Scatter Radiation Over and Under the Apron With a New Shielding System: Is It Time For Lighter Aprons?

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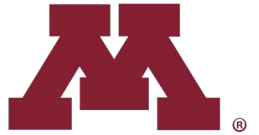

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Disclosures

Study Authors: No Disclosures
Study Presenter: Founder and CEO, Egg Medical, Inc.

Background

- Scatter radiation exposure in hospital x-ray labs has been linked to an increased risk of cancer, cataract, and vascular disease
- Current radiation shielding for personnel working in the scatter radiation field is usually limited to a table shield, a hanging shield, and a shielding apron worn by personnel
- The shielding effectiveness of aprons is expressed in lead “equivalence”
- A minimum shielding apron effectiveness is usually mandated by government regulatory agencies: usually 0.25 to 0.5mm Pb equivalence
- Due to the weight and awkward ergonomics of aprons, prolonged apron usage is associated with significant orthopedic problems for the user

Background

- Shielding aprons should be viewed more as radiation filters than shields

Lead Equivalent	X-ray transmission
0.25 mm	= 19% leak
0.375 mm	= 10% leak
0.50 mm	= 4% leak
0.70 mm	= 1% leak *

- Next-Generation scatter radiation shielding systems that dramatically reduce operator radiation exposure have been recently introduced
- ***Given the effectiveness of Next-Gen Shielding, can the weight (and Pb equivalency) be safely reduced?***

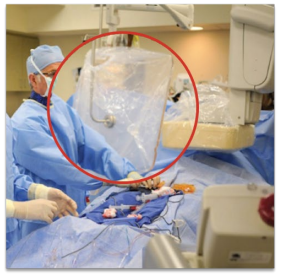
*Stam and Pillay: *Health Phys. 95(Supplement 2):S133–S136; 2008*

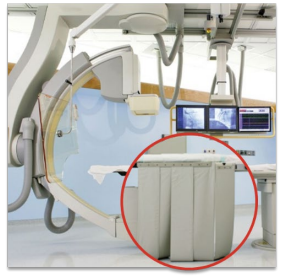
Study Aims

Compare operator scatter radiation exposure over and under a shielding apron during cardiac cath lab procedures with and without Next-Generation Radiation shielding

Standard Shielding

- Acrylic hanging shield (0.5mm Pb equivalence)
- Lower table shield (0.5mm Pb equivalence)





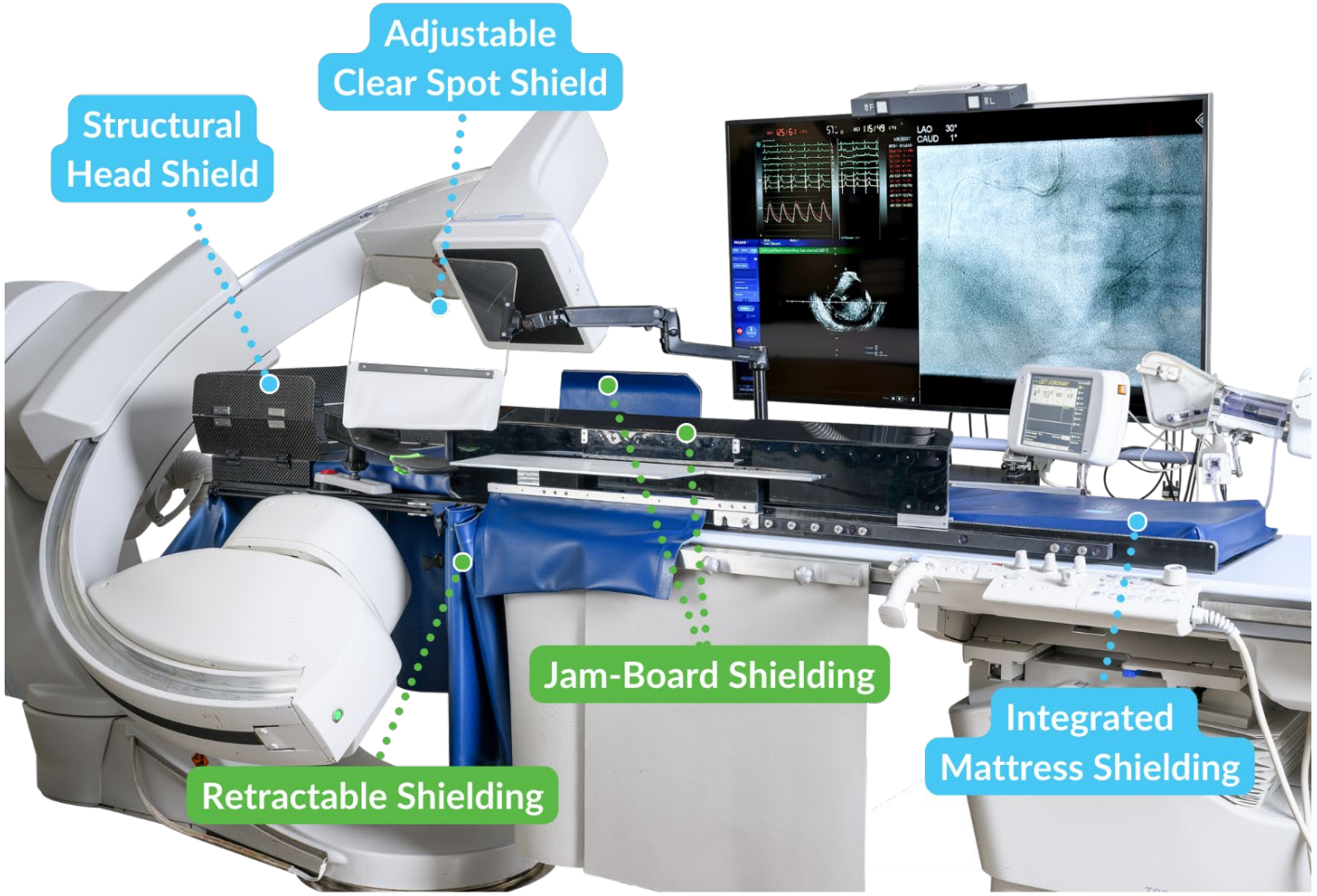
Standard Shielding

EggNest Protect Radiation Protection System
(Egg Medical, Inc., Arden Hills, MN, USA)

EGGNEST™ PROTECT

EggNest™ Protect System

- Replaces table mattress with carbon fiber shell and shielded mattress
- Moves with x-ray table
- 360° Protection - Protects Everyone working in the Lab

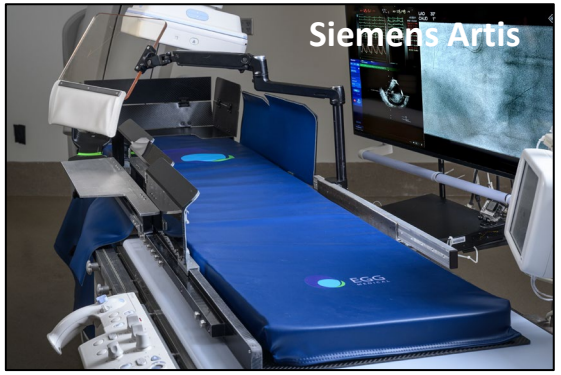


Study Design

- Study conducted in Cath Lab Rooms A & B over 4 weeks
- Standard Shielding in one room, EggNest system in the other
- The operator performed cases alternately in Rooms A & B

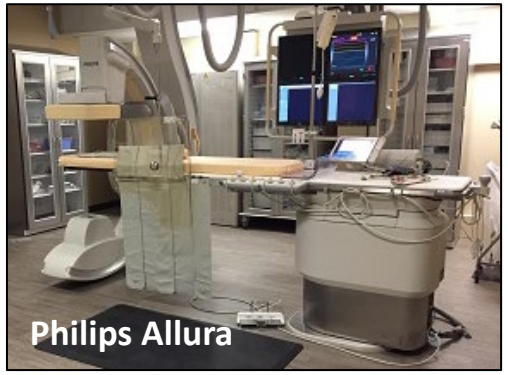
Weeks 1 & 2

Room A



EggNest™ Protect System

Room B



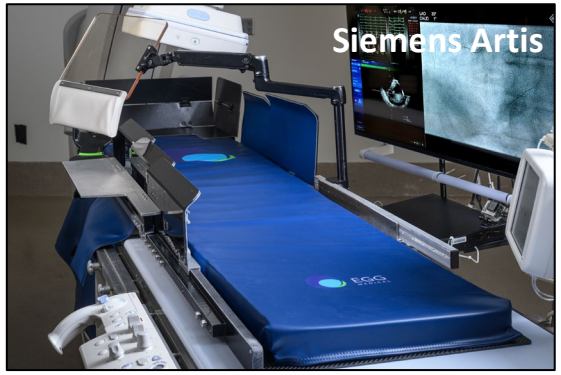
Standard Shielding

Weeks 3 & 4

Room A

Standard Shielding

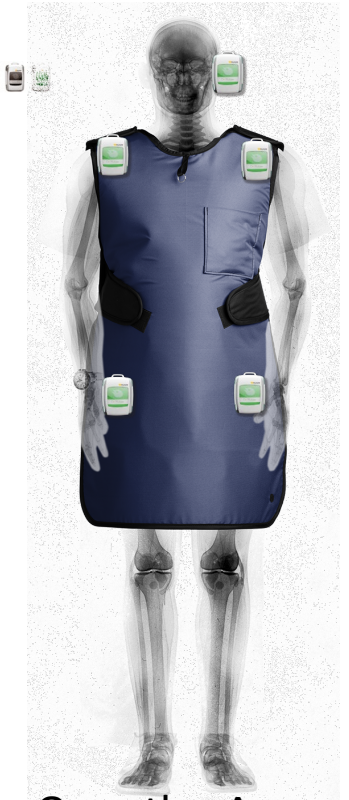
Room B



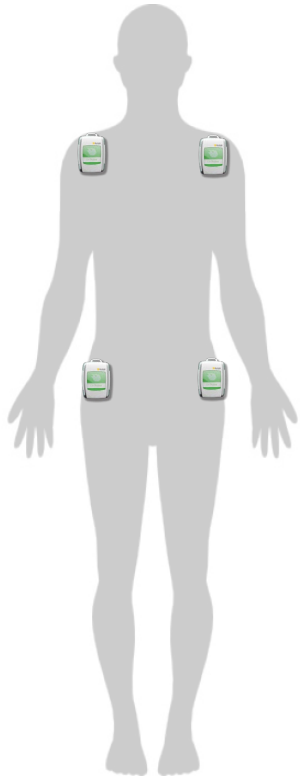
EggNest™ Protect System

Measurement of Radiation Exposure

- Radiation exposure was measured using an i3 measurement system (Fluke Biomedical, Everett, WA, USA) with 9 sensors placed on the operator
  - 4 over the apron (right and left shoulders, right and left waist)
  - 4 under the apron (similar positions)
  - 1 over left ear
- After each case, sensor data was downloaded to determine cumulative radiation exposure dose at each position during case
- The patient Dose-Area Product (DAP), fluoroscopy time, weight, BMI, and procedure type were recorded
- Operator radiation exposure normalized for patient DAP
  - Total sensor exposure/DAP



Over-the-Apron Sensors



Under-the-Apron Sensors

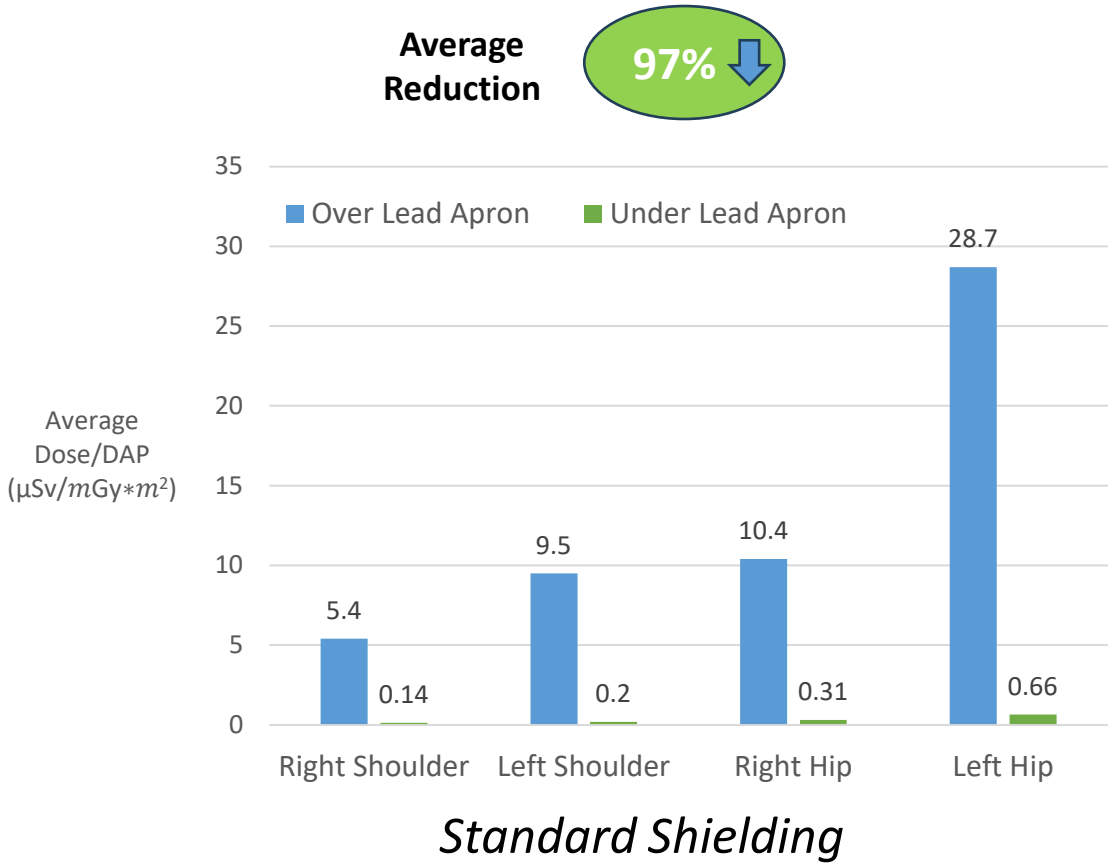
Case Demographics

- 51 patients were studied, 28 using standard Shielding and 23 using the EggNest™ System

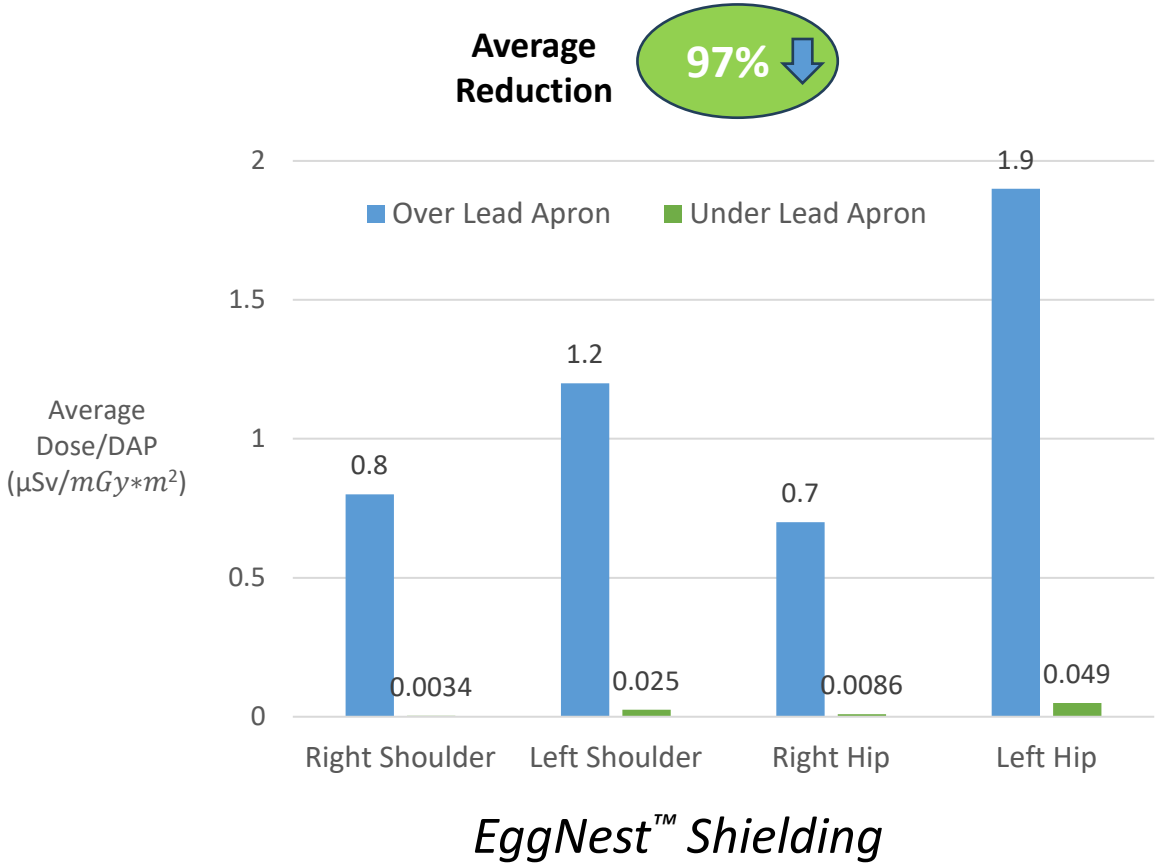
	Standard Shielding (n = 28)	EggNest (n = 23)	p value
DAP ($\mu GymGy * m^2$)	6.0 ± 6.5	7.8 ± 8.5	0.40
Fluoroscopy Time (min)	10.7 ± 10.6	13.5 ± 17.0	0.49
Patient Weight (kg)	90.3 ± 16.9	92.3 ± 28.1	0.76
PCI cases	8	8	
Coronary Angiograms	13	11	
Right Heart Cath (IJ access)	7	4	

mean±SD

Body Radiation Dose Over and Under 0.5mmPb Shielding Apron



Standard Shielding



EggNest™ Shielding

Operator Radiation Exposure With and Without EggNest™

		Standard Shielding Over Lead Apron	EggNest™ Over Lead Apron	Percentage Reduction
OVER the Apron Dose	Right Shoulder	5.4 ± 8.3	0.8 ± 0.5 *	85.2%
	Left Shoulder	9.5 ± 19.5	1.2 ± 0.9 *	87.4%
	Right Hip	10.4 ± 12.2	0.7 ± 0.7 *	93.3%
	Left Hip	28.7 ± 26.7	1.9 ± 1.2 *	93.4%

90% ⇩

		Standard Shielding Under Lead Apron	EggNest™ Under Lead Apron	Percentage Reduction
UNDER the Apron Dose	Right Shoulder	0.14 ± 0.44	0.0034 ± 0.0074 *	97.6%
	Left Shoulder	0.20 ± 0.54	0.025 ± 0.04 *	87.5%
	Right Hip	0.31 ± 0.77	0.0086 ± 0.018 *	97.2%
	Left Hip	0.66 ± 1.65	0.049 ± 0.094 *	92.6%

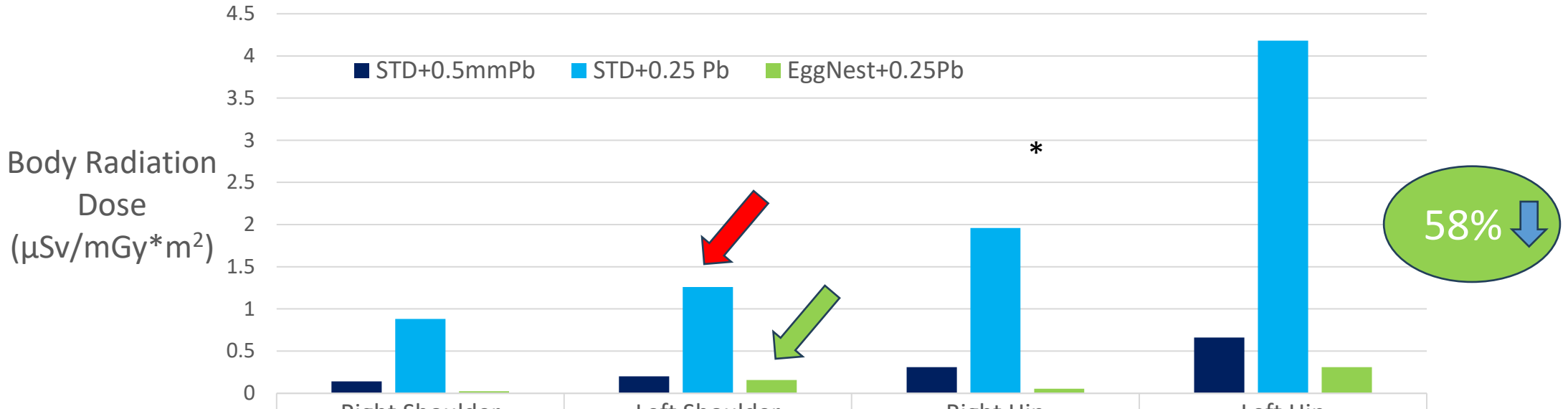
94% ⇩

*p<0.01 vs Standard Shielding

All Dose Values Reported as mean dose/DAP (µSv/$mGy*m$^2) ±SD

Effect of Using a 0.25mm Pb Apron on Body Radiation Dose

Compared to Standard Shielding and a 0.5mmPb Apron



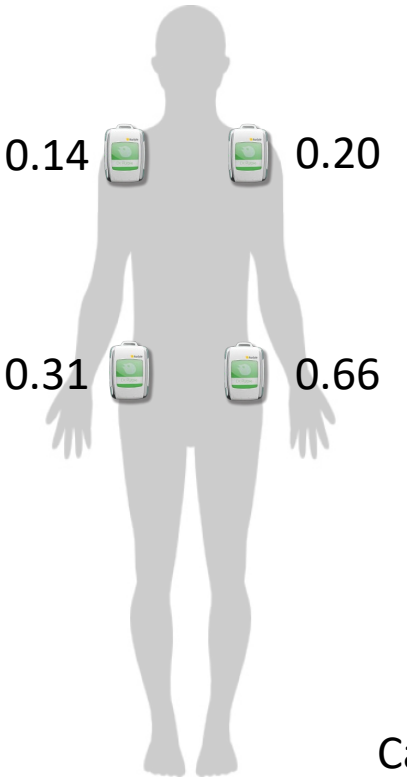
	Right Shoulder	Left Shoulder	Right Hip	Left Hip
STD+0.5mmPb	0.14	0.2	0.31	0.66
STD+0.25 Pb	0.88	1.26	1.96	4.18
EggNest+0.25Pb	0.022	0.158	0.054	0.31

Radiation transmission of a 0.5mm Pb apron is 3%
Calculated radiation transmission of a 0.25mm Pb apron is 19%
*EggNest+0.25mmPb apron dose = EggNest dose outside apron dose * 0.19

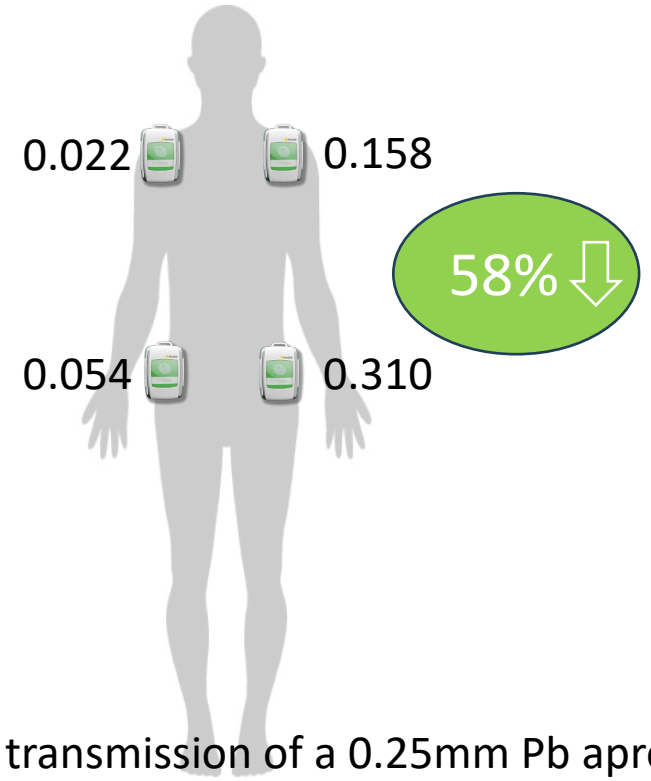
Half the weight,
58%+ more protection

Under Apron Radiation Dose Comparison

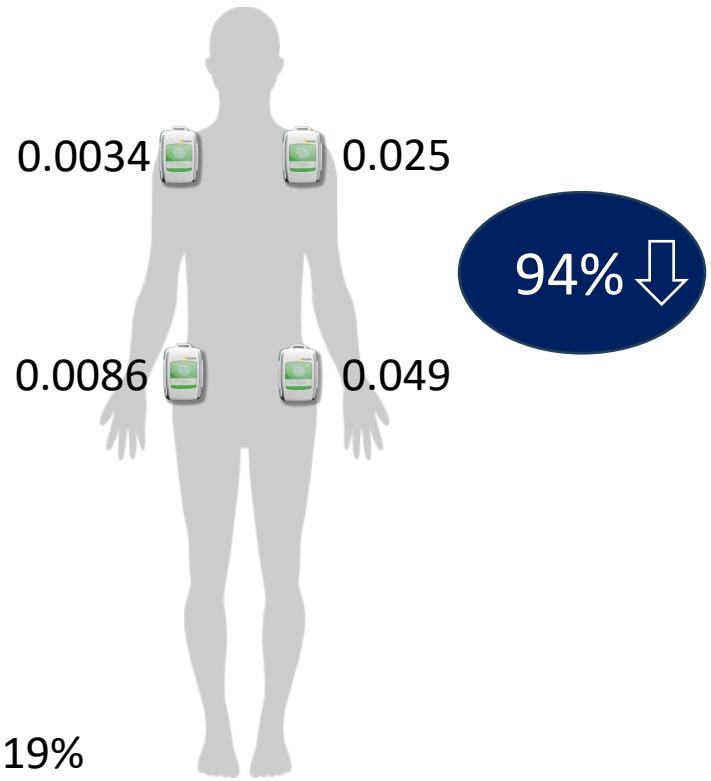
0.5 mm Pb Apron with Standard Shielding



0.25 mm Pb Apron with EggNest



0.5 mm Pb Apron with EggNest



Calculated radiation transmission of a 0.25mm Pb apron is 19%

All Dose Values Reported as Average Dose by DAP (µGy / $mGy{*}m$^2)

Conclusions

- 0.5mm Pb equivalent shielding apron transmits 3% of the incident x-ray photons (97% effective)
- The received body dose using a 0.5mm Pb apron and an EggNest™ Protect Shielding System is 94% less than standard shielding and a 0.5mm Pb apron
- The calculated body dose using a 0.25mm Pb apron (1/2 thickness) and an EggNest Protect shielding system is still 58% less than that using standard shielding with an apron that is twice the weight (0.5mm Pb)
- This study demonstrates that use of a Next-Generation Scatter Radiation Protection System can dramatically reduce operator radiation exposure
- Using Next-Generation Systems, operators may be able to markedly reduce the weight of additional protective equipment