RSNA 2024
Building Intelligent Connections

Uniklinikum Würzburg

REAL-TIME DOSIMETRY IN INTERVENTIONAL RADIOLOGY

Comparing scatter radiation dose in lower extremity and abdominal procedures

Kristina Krompaß

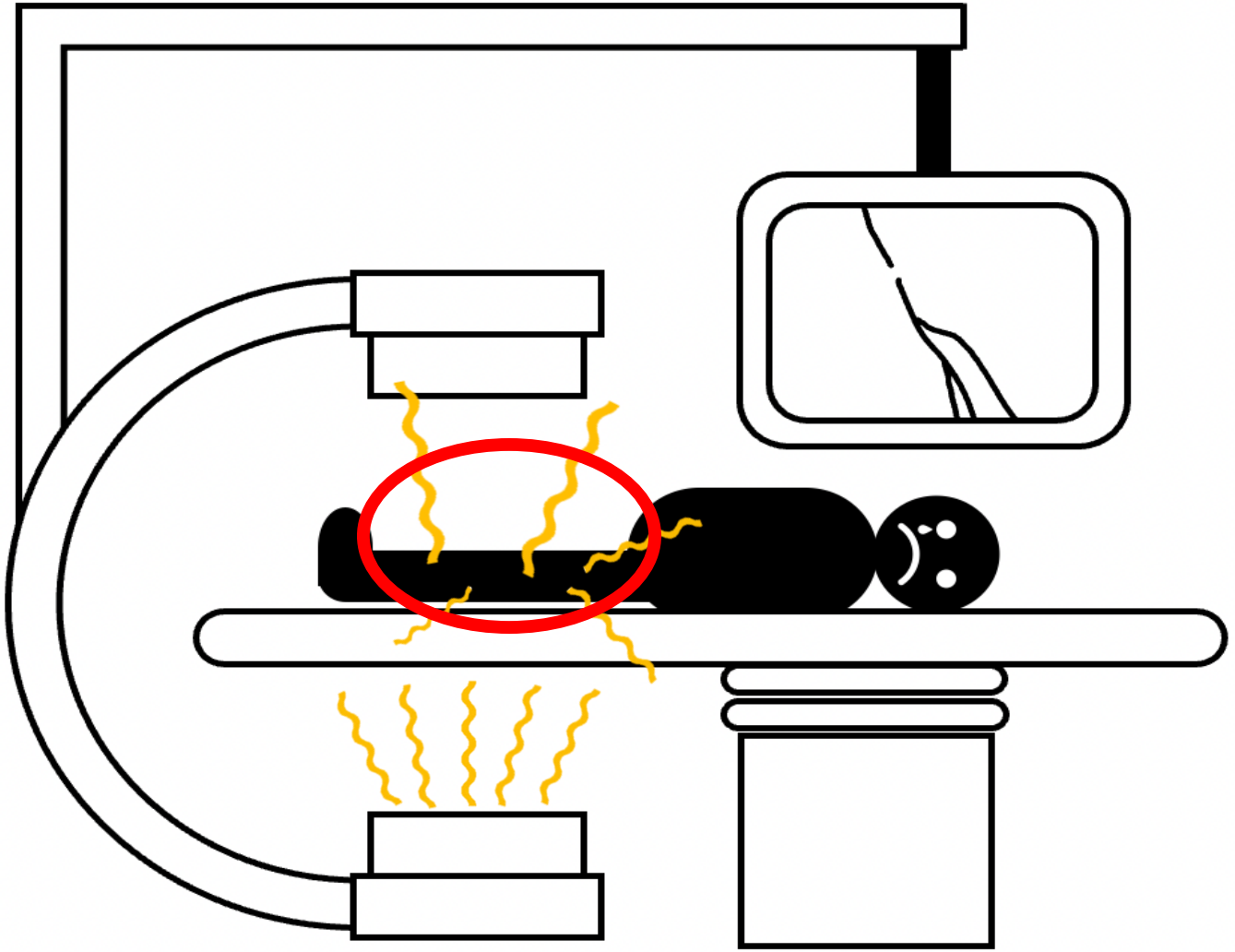
Department of Diagnostic and Interventional Radiology
Chair: Prof. Dr. Thorsten Bley

Institut für Diagnostische und Interventionelle Radiologie

- Background
- Objective
- Material & Methods
- Limitations
- Results
- Conclusion

nothing to declare.

Background:

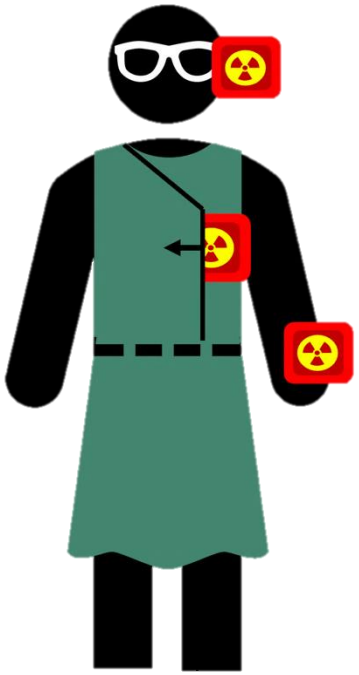


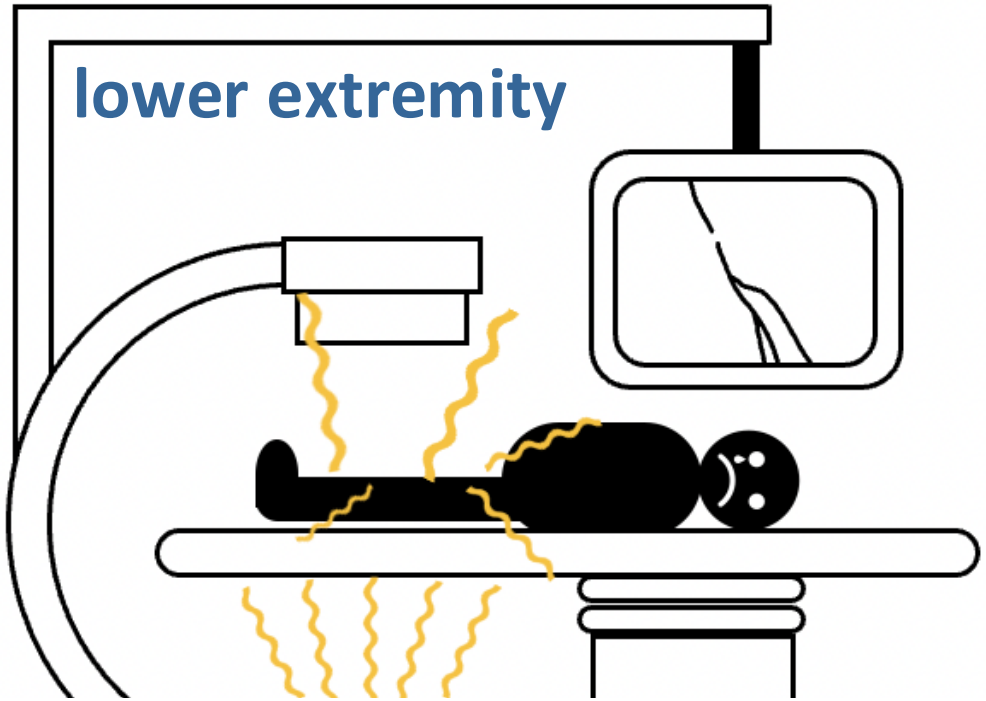
- Any interventions comes with radiation exposure for patients and clincal staff.
- Interventionalists stand close to primary radiation source, but the risk comes primarly from **scatter radiation** deflected by the patient. [1, 2]
- Lack of information on the equivalent doses of the **radiation-sensitive anatomy** (e.g. eye-lens).

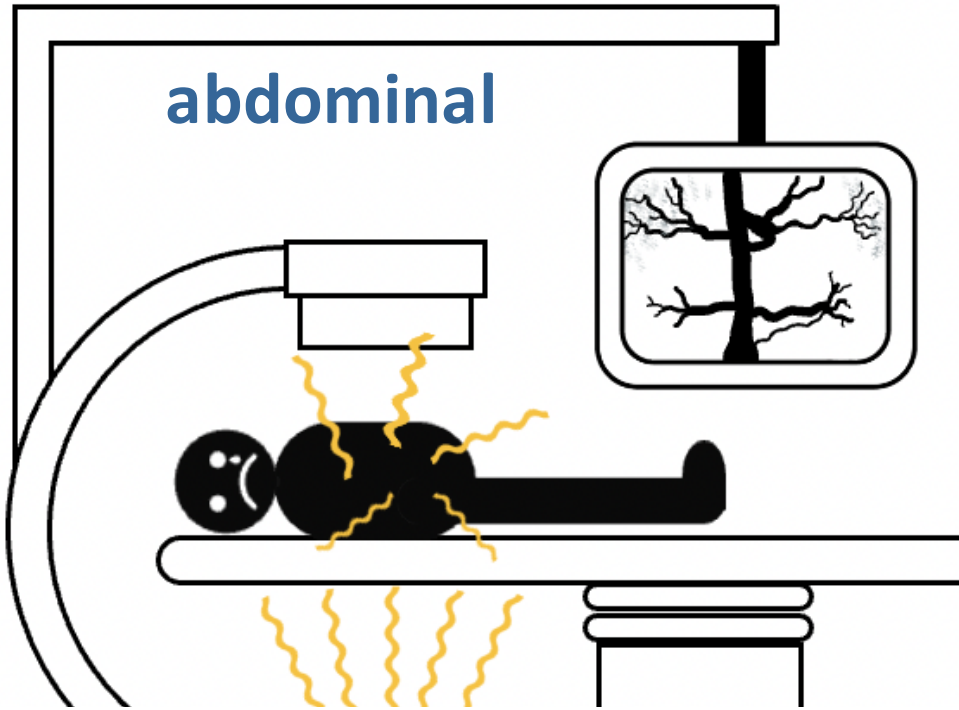
Objective:

Uniklinikum Würzburg

Comparsion of **the occupational dose exposure** of interventional radiologists' **cranium/eye lens**, **hand**, and **body trunk** during lower extremity and abdominal procedures







Material and Methods:

Uniklinikum Würzburg

Study concept

- Single center, 14 month
- 102 procedures

51 lower extremity	51 abdominal
DSA with or without PTA	transarterial chemoembolization adrenal venous sampling embolizations prior to SIRT

- 58 male
- Majority between 61 and 80 years
- No significant difference in height, weigth or BMI (most patients pre-obese)

Material and Methods:

Uniklinikum Würzburg

Standardized radiation protection

Interventionalist

- protective glasses (lead equivalent of 0.5 mm)
- thyroid shielding (0.5 mm)
- vest (0.35 mm)
- skirt (0.25 mm) by

Room equipment

- lead curtain (0.5 mm) on the patients table on the side of examiner
- movable lead acrylic shield (0.5 mm)

Material and Methods:

Uniklinikum Würzburg

Dosimeter placement

3 real-timedosimeters

RaySafe i2, Unfors RaySafe AB, Hovås, Sweden

- **cranium/eye lens (side of the x-ray tube)**
- **under the vest**
- **supporting hand**

Uniklinikum Würzburg

Dosimetry system details

- dose rate range of 40 µSv/h – 300 mSv/h
- dose response time of < 1 second above 100 µSv/h and of < 5 seconds otherwise
- dose equivalent quantity $H_p(10)$, which represents the dose recieved at a 10 mm depth from the skin [5]

Uniklinikum Würzburg

Dosimetry system details

- The vendor recommends the use of RaySafe i2 dosimeters outside the protective gear.

- Angular dependency:

  dose response variability of ± 5% for 5°, ± 30% for 50%, and +200%/-, 100% for 90° [5]

- Deep dose equivalent $H_P(10)$ is not the primary option for eye lens and hand dosimetry:

  For these measurement sites, obtaining $H_P(3)$ and $H_P(0.07)$ at 3 and 0.07 mm from the body surface would have been desirable

Results:

Uniklinikum Würzburg

Radiation analysis

overall:

- median exposure time: 525 seconds [378 – 941 seconds]
- dose-area product 18.3 Gy × cm2 [5.3 – 51.2 Gy × cm2]

lower extremity

- 462s [258 – 618]
- 5.3 Gy × cm^2 [3.6– 7.6]

abdominal

- 762s [462 – 1,200]
- 51.4 Gy × cm2 [39.4 – 111.4]

Results:

Uniklinikum Würzburg

Radiation analysis

overall:

- median exposure time: 525 seconds [378 – 941 seconds]
- dose-area product 18.3 Gy × cm2 [5.3 – 51.2 Gy × cm2]

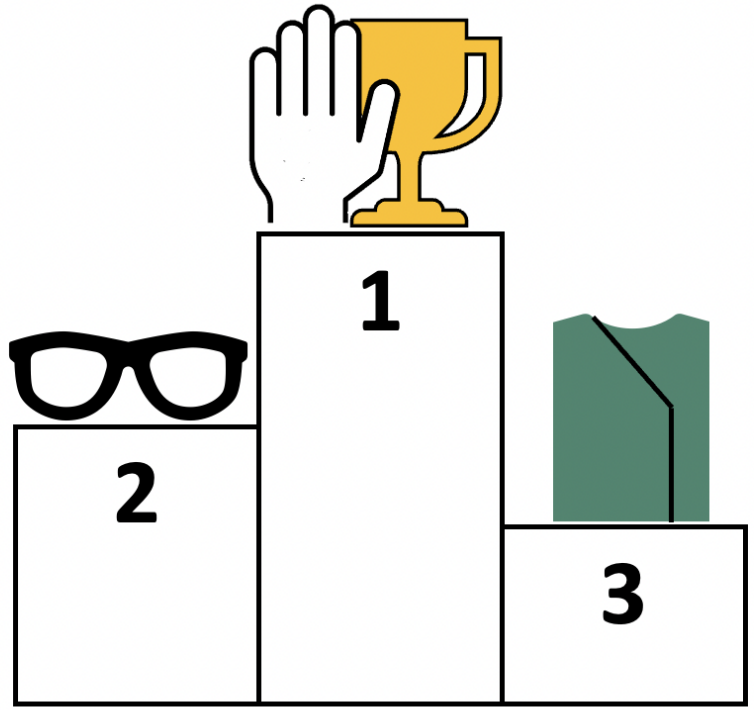
lower extremity		abdominal
462s [258 – 618]	almost x2	762s [462 – 1,200]
5.3 Gy × cm^2 [3.6– 7.6]	almost x10	51.4 Gy × cm2 [39.4 – 111.4]

Results:

Uniklinikum Würzburg

Radiation analysis

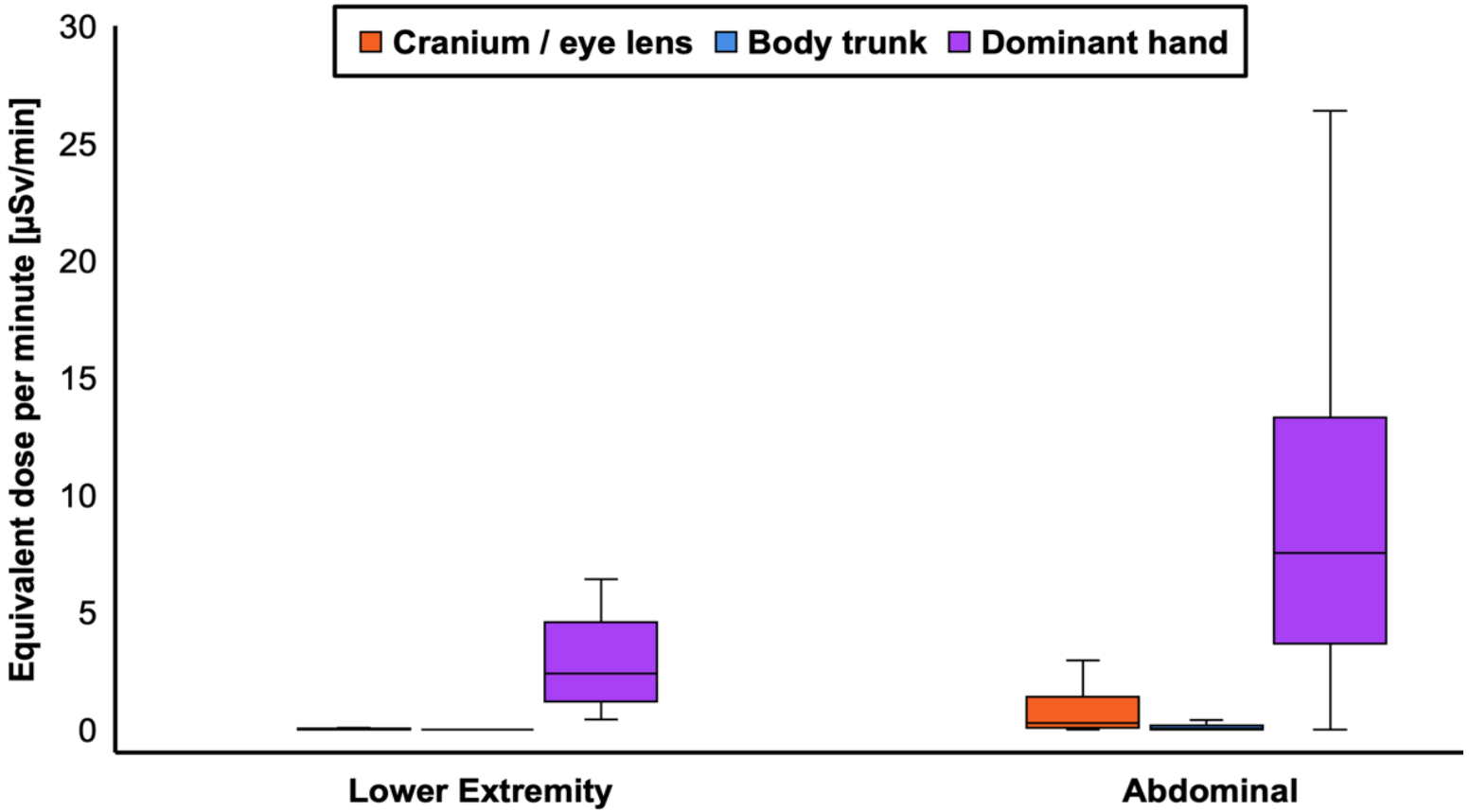
	Equivalent dose [µSv]	Equivalent dose over time [µSv/min]
Overall		
Cranium/eye lens	0.44 (0.06 – 5.92)	0.06 (0.01 – 0.41)
Body trunk	<0.01 (<0.01 – 0.46)	<0.01 (<0.01 – 0.04)
Supporting hand	35.83 (14.45 – 120.56)	4.42 (1.92 – 10.35)



Uniklinikum Würzburg

Radiation analysis

Time – corrected equivalent dose

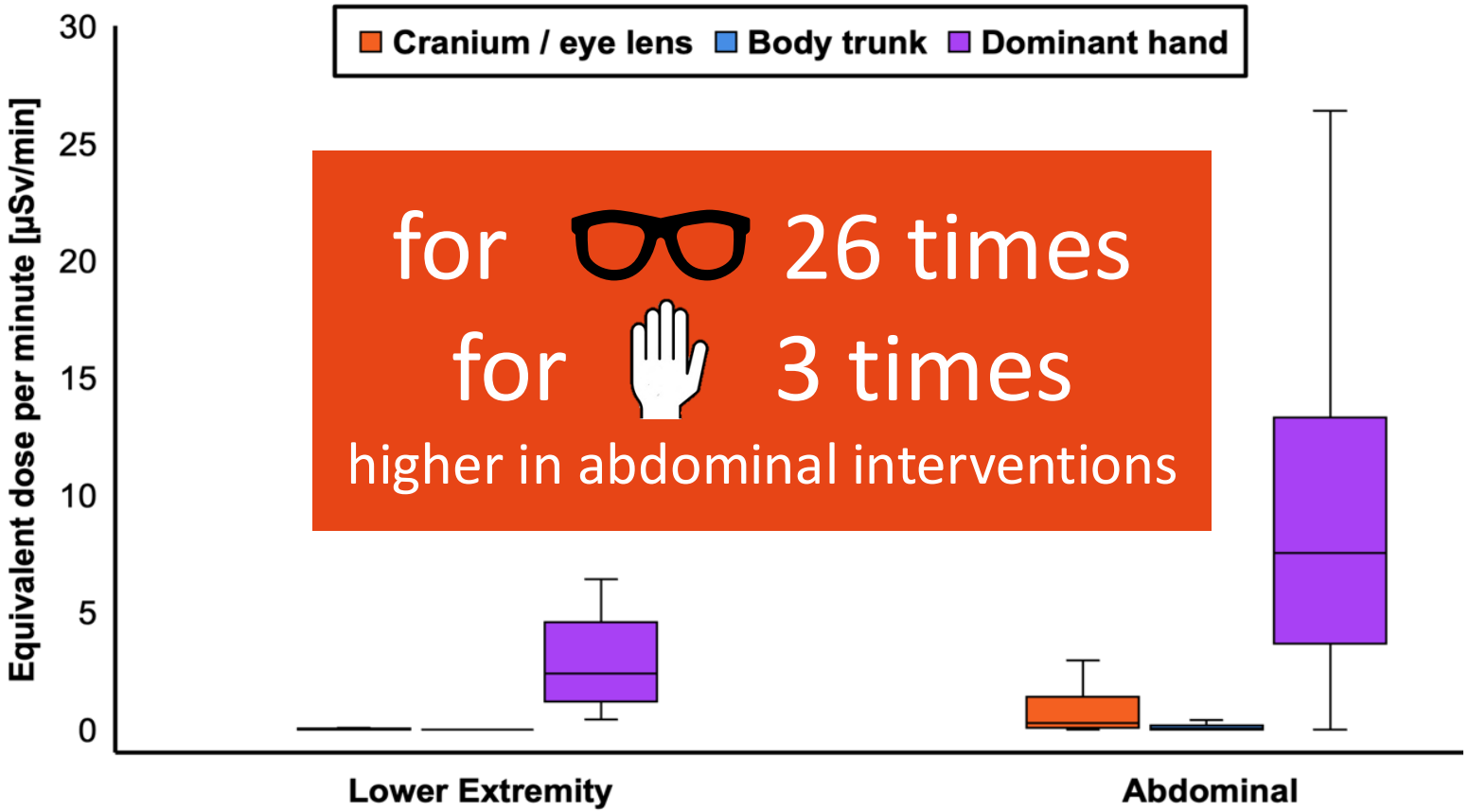


lower extremity	abdominal
0.01µSv/min [<0.01 – 0.04]	0.26µSv/min [0.08 – 1.25]
2.45µSv/min [1.21 – 4.55]	7.54µSv/min [3.86 – 13.13]

Uniklinikum Würzburg

Radiation analysis

Time – corrected equivalent dose



lower extremity	abdominal
0.01µSv/min [<0.01 – 0.04]	0.26µSv/min [0.08 – 1.25]
2.45µSv/min [1.21 – 4.55]	7.54µSv/min [3.86 – 13.13]

Uniklinikum Würzburg

Radiation analysis

EURATOM-guideline 2013/59 § 78 (2) StrSchG [6,7]:

- annual equivalent dose for the eye lens: 20mSv
- annual equivalent dose for the hand: 500mSv

Results:

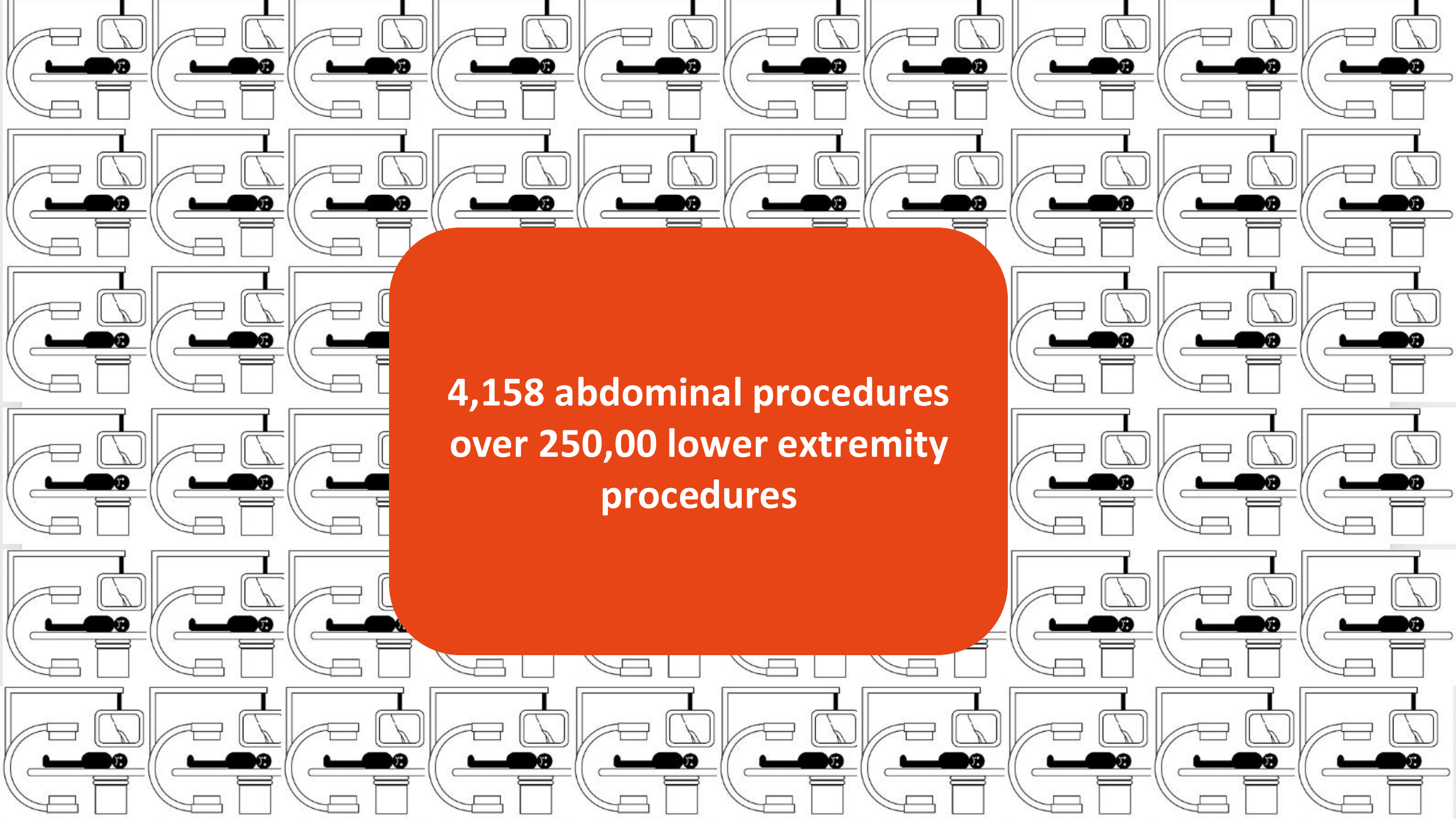
Uniklinikum Würzburg

Radiation analysis

EURATOM-guideline

- annual equivalent
- annual equivalent

4,158 abdominal procedures over 250,00 lower extremity procedures


4,158 abdominal procedures
over 250,00 lower extremity
procedures

4,158 abdominal procedures over 250,00 lower extremity procedures

Conclusion:

Uniklinikum Würzburg

Dose monitoring in real time is key to understand the radiation burden of different anatomical features.

Real-time dosimetry confirmed **sufficient radiation protection** with the application of dedicated safety measures even in dose-intensive abdominal procedures.

Interventionalists' **supporting hands** are subjected **to the highest radiation exposure**, followed by the cranium/eye lens and the body trunk.

Thank you for your attention!

Sources:

1. Adamus R, Loose R, Wucherer M, et al (2016) [Radiation protection in interventional radiology]. Radiologe 56:275–281. https://doi.org/10.1007/s00117-016-0083-0

2. Park S, Kim M, Kim JH (2022) Radiation safety for pain physicians: principles and recommendations. Korean J Pain 35:129–139. https://doi.org/10.3344/kjp.2022.35.2.129

3. RaySafe i2 System User Manual. https://www.raysafe.com/sites/default/files/2018-12/5001047-raysafe-i2-system_manual-en-4.1_0.pdf. Accessed 1 Nov 2024

4. European Society of Radiology (ESR) (2015) Summary of the European Directive 2013/59/Euratom: essentials for health professionals in radiology. Insights Imaging 6:411–417. https://doi.org/10.1007/s13244-015-0410-4

5. Authors on behalf of ICRP, Stewart FA, Akleyev AV, et al (2012) ICRP publication 118: ICRP statement on tissue reactions and early and late effects of radiation in normal tissues and organs--threshold doses for tissue reactions in a radiation protection context. Ann ICRP 41:1–322. https://doi.org/10.1016/j.icrp.2012.02.001