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Robotic PCI, Suspended Lead Suits, and Other Approaches to Reduce Radiation Exposure in the Cath Lab

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- Advisory Board: Corindus Vascular Robotics

Two Principle Occupational Risks in the Cath Lab

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Risks of **Radiation Exposure**

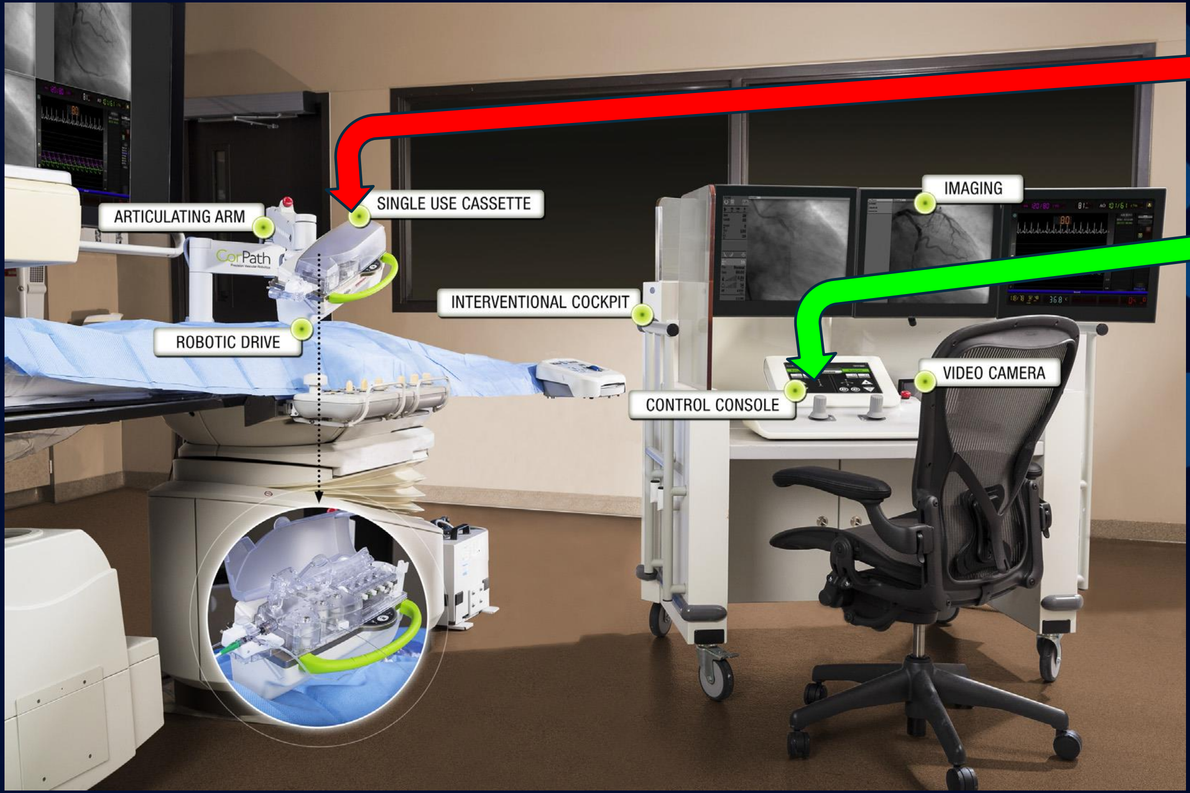
- Premature cataracts
- Carotid atherosclerosis and early vascular aging
- Left-sided brain malignancies
- DNA damage

Risks of **Wearing Lead**

- Orthopedic injuries
- Chronic work-related pain

To optimally reduce occupational risk, both of these should be addressed.

Robotic PCI:
Currently in Clinical Use



Robotic Arm

Robotic Controls

Mahmud et al.
J Am Coll Cardiol Intv
2016;9:2058–64

Robotic PCI:
Control Panel and Joysticks

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Wire control

Guide-catheter control

Balloon/stent control

Robotic PCI: Physician in the Cockpit – Away from the Radiation

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Robotic PCI: Data from the PRECISE Study

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Safety and Feasibility of Robotic Percutaneous Coronary Intervention

PRECISE (Percutaneous Robotically-Enhanced Coronary Intervention) Study

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New York and Syracuse, New York; Kingston, Tennessee; Medellin, Colombia; Gainesville, Georgia; Richmond, Virginia; Seattle, Washington; Washington, DC; Beersheba, Israel; and Boston, Massachusetts

Objectives The aim of this study was to evaluate the safety as well as the clinical and technical effectiveness of robotic-assisted percutaneous coronary intervention.

Background Robotic systems have been suggested to enhance the performance of cardiovascular procedures, as well as to provide protection from the occupational hazards that are associated with interventional practice.

Methods Patients with coronary artery disease and clinical indications for percutaneous intervention were enrolled. The coro-

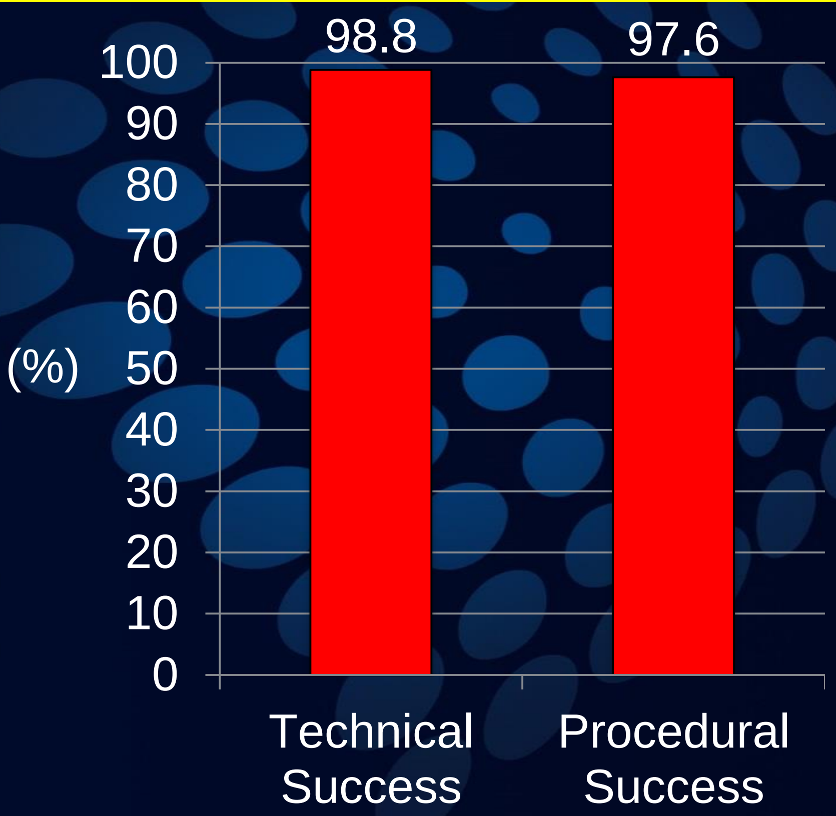
- Prospective observational design
- 20 physicians
- 9 sites
- 164 patients underwent attempted robotic PCI
- No device related complications

Weisz et al. J Am Coll Cardiol 2013;61:1596-600

Success Rates for Robotic PCI: The PRECISE Study

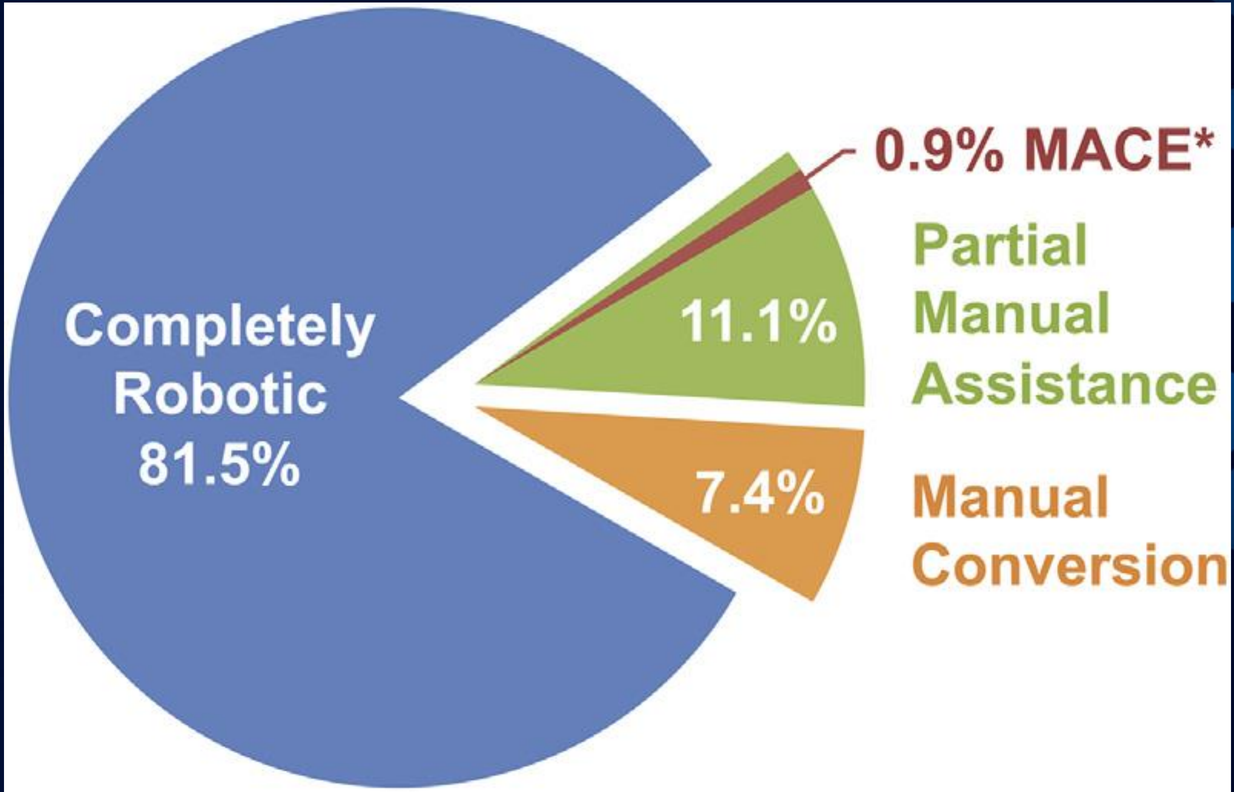
Primary endpoints:

- Technical success - successful advancement/retraction of all PCI devices without conversion to manual
- Procedural success - residual stenosis <30% at completion of procedure in absence of MACE at 48 hours or prior to hospital discharge (whichever came first)



Weisz et al. J Am Coll Cardiol 2013;61:1596-600

Robotic-PCI in Complex Lesions: CORA-PCI



- 108 robotic-PCI procedures (157 lesions)
- 78.3% of lesions were type B2 or C

Mahmud et al.
J Am Coll Cardiol Intv
2017;10:1320–7

Physician radiation exposure in the PRECISE study

Median Radiation Exposure per Case

At the Table	In the Cockpit	p
20.6 µGy	0.98 µGy	<0.0001

Weisz et al. J Am Coll Cardiol 2013;61:1596-600

Robotics:
95.2% ↓
Radiation

Operator A: Manual

(20.6 µGy per PCI) x (100 PCI per year)

Annual Exposure
2,060 µGy per year

Over First 20 Years of Career
41,200 µGy

Operator B: Robotics

(0.98 µGy per PCI) x (100 PCI per year)

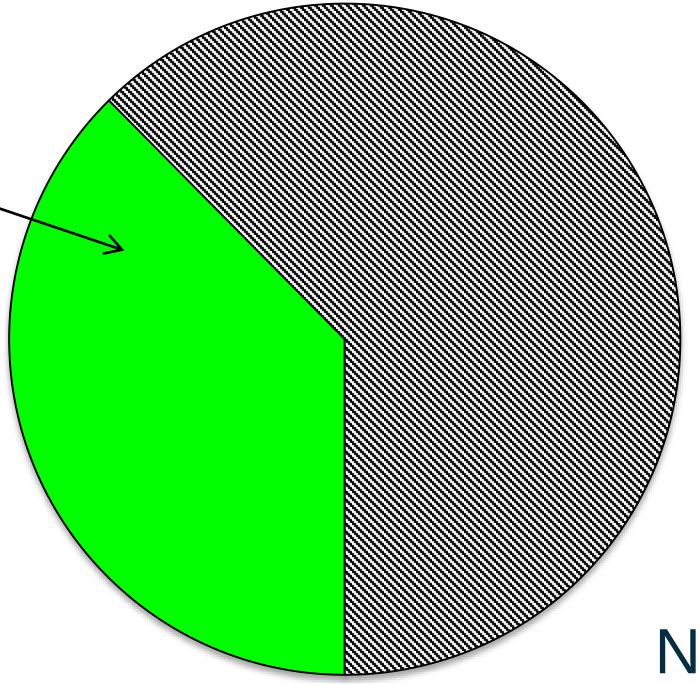
Annual Exposure
98 µGy per year

Over First 20 Years of Career
1,960 µGy

Robotic PCI:
No Lead Garments Required

Robotic PCI:
Limited to PCI – Not Used in Diagnostic Caths

Only 37.6% of elective diagnostic coronary angiograms revealed obstructive coronary artery disease.



N = 398,978

Patel et al. N Engl J Med 2010;362:886-95.

Robotics:
May Not be Limited to PCI in the Future

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Robotic-assisted transradial diagnostic coronary angiography

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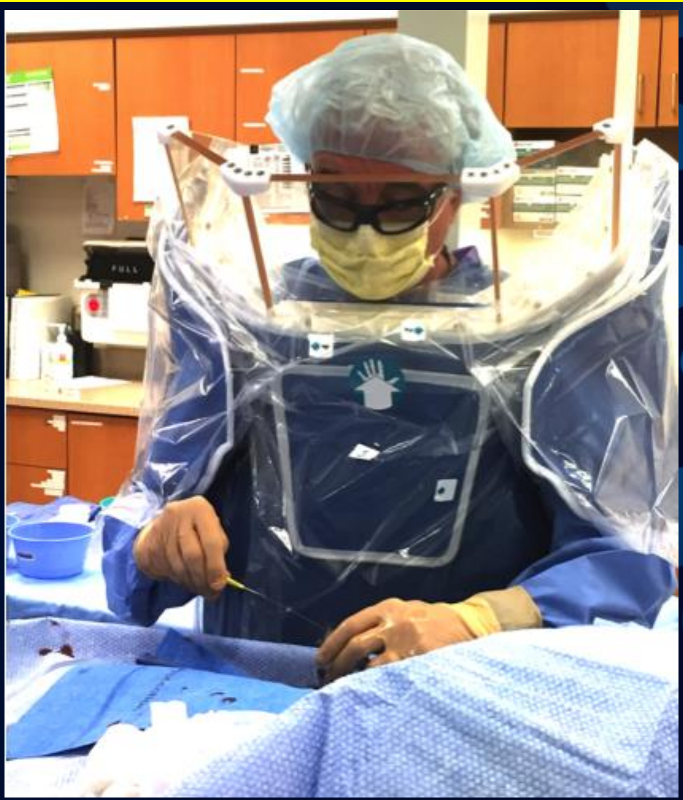
Abstract

Robotic percutaneous coronary interventions have recently been introduced in the cardiac catheterization laboratory. Robotics offers benefits of greater precision for stent placement and occupational hazard protection for operators and staff. First generation systems were able to advance and retract coronary wires, balloons, and stents, but did not have guide control functions. The second-generation robotic system (CorPath GRX) has an active guide management function offering the ability to move guide catheters. Expanding utilization of robotics to perform diagnostic coronary angiography would further reduce radiation scatter exposure and other occupational hazards to operators. This approach is particularly appealing in the setting of radial access, as universal radial diagnostic catheters can engage both the right and left coronary arteries without exchange. We describe here, the first two cases of such a procedure with the CorPath GRX robotic system.

KEYWORDS
coronary angiography, robotics, transradial

Swaminathan & Rao. Catheter Cardiovasc Interv 2018;92:54-57

Suspended Lead Suit



Madder et al. Cardiovasc Revasc Med 2017;18:190-196

Offers greater radiation protection & eliminates the need to wear traditional lead garments

Suspended Lead Suit: Radiation Reduction in IR Lab

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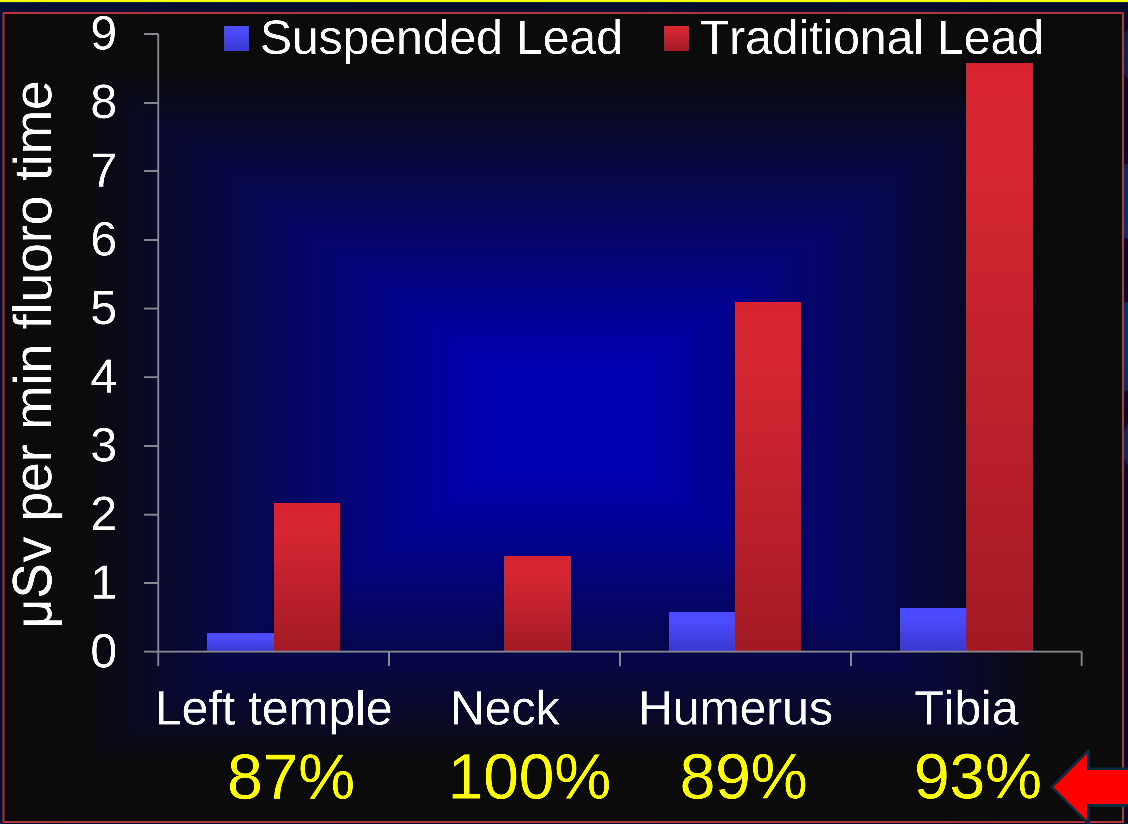

Compared to conventional lead aprons, a suspended lead suit significantly reduces operator radiation exposure during fluoroscopic procedures.

Savage et al.
Open J Radiol 2013;3:143-151

% reductions

Suspended Lead Suit: Physician Radiation During PCI

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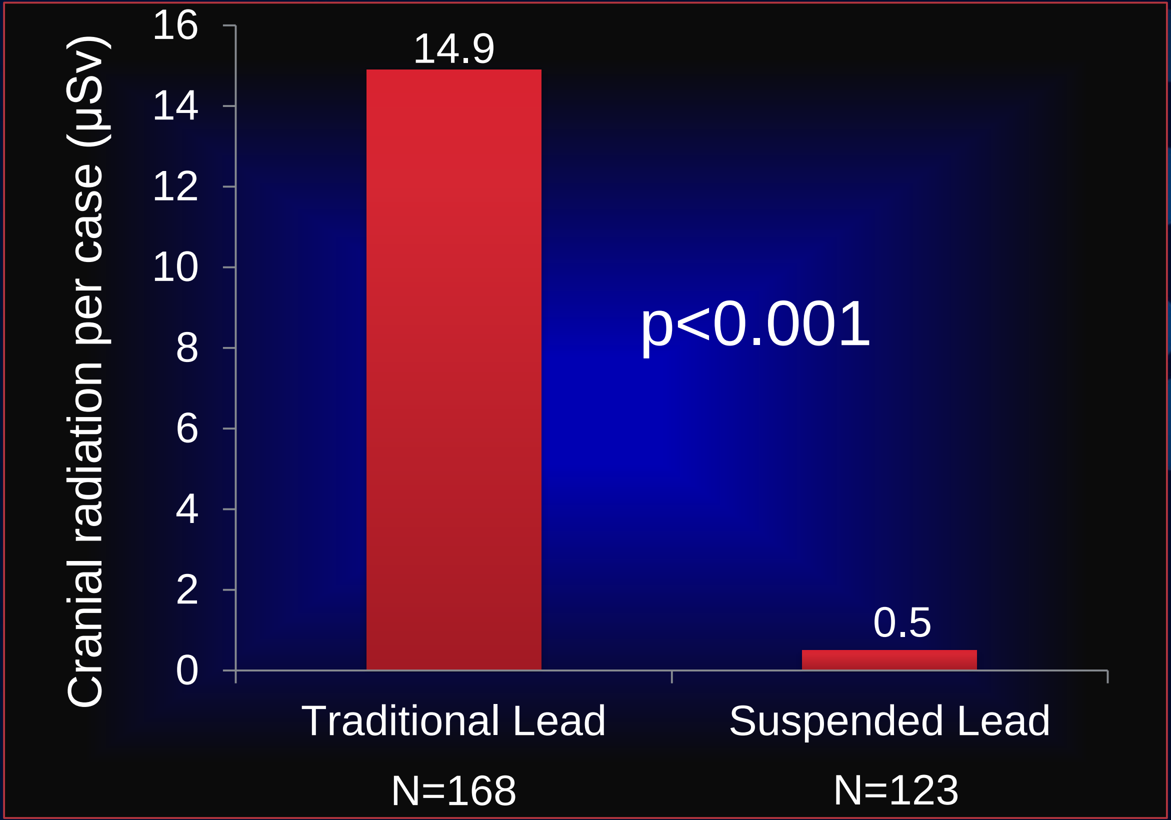

Compared to conventional lead aprons, a suspended lead suit reduced cranial radiation exposure during PCI by

97%

Madder et al.
Cardiovasc Revasc Med 2017;18:190-196

Radiation Safety for Staff: Time, Distance, & Shielding

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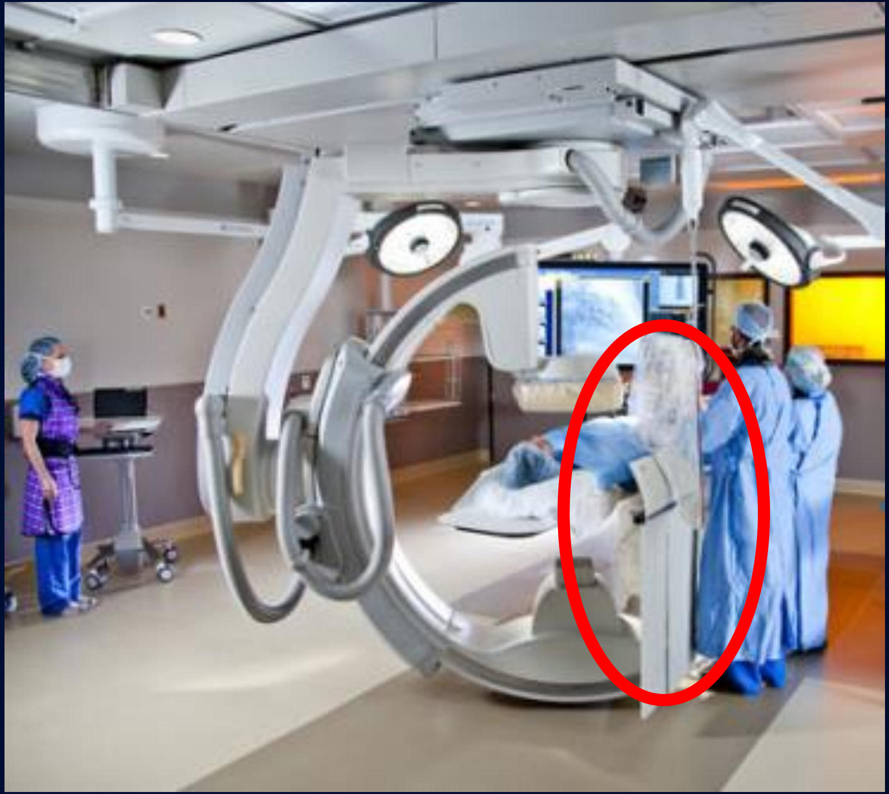

Time → Physician controls the pedal

Distance → Location may be fixed for tech

Distance → Nurse has to approach patient

Shielding → Where are the shields???

Radiation Safety for Staff: The SHIELD Study

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Radiation Exposure Among Scrub Technologists and Nurse Circulators During Cardiac Catheterization

The Impact of Accessory Lead Shields

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ABSTRACT

OBJECTIVES This study was performed to determine if the use of an accessory lead shield is associated with a reduction in radiation exposure among staff members during cardiac catheterization.

BACKGROUND Accessory lead shields that protect physicians from scatter radiation are standard in many catheterization laboratories, yet similar shielding for staff members is not commonplace.

Madder et al. J Am Coll Cardiol Intv 2018;11:206-12

Radiation Safety for Staff: The SHIELD Study

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PHASE I

Standard radiation protection

N = 401 cases

PHASE II

Standard radiation protection + proactive shielding

Lead shields height 1.8 m
width 0.7 m
effective lead thickness 0.5 mm Pb

N = 363 cases

Madder et al. J Am Coll Cardiol Intv 2018;11:206-12

Radiation Safety for Staff: The SHIELD Study

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Scrub Technologist

Nurse Circulator

Madder et al.
J Am Coll Cardiol Intv
2018;11:206-12

Radiation Safety for Staff: The SHIELD Study

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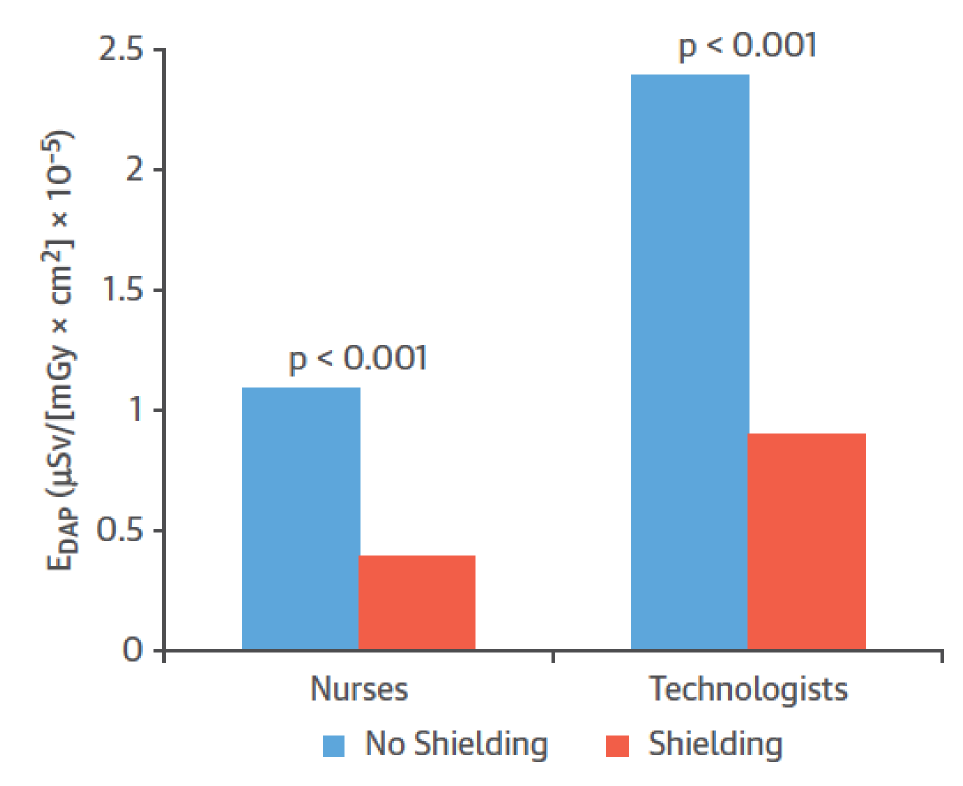

Use of shields associated with:

62.5%

lower dose among techs

&

63.6%

lower dose among nurses

Madder et al. J Am Coll Cardiol Intv 2018;11:206-12

Procedural Factors Independently Associated with Radiation Doses

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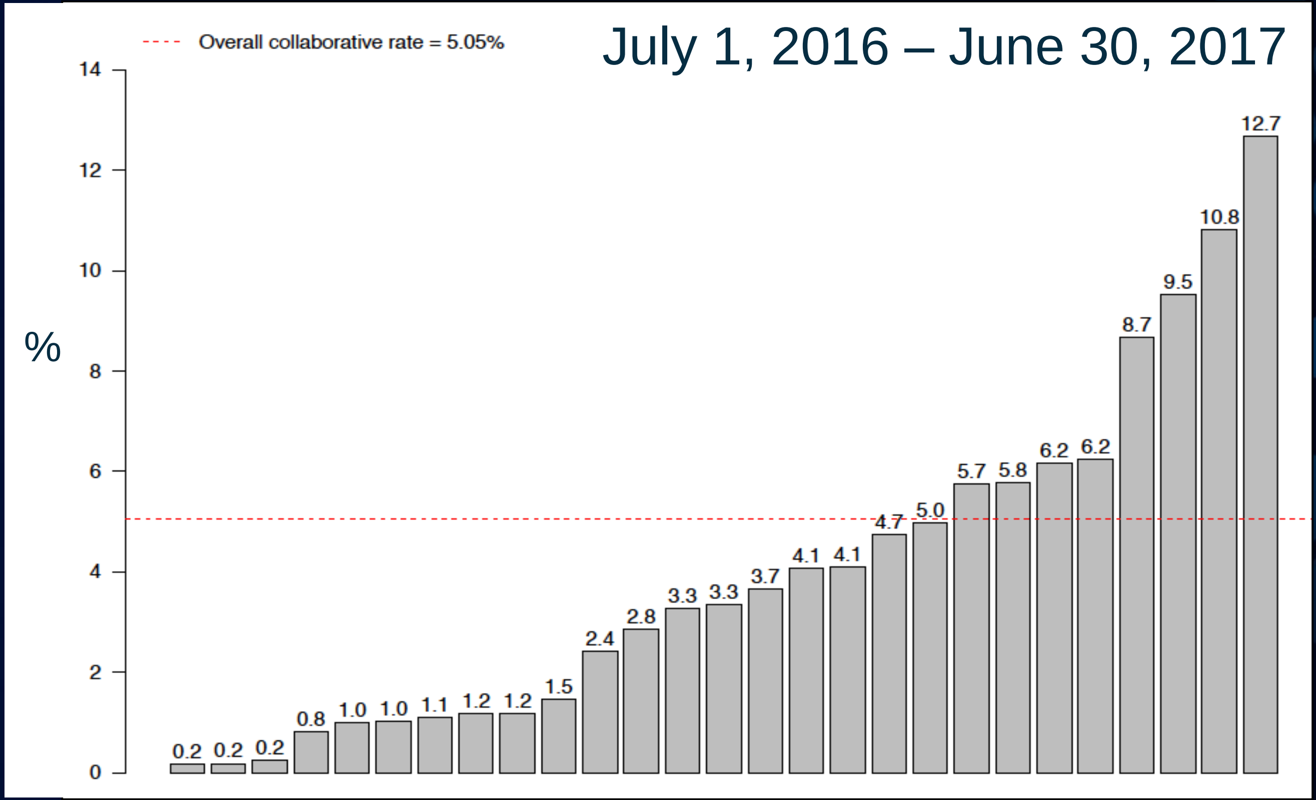
TABLE 3 Variables Independently Associated With Log of Effective Dose Normalized to Dose-Area Product Among Technologists and Nurses by Multivariate Linear Regression Analysis

	Δ% Exposure	β	p Value
Scrub technologists			
Accessory lead shield	−34.2 (−45.8 to −20.1)	−0.4 (−0.6 to −0.2)	<0.001
Radiation-absorbing pad	−47.0 (−55.9 to −36.2)	−0.6 (−0.8 to −0.4)	<0.001
Nurse circulators			
Accessory lead shield	−36.4 (−49.6 to −19.7)	−0.5 (−0.7 to −0.2)	<0.001
Fractional flow reserve	41.9 (0.7 to 100.1)	0.4 (0.0 to 0.7)	0.046
PCI	112.2 (66.2 to 171.0)	0.8 (0.5 to 1.0)	<0.001

Madder et al. J Am Coll Cardiol Intv 2018;11:206-12

Frequency of PCI Cases with Procedural Air Kerma ≥5 Gy



- 27 Hospitals in Michigan
- N = 25,571 PCIs
- Data from BMC2 Registry

Madder et al. TCT 2018