

Radiation Safety Foundations Toolkit

Core principles, occupational risk, and ALARA+ framework for the entire cath lab team

Audience: Cath Lab Physicians, Nurses, Technologists, Imaging Specialists

The Problem in Practice

The cath lab is the most radiation-intensive environment in medicine — and most teams are underprotected.

Over a career, an interventional cardiologist absorbs the equivalent of 25,000 to 50,000 chest X-rays and nurses and technologists face comparable cumulative exposure. The protective equipment most teams wear was designed in the 1960s and contributes its own injury burden: more than 66% of interventional cardiologists report musculoskeletal pain from lead aprons, and 77.2% of cath lab nurses experience work-related musculoskeletal disease annually.

Most cath lab staff know radiation is a hazard. The problem is that current regulations, equipment standards, and institutional policies have not kept pace with what modern practices look like — and there is no systematic mechanism compelling teams to act.

Occupational Hazard	Clinical Evidence
Career radiation dose (IC)	50–200 mSv — equivalent to 25,000–50,000 chest X-rays to the head
Musculoskeletal injury (ICs)	66% report pain from wearing radiation protective garments
Cath lab nurse MSK disease	77.2% experience work-related musculoskeletal disease annually; up to 65.5% require leave
Radial access growth	13-fold increase in five years — total team exposure rising every year
Complex PCI share	~40% of all procedures, increasing total team exposure duration

Why Current Behavior Persists

Lead aprons are the default because they are mandated by regulations written before modern practices existed. ALARA (As Low As Reasonably Achievable) remains the governing standard, but regulations are outdated and the system is a patchwork. ALARA+ aims to improve the current framework, updating practices to protect the modern cath lab team.

The Decision Point

Every member of your cath lab team needs to make an active choice about their own protection — and your institution needs to make one too.

The decision is not whether radiation is dangerous. The decision is whether your team will continue to operate under a protection standard designed in 1970, or whether you will adopt a modern framework that addresses both radiation exposure and physical injury simultaneously.

Leading cardiovascular, radiology, and surgical societies have developed ALARA+ — “as low and as light as reasonably achievable” — a new framework that builds on traditional radiation safety principles by explicitly addressing the physical burden of protective equipment alongside radiation dose reduction.

Traditional ALARA	ALARA+ (New Framework)
Minimize radiation dose only	Minimize radiation dose AND physical burden of protective equipment
Lead aprons as default protection	ERPDs as standard of care where clinically feasible
Focused on primary operator dose	Addresses entire care team including nurses, techs, and cardiac imagers

Minimum Viable Action (Next 60-90 Days)

One Step Your Team Can Take Now

Conduct a baseline radiation safety assessment for your cath lab. Review current dosimetry monitoring compliance, lead apron inspection records, and whether all team members — including nurses, technologists, and cardiac imagers — are included in your radiation monitoring program. This is the foundation for any policy or equipment change.

Immediate Actions by Role

Medical Director / Cath Lab Leadership

- Schedule a radiation safety review with your RSO within the next 30 days
- Confirm all team members — including nurses, techs, and imagers — are badged and monitored
- Request a review of lead apron inspection logs; replace garments that have not been inspected in >12 months
- Identify one procedure type as a candidate for ERPD pilot (high-volume, high-complexity, or longest fluoroscopy time)

Physicians and Clinical Staff

- Review your personal dosimetry data for the past 12 months; request data from your RSO if unavailable
- Complete a self-assessment of musculoskeletal symptoms related to lead apron use
- Familiarize yourself with the ALARA+ framework and available ERPD options

Nurses, Technologists, and Imaging Specialists

- Confirm you are enrolled in your institution's dosimetry monitoring program
- Report any musculoskeletal symptoms through your institution's occupational health reporting pathway
- Request inclusion in any planned radiation safety policy review or ERPD evaluation process

Cath Lab Team Radiation Safety Readiness Assessment

Complete this assessment individually or as a team. It identifies gaps in your current radiation safety program and prioritizes your next actions. Check every item that is currently in place.

Part A: Dosimetry Monitoring

For all cath lab team members — physicians, nurses, technologists, and cardiac imagers.

- ☐ I am enrolled in my institution's dosimetry (radiation badge) monitoring program
- ☐ I receive and review my dosimetry report at least quarterly
- ☐ My cumulative career dose data is accessible and I know how to request it from my RSO
- ☐ All nurses and technologists in my lab are badged and monitored — not just physicians
- ☐ Cardiac imagers performing structural heart procedures are included in our monitoring program
- ☐ Dosimetry badges are worn correctly (at collar level, outside lead garment) on every case

Part B: Protective Equipment

- ☐ My lead apron has been formally inspected within the past 12 months
- ☐ I have not experienced tearing, cracking, or deformation of my lead garment
- ☐ My institution has a documented lead apron inspection and replacement policy
- ☐ I have access to thyroid shields, leaded glasses, and ceiling-suspended shields
- ☐ I am aware of Enhanced Radiation Protection Device (ERPD) options available for my lab type

Part C: Physical Health and Musculoskeletal Symptoms

- ☐ I have not experienced new or worsening lower back, neck, or shoulder pain in the past 12 months
- ☐ My institution has an occupational health reporting pathway for cath lab MSK injuries
- ☐ I know how to report a work-related musculoskeletal symptom through my institution
- ☐ Female staff in my lab have access to accurate information about radiation safety during pregnancy

Part D: Institutional Policies and Training

- ☐ My institution has a written cath lab radiation safety policy reviewed in the past 3 years
- ☐ I have completed radiation safety training in the past 2 years
- ☐ My lab has a designated Radiation Safety Officer (RSO) I can contact
- ☐ ALARA principles are formally incorporated into our lab's safety protocols
- ☐ My institution is aware of the ALARA+ framework and its implications for our safety program

Scoring Your Assessment

17–20 checked: Strong foundation. Focus on ERPD evaluation and ALARA+ policy adoption.

10–16 checked: Gaps exist. Prioritize dosimetry enrollment and lead apron inspection compliance in the next 30 days.

Fewer than 10 checked: Significant exposure. Request an urgent meeting with your RSO and cath lab director using this checklist as your agenda.

Radiation Safety One-Pager

For a cath lab team member, division lead, or department chair presenting the radiation safety issue at a team meeting, grand rounds, or department review.

Radiation Safety in the Cath Lab: A Decision Brief for the Care Team

The Decision

Commit as a team to completing a baseline radiation safety assessment within 60 days and presenting findings to cath lab leadership. This is not a policy decision or a purchase decision. It is a team decision to take stock of where you are — and to make sure everyone in the lab, not just the physicians, is included in that accounting.

What Is Actually Happening in the Cath Lab

- An interventional cardiologist absorbs the equivalent of 25,000–50,000 chest X-rays over a career. The radiation is real, cumulative, and associated with increased rates of cancer, cataracts, and skin disease.
- A standard 15 lb lead apron exerts approximately 300 psi of pressure on lumbar discs. More than 66% of interventional cardiologists report musculoskeletal pain from wearing protective garments. The equipment designed to protect you is also injuring you.
- 77.2% of cath lab nurses experience work-related musculoskeletal disease annually, and up to 65.5% require a leave of absence. Nurses and technologists carry the same protective burden — and face comparable radiation exposure — but are routinely excluded from safety conversations.
- Cardiac imagers performing structural heart procedures are often positioned closest to the radiation source. Their exposure frequently equals or exceeds that of the primary operator — yet they are rarely included in radiation safety programs or monitoring.

The Framework Has Changed

Leading medical societies developed ALARA+ ('as low and as light as reasonably achievable') — a modern framework that addresses both radiation dose reduction and the physical burden of protective equipment. A new generation of Enhanced Radiation Protection Devices (ERPDs) reduces scatter radiation by 90–99% and enables facilities to operate lead-free

What a Yes Means in Practice

- Every team member, physician, nurse, technologist, and imager, completes the Cath Lab Team Radiation Safety Readiness Assessment in this toolkit
- Results are reviewed as a team and gaps are identified: who is not badged, whose apron has not been inspected, who has unreported MSK symptoms
- Findings are presented to the cath lab director and RSO with a request for a formal institutional radiation safety policy review
- The team identifies one candidate procedure or lab as an entry point for ERPD evaluation

What Inaction Costs

Resident trainees are choosing other specialties because of occupational hazards in the cath lab. Female staff are reducing cath lab activity during childbearing years due to radiation concerns. Experienced nurses and technologists are leaving a field they entered because the physical toll compounds every year. The workforce shortage this creates is not abstract — it threatens patient access to life-saving procedures, particularly in rural and underserved communities.

Talking Points by Audience

Organized by the specific objections and entry points each team member group raises. Use the relevant section before a team meeting, a one-on-one conversation, or when presenting to department leadership.

For Physicians: Addressing Complacency and Minimization

When the concern is: 'I've been doing this for years and I feel fine.'

- Radiation injury is cumulative and largely invisible until it isn't. The cancers, cataracts, and brain and eye effects associated with chronic low-dose radiation exposure do not announce themselves during a case. They accumulate over a career and present years later, often without a clear causal link that prompts recognition.
- Career exposure equivalent to 25,000–50,000 chest X-rays is documented for interventional cardiologists. Feeling fine now is not evidence of low risk, it is evidence of a latency period that is working as expected.
- The MSK injury picture is more immediate. 66% of ICs report musculoskeletal pain from wearing radiation protective garments. 9.4% report injury-related absence.

When the concern is: 'My dosimetry badge shows I'm within limits.'

- The US occupational dose limit of 50 mSv per year is 2.5 times higher than the ICRP recommendation of 20 mSv per year. Being within the US limit does not mean you are within the internationally recommended limit.
- Badge compliance tells you whether you are within a regulatory threshold. It does not tell you whether your cumulative career dose is on a trajectory toward harm. Request your full career dosimetry record from your RSO and review it in that context.
- ALARA means as low as reasonably achievable — not as low as the regulatory maximum allows. The standard is a floor, not a target.

When the concern is: 'We already have lead aprons. That's what they're for.'

- Lead aprons are the solution to one problem: radiation scatter — and the cause of another. A standard 15 lb apron exerts approximately 300 psi of pressure on lumbar discs. Over a career of multi-case days, that load is not trivial: more than 50% of frequent lead apron users experience lower back pain.
- ALARA+ was developed specifically because the field recognized that traditional radiation protection solved the radiation problem while creating an orthopedic one. Wearing lead is not a complete answer. It is the 1970s answer.
- ERPDs eliminate both problems simultaneously: 90–99% scatter radiation reduction with no physical burden. The question is not whether they work — the clinical evidence is clear. The question is whether your institution has evaluated them.

For Nurses and Technologists: Making the Case for Inclusion

When the concern is: 'Radiation safety is the physicians' issue, not mine.'

- Nurses and technologists in the cath lab are exposed to ionizing radiation on every case. The exposure is not incidental — it is occupational, cumulative, and documented. 77.2% of cath lab nurses experience work-related musculoskeletal disease annually.

When the concern is: 'I don't think I'm being monitored.'

- Contact your Radiation Safety Officer directly and ask. Request confirmation that you are enrolled in your institution's dosimetry program and that your badge is being read and reported. This is a reasonable, professional request — not an escalation.
- If you are not enrolled, document the gap and request enrollment in writing. Use the Cath Lab Team Radiation Safety Readiness Assessment in this toolkit to identify other gaps and bring the full picture to your department leader or RSO.
- 77.2% of cath lab nurses experiencing annual work-related MSK disease means this is a systemic issue, not an individual one. You are not alone in this — and you have professional society support behind you in raising it.

For Cardiac Imagers: Naming an Unrecognized Risk

When the concern is: 'I'm not the primary operator — my exposure must be lower.'

- Cardiac imagers performing structural heart procedures are frequently positioned closest to the radiation source during the procedure. Their scatter radiation exposure often equals or exceeds that of the primary operator — particularly during complex, long-duration cases.
- Despite this, cardiac imagers are rarely included in institutional radiation safety conversations, monitoring programs, or ERPD evaluation processes. The assumption that imaging is a lower-exposure role in the structural heart lab is not supported by the published exposure data.
- Sweis et al. (PMID: 40276545) documents radiation exposure in cardiac imagers specifically. If your institution has not reviewed this data and incorporated imaging specialists into your safety program, that is a gap worth naming explicitly.

When the concern is: 'What can I actually do about this?'

- Request enrollment in your institution's dosimetry monitoring program if you are not already included. Request that your badge data be reviewed alongside the rest of the structural heart team.
- Advocate for your inclusion in any ERPD evaluation process. The shielding geometry matters for your position specifically — an evaluation that does not include imaging specialist positioning is an incomplete evaluation.
- Raise the issue at your next structural heart team meeting using the data from this toolkit. You have published evidence, professional society support, and a clear ask: include imaging specialists in radiation safety policy and practice.

Authoritative Proof

Key Evidence Base

- SCAI 2023 Occupational Safety Data: Career exposure equivalent to 25,000–50,000 chest X-rays; 66% of ICs report MSK pain from protective garments
- SCAI 2023 Occupational Health Survey (Abudayyeh I et al., JSCAI 2025): 77.2% of cath lab nurses experience work-related musculoskeletal disease annually; up to 65.5% require leave of absence
- ALARA+ Framework (Salavitarab et al., JSCAI 2025): SCAI-endorsed multisociety framework addressing both radiation dose and physical burden of protective equipment
- ERPDs reduce scatter radiation exposure by 90–99% across validated clinical studies (Rizik 2024, Lisko 2024, Wilson 2024)
- Ross et al. (Am J Cardiol, 1997): Standard 15 lb lead apron exerts ~300 psi of pressure on lumbar discs; >50% of frequent users experience lower back pain

Full citations and clinical documents available at www.alara-plus.org