Shielding other parts of the body sck cen

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Staff shielding of other parts of the body - 29/04/2022

"The experts say you shouldn't risk going out and driving on snow-covered roads this weekend"



https://spectrumlocalnews.com/nc/triad/news/2018/12/08/why-you-should-not-drive-on-snow-covered-roads-even-if-you-thinkyou-are-an-expert--have-good-equipment

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https://www.grit.com/community/travel/driving-in-snow-and-ice-zm0z16jfzreg/

3 Principles of radiation protection

• Time

• Distance

Shielding

Reference

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Siemens Healthineers.com,

ECR2022, Coronary Artery Disease: A glimpse into the future of coronary intervention

Many radiation protection devices available to the staff Some old ones



Schueler B, 2010, Tech Vasc Interv Radiol



mavig.com; lead apron



protechmed.com; Proguard Protex



infabcorp.com;TCV

Many radiation protection devices available to the staff And some more recent ones



McCutcheon et al 2021, Circ Cardiovasc Interv 2020

Reference





rampartic.com, M1128



biotronik.com; Zero-Gravity



Autminnie.com; BloXR

Effectiveness of shielding devices against X-ray during fluoroscopically-guided procedures: 3 possible approaches

Monte Carlo simulation



- Computer-aided calculations
- Dosimeters on and in staff phantom
- Numerous static configurations modelled

Measurements on staff



- Clinical procedures
- Dosimeters on staff (not in!)
- No organ dose measurements!
- Dynamic configurations

Phantom measurements



- Clinical settings
- Dosimeters on and in staff phantom
- Few static configurations

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ZG suspended system: dose reduction in all simulated configurations

- High protection to brain and eye lens (~-95%)
- Equivalent or better than lead apron for organs normally covered (but low doses anyway)
- Can be used in combination with other equipment
- Similar trends from measurements
- Ergonomics: no weight on shoulders but bulky and feet not visible

→ Steep learning curve

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Reference



biotronik.com; Zero-Gravity

- No recent studies but it worked for older models...
- Equivalent or better than lead apron for organs normally covered (but low doses anyway)
- Can be used in combination with other equipment
- Ergonomics: no weight on shoulders



rampartic.com, M1128

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Reference

Lead-free aprons : equivalent to lead apron in all simulated configurations

- No significant difference in effectiveness for organs in the chest region (effective dose):
 - Far from field: ~-80%
 - Close to field: ~-90%
- Ergonomics: effect of arm holes?
- Be aware of the real apron properties!
 - Not characterized by a single attenuation value!
 - Knowing the composition would be ideal!



Saldarriaga Vargas et al 2018 RPD

Lead-free aprons : Challenging to measure on staff

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Reference

• Difference (%) between monthly dosimeters above and under the aprons



Lead(-free) drapes: potential for dose reduction at least for the hands

- 62% and 30% decrease to the left and right hands on average (MC simulations)
- Very limited to no effect for other organs (including organs covered by aprons)
- Effect on chest exposure and eye exposure from clinical measurements?





Lead(-free) drapes: potential for dose reduction at other locations? Example from two hospitals

Reference

180 70 160 60 R Finger 140 mSv/Gy.m² -20% 50 120 **R** Finger mSv/Gy.m² -10% 40 100 L Eye 8 80 30 L Eye 0% 60 -50% 20 40 10 20 0 0 L Finger WB L Finger WB -30% -50% -40% -40% sck cen

80

McCutcheon et al 2021, Circ Cardiovasc Interv 2020

ISC: Restricted

Lead(-free) drapes: sensitive to position and design

- Drape closer to the X-ray field: increase dose reduction
- Hands above the drape

Reference

- Drape between staff and patient side
- → Need to be positioned between staff and X-ray source(s)
 - ≈ Staff in the "shadow" of the drape



McCutcheon et al 2021, Circ Cardiovasc Interv 2020

Lead(-free) drapes: sensitive to position and design

- No effect on patient organ dose
- Very local increase in superficial dose possible (fluorescence)
- If correctly positioned (ie outside primary beam)



And the hand cream?



Autminnie.com; BloXR

E	quipment type	Cost
C	Cap	€
F	ace mask	€€
G	Glasses	€€
T	hyroid collar	€
G	loves	€
L	ead-free aprons	€€
L	ead aprons	€€
D	Drapes	€ (disposable)/
		€€ (reusable)
Т	able-suspended	€€
С	urtain	
C	Ceiling-suspended	€€€
S	creen	
Z	ero-Gravity	€€€€
S	uspended system	
-		
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There is more than pure radiation protection effectiveness

Cost symbols are: € = €0 to €100, €€= €100 to €1000, €€€ = €1000 to €10000, €€€€ = €10000 to €100000

MEDIRAD recommendations

Main data sources



- MEDIRAD recommendations from task 2.2.3
 - <u>http://medirad-project.eu/recommendations/</u>
- MEDIRAD deliverable 2.19 and derived publications:
 - <u>http://medirad-project.eu/press-and-publications</u>
 - Efficacy of MAVIG X-Ray Protective Drapes in Reducing Operator Radiation Dose in the Cardiac Catheterization Laboratory: A Randomized Controlled Trial K. McCutcheon et al. Circ Cardiovasc Interv 2020
 - Evaluation of a suspended radiation protection system to reduce operator exposure in cardiology interventional procedures F. Zanca et al. Catheter Cardiovasc Interv 2021
 - Efficacy of MAVIG X-Ray Protective Drapes in Reducing CTO Operator Radiation K. McCutcheon et al. J Interv Cardiol 2021
 - Occupational exposure to physicians working with Zero-Gravity[™] system in haemodynamic and electrophysiology lab and the assessment of its performance against standard ceiling suspended shield. J. Domienik-Andrzejewska et al. Radiation and Environmental Biophysics 2022
 - The effect of lead free cap on the doses to the head of interventional cardiologists working in haemodynamic room. International Journal of Occupational Medicine and Environmental IJOMEH 2022
 - Evaluation of effectiveness of staff radiation protection devices for interventional procedures. Submitted to Phys Med
 - Do X-ray protective drapes increase patient exposure? Submitted to J Interv Cardiol

Device specific recommendations

- Separately for each tested devices
 - Lead and lead-free cap
 - leaded mask
 - Lead and lead-free drapes
 - light lead and lead-free aprons
 - Zero-gravity suspended system
- Also other common devices:
 - Ceiling-suspended screen
 - Lead glasses
- Pro and cons

Reference

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- Based on MEDIRAD results
- Completed with literature
- ~¹/₂ page per device



Main data sources



 EURADOS WG12 SG1 report: Individual Exposure and Monitoring in Interventional Radiology and Cardiology: <u>https://eurados.sckcen.be/documents-publications/reports-documents</u>

Main features of common equipment

Equipment type	Dose reduction level	Notes	Cost	References
Thyroid collar	Thyroid: 85% (80-92%)	Effectiveness strongly affected by proper fitting	€	ICRP139
Gloves	Hands: 0 - 60%	Risk of increase in patient and staff exposure if gloves in the primary x-ray field	€	ICRP139
		Risk of longer exposure duration due to loss of tactile sensitivity and dexterity		
Lead-free aprons ^a	Effective dose ^b : ~80% (70-95%)	Effectiveness depends on apron composition and irradiation conditions	€€	Huet et al 2022
		Lead-equivalence usually insufficient for estimating effectiveness		
Lead aprons	Effective dose ^b : ~80% (70-95%)		€€	Huet et al 2022
Drapes	Hands: ~40% (10-70%)	Dose increase if drape in primary beam	€ (disposable)/	Huet et al 2022
			€€ (reusable)	
Table-suspended curtain	Leg dose: ~70% (50%-95%)		€€	ICRP139
Ceiling-suspended	Hands: ~30% (10-70%)	Strongly affected by screen positioning	€€€	Koukorava et a
screen	Effective dose ^c : ~40%	Lead stripes at the screen bottom ease proper positioning		2011 and 2014
	Eye lens:~55% (20-90%)			Silva et al 2017
	Brain ^d : ~85% (75-95%)			
Zero-Gravity	Effective dose ^f : ~80%	Bulkiness of the Zero Gravity might limit its use for complex	€€€€	Huet et al 2022
suspended system	Eye lens: >=95%	and emergency procedures		
-	Brain: >=95%			Dragusin et al
Cabin ^e				2007,
EURA	DOS WG12 SG1 report: Individu	al Exposure and Monitoring in Interventional Radiolog	v and Cardiolog	ISC: Restricted

Main features of common equipment (cont'd)

Equipment type	Dose reduction level	Notes	Cost	References
Сар	Brain: ~35% (10-60%)	Strongly affected by exposure conditions Not all brain region protected	€	Huet et al 2022
Face mask	Brain: ~65% (0% - 70%) Eye lens: ~25% (0% - 80%)	Strongly affected by design and exposure conditions Not all brain region protected	€€	Huet et al 2022
Glasses	Eye lens: ~50% (25-90%)	Strongly affected by design and exposure conditions	€€	Koukorava et al 2011 and 2014

EURADOS WG12 SG1 report: Individual Exposure and Monitoring in Interventional Radiology and Cardiology

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