

Radiation Safety in Vascular Surgery

A Practical Guide for Residents created by Sonya Tuerff, MD MBA FACS

1. Overview

Vascular surgeons are routinely exposed to ionizing radiation due to fluoroscopy-guided interventions. Chronic occupational exposure carries measurable risks, making radiation safety a core competency in training and practice.

2. Biological Effects of Radiation

Deterministic vs Stochastic Effects

Category	Definition	Examples	Threshold
Deterministic	Severity increases with dose	Skin burns, cataracts, alopecia	Yes
Stochastic	Probability increases with dose	Cancer, genetic mutations	No

Clinical Insight:

Even low-dose repeated exposure increases long-term cancer risk. The lens and thyroid are especially radiosensitive.

3. Occupational Risks

Organ System	Risk	Clinical Relevance
Eyes	Cataracts	Reduced with leaded eyewear
Thyroid	Nodules/cancer	Requires shielding
Skin	Radiation injury	Seen in high-dose exposure
Hematologic	Leukemia	Long-term stochastic risk
Reproductive	Infertility/fetal risk	Important in pregnancy

4. Core Principles: ALARA

As Low As Reasonably Achievable

Principle	Action	Example
Time	Minimize exposure	Pulsed fluoroscopy
Distance	Maximize distance	Step back during imaging
Shielding	Use barriers and PPE	Lead + ceiling shields

5. Personal Protective Equipment (PPE)

Equipment	Purpose	Key Notes
Lead apron (0.5 mm)	Whole body protection	Blocks ~90–99% scatter
Thyroid shield	Thyroid protection	Mandatory
Lead glasses	Eye protection	Prevents cataracts
Lead gloves	Hand protection	Avoid direct beam use
Dosimeter	Exposure monitoring	Wear at collar
Fetal badge	Fetal monitoring	Under apron at waist

OSHA References:

- <https://www.osha.gov/ionizing-radiation/control-prevention>
- <https://www.osha.gov/ionizing-radiation/pregnant-workers>

6. ACGME Expectations

Residents must be trained in:

- Radiation safety principles
- Safe fluoroscopy use
- Proper PPE and monitoring

Reference: <https://www.acgme.org>

7. Pregnancy Safety Guidelines

Exposure Limits

Organization	Limit
NRC	≤ 5 mSv total pregnancy
ICRP	≤ 1 mSv fetal exposure

Guidelines for Pregnant Residents

Category	Recommendation
Declaration	Optional but recommended
Monitoring	Fetal dosimeter
Shielding	≥ 0.5 mm lead apron
Case selection	Limit high-fluoro cases
Positioning	Maximize distance

Key Point:

Most occupational exposures within limits do **not** result in fetal harm.

8. Intraoperative Exposure Reduction

Technique	Benefit
Pulsed fluoroscopy	Lower radiation dose
Collimation	Smaller exposure field
Low-dose mode	Reduced scatter
Proper C-arm positioning	Lower operator exposure
Avoid magnification	Prevents dose escalation

9. Key Takeaways

- Radiation exposure is **cumulative**
- Apply **ALARA** in every case
- PPE use is **mandatory**
- Pregnancy requires **modified precautions, not exclusion**
- Safety is a **daily habit, not a one-time lesson**

Quick Reference

Always:

- Wear lead + thyroid shield
- Step back when imaging
- Use pulsed fluoroscopy
- Track your dose
- Protect your eyes