Personal and environmental dosimetric measurements using TLD method in Cardiac Catheterization Laboratory (CathLab) at the Rzeszow's Regional Hospital No 2, Poland

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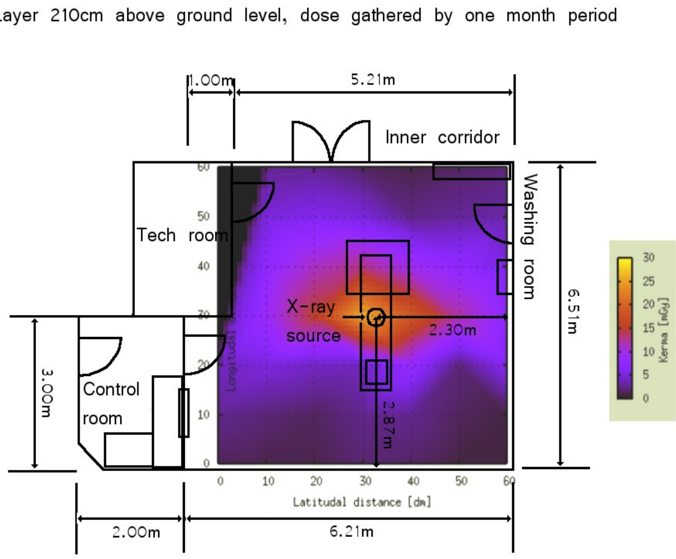
Introduction

According to Euroatom directive 96/29 Basic Safety Standards – on the protection of workers and general population against danger arising from ionizing radiation, Euroatom directive 97/43 Basic Safety Standards – on health protection of individuals against danger of ionizing radiation in relation to medical exposure, Polish Atomic Law (in Polish: Dz. U. Nr 161:2004, poz. 1689), Regulation of Polish Ministry of Health about safe using of ionizing radiation in medical exposures (in Polish: Dz. U. Nr 194:2005, poz. 1625). Health Care Centers using X-ray equipment in diagnostics and interventional cardiology, are obligated to optimize radiological exposures and to perform employee and patient dosimetry and necessary quality control tests. This work has for it's main goal performing environmental and personal dosimetry, during interventional cardiology procedures. Such measurements are especially important for the Cathetery Lab. employees. Determining the most dangerous areas in the workplace, will help minimizing of the radiation influence on employees organisms.

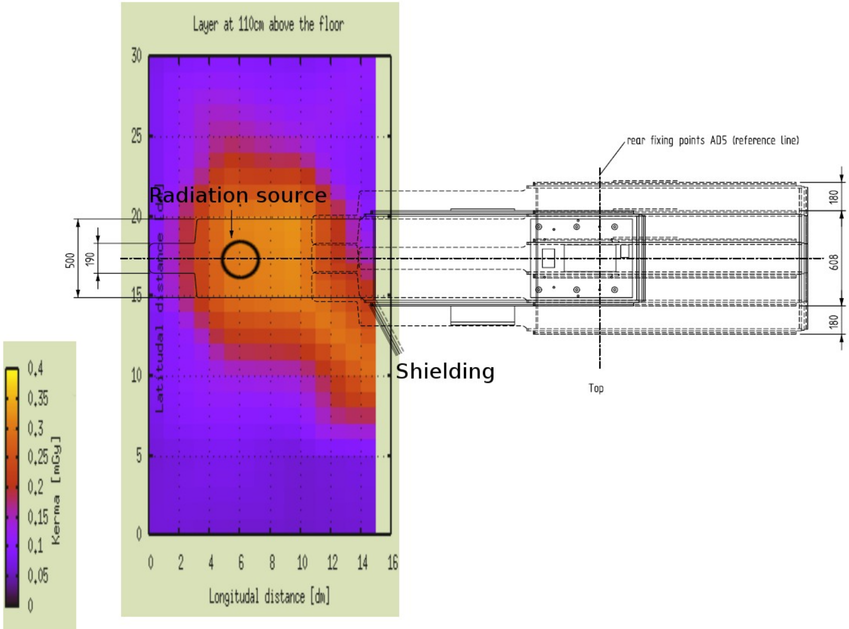
Materials, methods and results

Three dimensional radiation distribution was measured in two stages. First – monthly "in vivo" measurements using MCP-N (LiF:Mg,Cu,P) detectors, grouped by three in environmental dosimeters. Grid of about 100 detecting points was designed to measure X-ray dose distribution present during interventional cardiology procedures. Most dosimeters were located at 210 cm level from the floor, because of not disturbing every day working. The rest was put on the available parts of equipment. After one month dosimeters were removed and the results were shown on the following diagram:

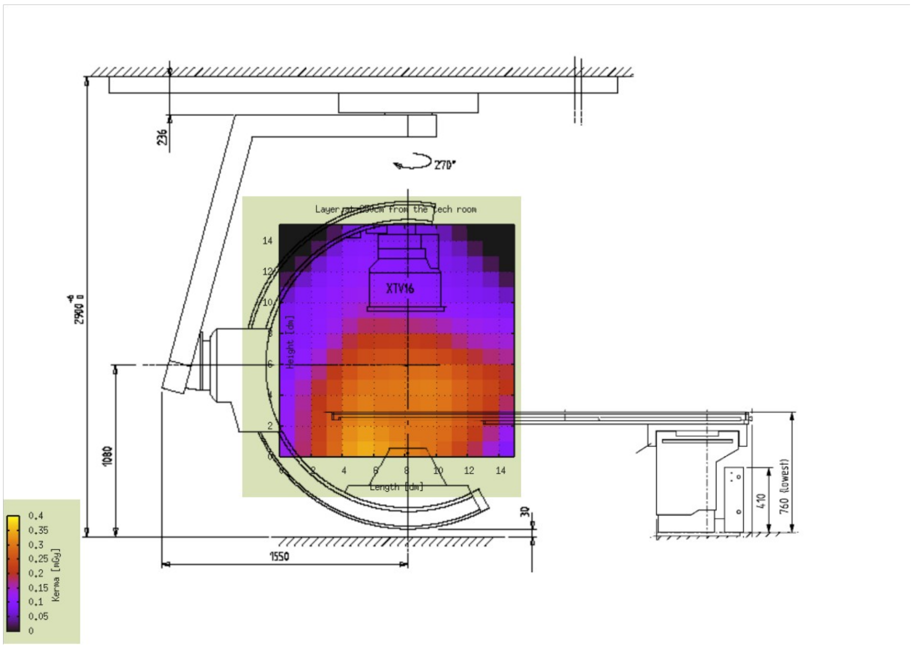


Picture 1: Illustration of monthly Kerma in air distribution in cathetery lab.

The second stage of experiment was based on four TL detectors curtains. Dose distribution was measured only in the cube of 3,5x2x2m around the X-ray tube. Such procedure was made to get more information about radiological danger near the tube and operating table. To avoid disturbance of staff's work, one have used a water phantom to simulate the patient's body. For every curtain was made complete set of projections used in coronaro-artery imaging. Chosen results of interpolated dose distribution graphs are presented on the pictures 2 and 3.

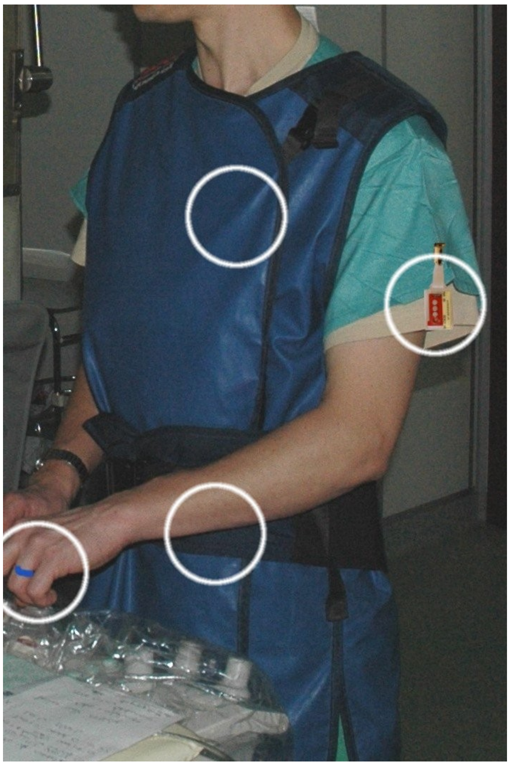


Picture 2: Horizontal Kerma in air distribution chart. Measurements at level 110 cm, scattering from physicians shielding visible.



Picture 3: Vertical Kerma in air distribution. Layer next to the right side of the patient's table, 250 cm from the tech room wall.

Personal dosimetry for employees has been made using TLD's during haemodynamics procedures. Every employee (physicians, nurses, technicians) has received three individual dosimeters, based on high sensitive MCP-N detectors and one ring type dosimeter. The main dosimetry was done for whole body covered by lead gown (one dosimeter on a chest and additional on a belt). Remaining dosimeter was worn on the left arm (not covered by lead gown). Dosimeter locations are shown at picture 4.



Picture 4: Localisations of staff's dosemeters (photo by authors).

The averaged results are gathered in table below.

Monthly mean dose equivalent Hp(10) [mSv] on:	Nurses	Physicans	Technicans
Belt	0,21	0,19	-
Chest	0,18	0,29	0,17
Arm	0,98	3,85	0,32

Yearly mean dose equivalent Hp(10) [mSv] on:	Nurses	Physicans	Technicans
Belt	2,55	2,22	-
Chest	2,1	3,44	2,04
Arm	11,73	46,18	3,84

Table 1: Averaged results of staff dosimetry.

The patient dosimetry was made for 11 clinical cases, using similar dosimeters as for the staff. Every patient got three dosimeters for different body parts (head, chest and pelvis/gonads).

The received results varies strongly from case to case. The example results are shown below.

Example no: 1	**Example no: 2**
Procedure: coronarography + deobstruction of LAD Exposure time: 38 minutes Absorbed dose equivalent on: head: 5,85 mSv chest: 80,02 mSv pelvis/gonads: 1,4 mSv	Procedure: coronarography Exposure time: 1,2 minutes Absorbed dose equivalent on: head 0,41 mSv chest: 2,35 mSv pelvis/gonads: 0,05 mSv

Mean values for coronarographys are listed below. For interventional procedures values couldn't be averaged, because of lack of uniformity.

Mean radiation time: **5,13** minutes

Mean absorbed dose equivalent on:

head: **1,11** mSv, SD=1,13 mSv,

chest: **9,89** mSv, SD=6,31 mSv,

pelvis/gonads: **0,16** mSv, SD=0,09 mSv.

Mean dose rates:

head: **0,22** mSv/min, SD=0,22 mSv/min,

chest: **1,93** mSv/min, SD=1,23 mSv/min,

pelv./gon.: **0,03** mSv/min, SD=0,02 mSv/min.

High variation is caused by wide clinical specificity. Small test group and differences in body shape (fat or slender patients) influences the set up tube parameters (kV and mA).

Conclusions

During environmental measurements one have noticed, that on the level of 210cm above the floor Kerma in air distribution is a result of X-ray tube movement. Most of measured Kerma comes from direct beam and a contribution of patient scattered radiation is negligible.

At lower levels (60cm, 110cm and 160cm) measured Kerma incorporates radiation from direct beam and also radiation scattered from patient's body (a phantom in our experiment).

Staff dosimetry brought following conclusions:

- Although exposure time for nurses is much shorter than for physicians, nurses are getting a higher dose on the belt level, and similar on the chest.
- Nurses are mostly affected by radiation scattered from patient's body.
- Estimations of whole body absorbed dose equivalent based on dosimeters located on the chest underestimate exposure for nurses.
- Estimations based on belt should give better result for nurses, due to dose distribution around angiograph. For physicians, chest based estimations give true results.

Patient's dosimetry only conclusions were that the population used for measurements was too small to obtain unquestionable results. Very big diversity of used procedures causes big differences in absorbed dose equivalents. Due to automatic exposure settings based on patient's chest thickness any normalizations should be done with knowing that parameter.