ALARA+: Moving Beyond Lead Removal Toward Risk Reduction

Momentum is building to not only reduce exposure and lead but to thoughtfully and responsibly remove occupational risk for every procedure, every day.

By Kevin Croce, MD, PhD, and Brandon Wright, MS

For decades, radiation safety in interventional medicine has been guided by a simple but powerful principle: ALARA, as low as reasonably achievable. The concept remains foundational today. Although this concept remains foundational, advances in imaging technology and enhanced radiation protection devices (ERPDs) invite us to broaden our perspective.

Perhaps the next evolution of occupational safety is not about removing lead. Instead, it is about removing risk.

Across interventional cardiology, radiology, vascular surgery, electrophysiology, and structural heart programs, there is increasing discussion around practicing without traditional lead garments. ERPDs and modern dose-reduction technologies have generated excitement about what the future fluoroscopy suite may look like.

Momentum is clearly building. In June 2026, Arizona enacted Senate Bill 1121, modernizing radiation safety standards by allowing hospitals and surgical centers to determine whether lead garments are necessary in procedure rooms equipped with ERPDs. That momentum was further reinforced on July 14, 2026, with the publication of a landmark multisociety expert consensus statement on occupational radiation safety.[1-3] Importantly, the document supports evidence-based integration of ERPDs within a comprehensive radiation safety program. In many ways, the document reflects the philosophy of ALARA+: embracing innovation while maintaining multiple layers of protection and reducing occupational risk.

This evolution is overdue. The orthopedic burden associated with lead remains substantial. Physicians, nurses, and technologists frequently experience chronic neck, shoulder, back, and hip pain that can affect career longevity, quality of life, and workforce sustainability.

At the same time, innovation must be paired with caution. ERPDs should not be viewed as universal replacements for lead garments until their performance has been validated across different procedures, imaging geometries, room configurations, and operator positions. Scatter radiation is dynamic, varying with patient size, beam angulation, detector position, field size, table position, and staff location. Performance demonstrated in one clinical setting cannot automatically be assumed in another.

Rather than asking whether we can eliminate lead today, we should ask how we can most effectively reduce overall occupational risk. That is the foundation of ALARA+: combining best practices, procedural awareness, improved shielding, and emerging technologies to reduce both radiation exposure and orthopedic burden without introducing risk.

THERE IS NO SILVER BULLET

Radiation safety has always depended on layered protection. Lead garments, ceiling-suspended shields, table skirts, distance optimization, thoughtful positioning, and fluoroscopy dose management all contribute to reducing occupational exposure. Individually, none is perfect. Together, they provide a comprehensive system of protection that has protected health care professionals through millions of procedures.

The same philosophy should guide adoption of newer technologies.

The automotive industry offers a useful analogy. When airbags were introduced, they represented a major advance in safety, but they did not replace seat belts. Instead, they added another layer of protection. The safest approach was using both together.

Similarly, ERPDs may significantly reduce occupational exposure and eventually reduce reliance on traditional lead garments. Today, however, they should be currently viewed as additional layers of protection rather than wholesale replacements for proven safeguards.

The ultimate goal should be risk reduction.

REMOVING LEAD IS NOT THE SAME AS REMOVING RISK

Reducing reliance on lead garments does not automatically improve safety. Removing an established layer of protection without sufficient validation safety and without real-time monitoring of operator dose could simply exchange orthopedic burden for uncontrolled radiation exposure.

Importantly, this is not a binary choice between full lead and no lead. Emerging technologies may allow health care professionals to safely reduce the weight they carry through lighter-weight garments, lower lead equivalencies, or alternative protective configurations while maintaining multiple layers of protection. For many institutions, this may represent a more practical and responsible near-term strategy than complete lead elimination.

Innovation should be embraced, but it should also be evaluated under real-world clinical conditions rather than idealized scenarios.

WHO SHOULD DECIDE?

Decisions regarding lead reduction or lead removal should never be driven solely by marketing claims, anecdotal experiences, or isolated studies. They should be collaborative, evidence-based, and continuously monitored.

Health care professionals should work alongside their Radiation Safety Officer, radiation safety committee, medical physics team, hospital leadership, and applicable state regulatory authorities to determine what is appropriate for their specific clinical environment.

Radiation protection is ultimately a shared responsibility. Changes in practice should be aligned with institutional policies, regulatory requirements, and focused on the long-term safety of health care workers.

THE IMPORTANCE OF MEANINGFUL TESTING

As ERPD technologies continue to mature, how performance is measured and reported becomes increasingly important. Today, radiation reduction data are often generated using different methodologies, procedural geometries, endpoints, detector locations, and reporting practices, making meaningful comparisons between systems difficult. The field would benefit from standardized data testing and reporting, that includes consistent staff positions, measurement heights, procedural categories, room geometry, dosimeter placement and normalization techniques.

One valuable approach is normalizing occupational dose measurements by dose area product (DAP). Because DAP reflects the total radiation energy delivered during a procedure, expressing occupational dose relative to DAP helps account for differences in case complexity and radiation output, allowing more meaningful comparisons across studies and technologies.

Equally important is transparent reporting of the number of cases, DAP range, procedural geometry, staff position definitions, dosimeter location, whether lead or reduced lead garments were worn, and the type of dosimetry used. These details improve reproducibility and enable physicians, administrators, radiation safety teams, and purchasing committees to make informed, apples-to-apples comparisons.

Standardization benefits everyone. It promotes transparency, rewards innovation, and allows purchasing decisions to be based on meaningful evidence rather than marketing narratives.

EVERY CASE. EVERY DAY.

The future of occupational wellness will not be defined by a single device or a single philosophy. It will be defined by an unwavering commitment to protecting health care professionals during every procedure, every day.

That means continuing to optimize fluoroscopy practices, improving shielding technologies, reducing orthopedic burden wherever possible, collecting better clinical evidence, and demanding transparency in how performance is measured and reported.

Most importantly, it means recognizing that innovation and caution are not opposing forces. We can embrace new technologies while remaining committed to proven safety principles. We can pursue a future with less lead while acknowledging that we may not be fully there today for all cases and all environments.

That is the promise of ALARA+: not simply reducing exposure and not simply removing lead, but thoughtfully, responsibly, and relentlessly removing occupational risk for every procedure, every day. ■

1. Rizik DG, Sutton NR, Lansky AJ, et al. SCAI/ASE/HRS/SIR/SVS expert consensus statement on enhanced radiation protection: time for mandatory and urgent action. JACC Cardiovasc Interv. Published online July 14, 2026. doi: 10.1016/j.jcin.2026.06.011
2. Rizik DG, Sutton NR, Lansky AJ, et al. SCAI/ASE/HRS/SIR/SVS expert consensus statement on enhanced radiation protection: time for mandatory and urgent action. J Vasc Interv Radiol. Published online July 14, 2026. doi: 10.1016/j.jvir.2026.108927
3. Rizik DG, Sutton NR, Lansky AJ, et al. SCAI/ASE/HRS/SIR/SVS expert consensus statement on enhanced radiation protection: time for mandatory and urgent action. J Soc Cardiovasc Angiogr Interv. Published online July 14, 2026. doi: 10.1016/j.jscai.2026.105455

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