TEAM PROTECTION

Discover the Rampart Portfolio

LIVE-DOSIMETRY

SHADOW

BUNKER

SENTRY

RAMPART

Contact our team