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Institutional diagnostic reference levels in complex interventional radiology procedures

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1. Introduction

- Interventional Radiology (IR) procedures are among those potentially delivering significant radiation doses to the patients, optimization of these procedures is therefore essential.

- Diagnostic Reference Levels (DRLs) offer a valuable tool towards the optimization of patient radiation dose in all radiology practices.

- The objective of this study is to report Institutional (local) Diagnostic Reference levels (DRLs), in order to aid in optimizing the protection of patients and to contribute to the establishment of the national DRLs in Interventional Radiology (IR) procedures.

2. Materials & Methods

- 276 patients who underwent diagnostic or therapeutic interventional radiology (IR) procedures at the Radiology Department of 424 General Military Hospital of Thessaloniki from 01/2022 to 12/2023 were included in the study.

- All procedures were performed at SIEMENS ARTIS ZEE DFA Angiography system.

- Quality assurance measurements, including fluoroscopy and acquisition incident air kerma rate, fluoroscopy and acquisition flat panel incident air kerma rate, high contrast and low contrast resolution and Dose Area Product (DAP) accuracy, were routinely performed at the Angiography system.

2. Materials & Methods

- Four (4) types of IR procedures were selected to be included in the study, based on a) their higher frequency and b) the high radiation doses they delivere to the patients. These procedures were:

1. Brain Aneurysm Embolization, BAE (16 patients),
2. Peripheral Embolization, PE (77 patients),
3. Peripherally Inserted Central Catheter, PICC (115 patients) and
4. Port Catheter insertion, PC (45 patients).

2. Materials & Methods

- Detailed dose reports, as provided by the system, were collected for all patients including:
  - Air Kerma area product, P_{KA} (mGy m^2)
  - Air Kerma at the patient entrance reference point, $K_{a,r}$ (mGy)
  - Fluoroscopy Time, FT (min)

- Statistical analysis was performed, using IBM SPSS 26 software. Shapiro-Wilk or Kolmogorov-Smirnov normality tests were performed, depending on the number of patients in each procedure.

- The diagnostic reference levels for each diagnostic and therapeutic IR procedure were determined as the 75th percentile value of the distribution of each sample.

3. Results - Institutional DRLs

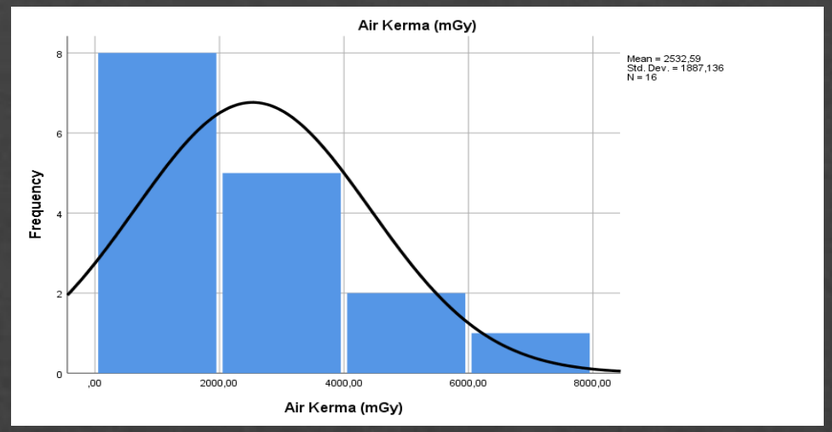
(1) Brain Aneurysm Embolization (BAE)

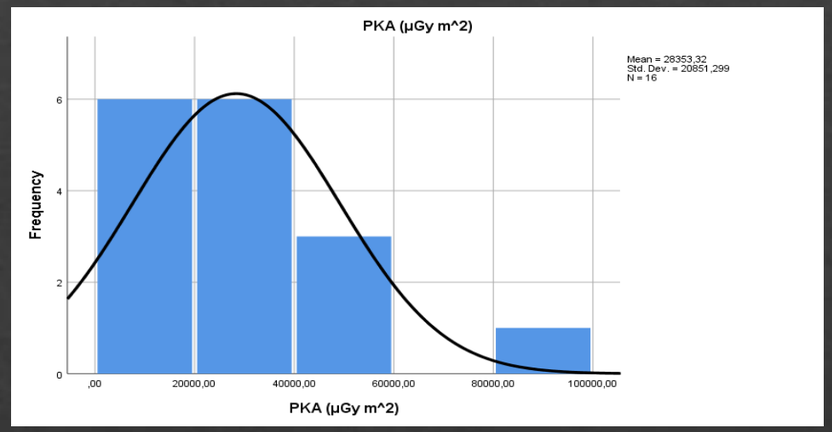
- P_{KA}: 44.0 mGy m^2
- $K_{a,r}$: 3547 mGy
- FT: 54.05 min

(2) Peripheral Embolization (PE)

- P_{KA}: 32.1 mGy m^2
- $K_{a,r}$: 1620 mGy
- FT: 39.55 min

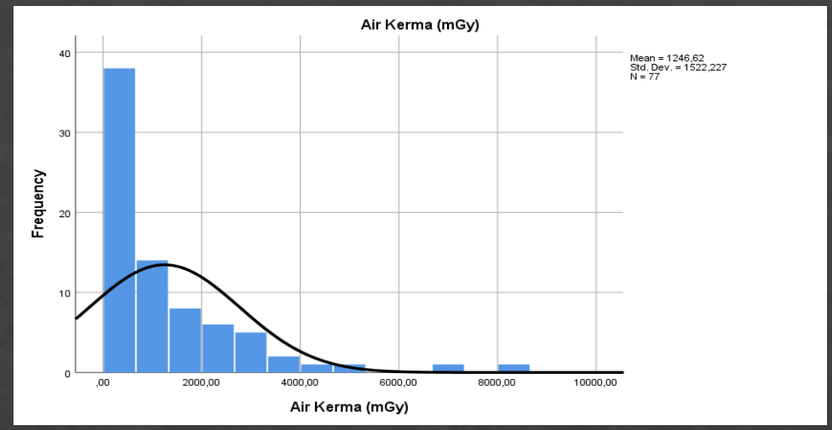
(1)

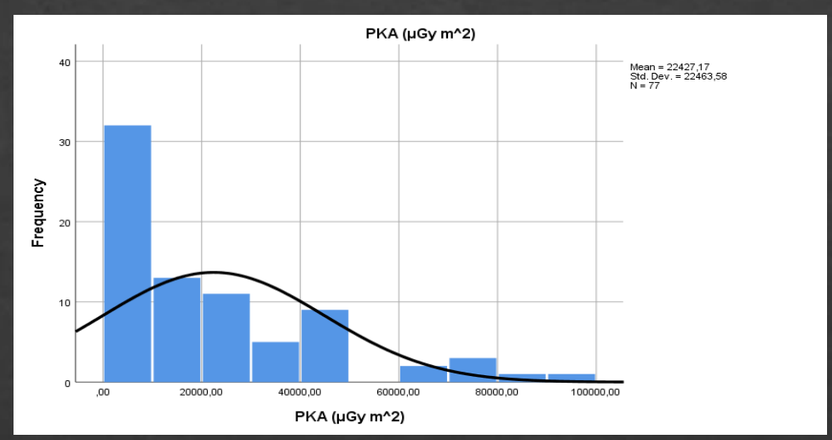




		FLUORO TIME (min)	PKA (µGy m^2)	Air Kerma (mGy)
N	Valid	16	16	16
	Missing	0	0	0
Mean		45,5788	28353,3219	2532,5938
Std. Error of Mean		3,75231	5212,82483	471,78402
Median		50,5500	22174,0000	1933,0000
Std. Deviation		15,00925	20851,29930	1887,13608
Variance		225,278	434776682,504	3561282,577
Percentiles	75	54,0500	44006,0000	3547,0000

(2)





		FLUORO TIME (min)	PKA (µGy m2)	Air Kerma (mGy)
N	Valid	77	77	77
	Missing	0	0	0
Mean		30,1299	22427,1727	1246,6182
Std. Error of Mean		2,36521	2559,96247	173,47381
Median		24,4000	15921,0000	667,7000
Std. Deviation		20,75466	22463,57952	1522,22655
Variance		430,756	504612404,929	2317173,661
Percentiles	75	39,5500	32075,0000	1620,0000

3. Results - Institutional DRLs

Significantly lower values were found for the less complex procedures

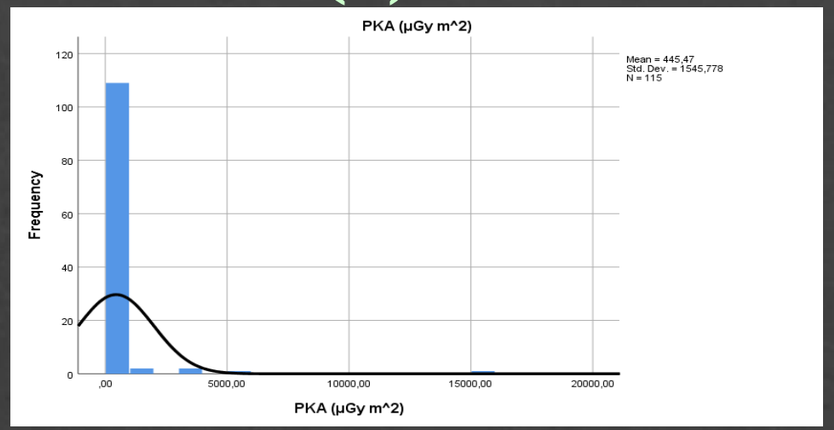
(3) Peripherally Inserted Central Catheter (PICC)

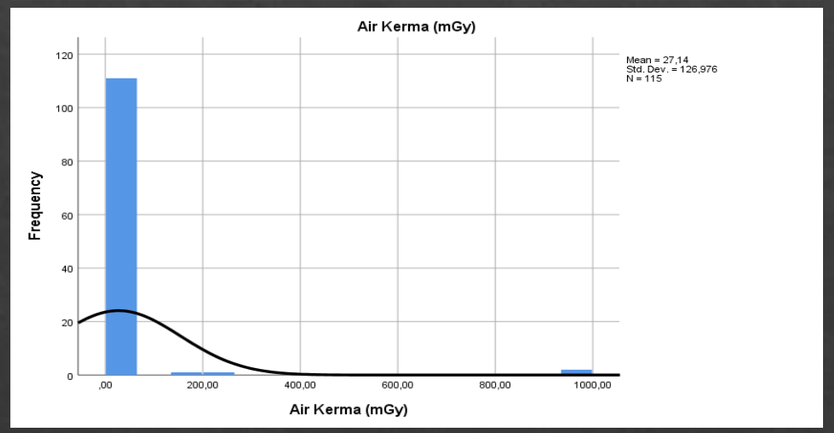
- P_{KA}: 0.282 mGy m²
- $K_{a,r}$: 9.5 mGy
- FT: 2.20 min

(4) Port Catheter insertion (PC)

- P_{KA}: 0.205 mGy m²
- $K_{a,r}$: 7.9 mGy
- FT: 1.35 min

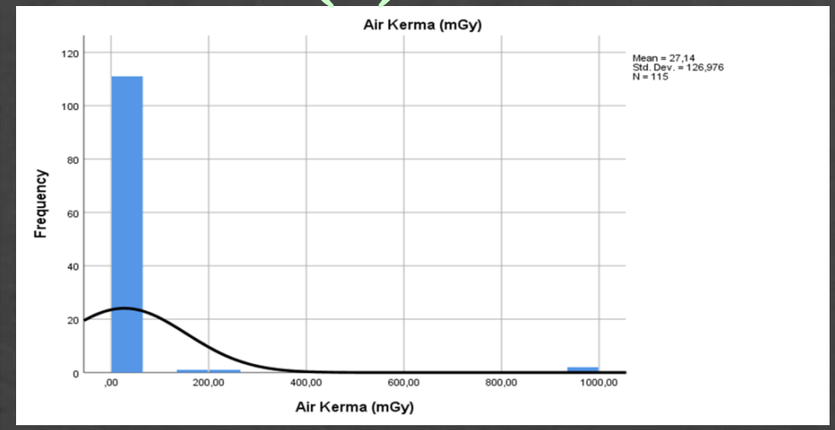
(3)

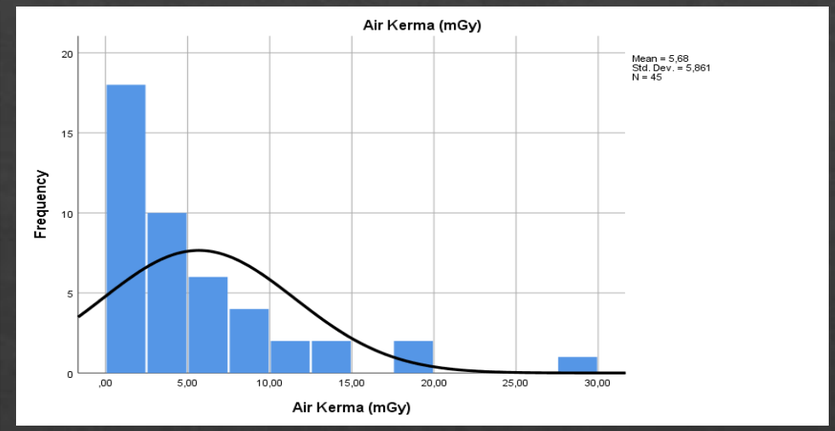




		FLUORO TIME (min)	PKA (µGy m2)	Air Kerma (mGy)
N	Valid	115	115	115
	Missing	0	0	0
Mean		2,0304	445,4676	27,1374
Std. Error of Mean		0,22449	144,14458	11,84060
Median		1,2000	139,2700	5,5000
Std. Deviation		2,40734	1545,77843	126,97624
Variance		5,795	2389430,966	16122,966
Percentiles	75	2,2000	281,9300	9,5000

(4)





		FLUORO TIME (min)	PKA (µGy m2)	Air Kerma (mGy)
N	Valid	45	45	45
	Missing	0	0	0
Mean		0,9933	150,2329	5,6764
Std. Error of Mean		0,11247	24,37151	0,87375
Median		0,8000	105,5800	3,5000
Std. Deviation		0,75450	163,48903	5,86131
Variance		0,569	26728,664	34,355
Percentiles	75	1,3500	204,6150	7,9500

4. Conclusions

- Institutional DRLs for the selected IR procedures were established and compared to published values.
- Results indicate that there are IR procedures that result in significant radiation exposure to the patient and more investigation in these procedures is essential.
- Resulted DRLs for BAE were higher than PE due to the complexity of the procedure.
- Resulted DRLs do not differ significantly from those found in the literature
- Data collection is ongoing, and differences between Interventional Radiologists will be explored and reported.
- A wider collection of data from other institutions is needed in order for National DRLs to be established.

5. References

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