

Staff Doses in Interventional Cardiology

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Background

The use of fluoroscopy guided procedures in cardiology is increasing and therefore the National Institute of Radiation Protection in Denmark (NIRP) would like to investigate whether the doses to the staff at Danish Hospitals are sufficiently monitored. Especially doses to the hands and eyes are of concern, because the staff is working close to the patient and the X-ray tube during the procedures.



Material

The project was carried out in cooperation with cardiology laboratories at two public hospitals in Denmark. Hospital 1 was monitored in 1 month, and Hospital 2 was monitored in 3 months.

The Staff is routinely monitored with film badges worn under the lead apron. In addition, the persons in the study wore an extra film badge placed on the shoulder above the lead apron.

The effective doses to the staff were calculated using the dosimetric algorithm proposed by Niklason et al¹. The algorithm requires the use of two dosimeters worn over the apron at the neck level and under the apron at the waist level, respectively.

When a thyroid shield is not worn, the effective dose is:

$$E = 0,06 (Hp(0,07)_{\text{over apron}} - Hp(10)_{\text{under apron}}) + Hp(10)_{\text{under apron}}$$

When a thyroid shield is worn, the effective dose is:

$$E = 0,02 (Hp(0,07)_{\text{over apron}} - Hp(10)_{\text{under apron}}) + Hp(10)_{\text{under apron}}$$

Extremity doses were monitored by means of ring TLD dosimeters, and the doses to the eyes were estimated by the dosimeters placed on the shoulder over the apron.

In total, 44 persons participated in the study, and NIRP received valid data from 33 persons.

Results

Results from Hospital 1. The hospital was monitored in one month

Hospital 1 Staff	Number of Performed Procedures (1 month)	Estimated Eye Doses (mSv)	Effec.Doses Niklason w.o. thyroid shield (mSv)	Effec.Doses Niklason with thyroid shield (mSv)
Cardiologist 1	15	1,2	0,26	0,22
Cardiologist 2	45	3	0,27	0,16
Cardiologist 3	24	16	1,34	0,71
Cardiologist 4	16	1,4	0,18	0,13
Cardiologist 5	16	1,2	0,17	0,12
Cardiologist 6	-	0,1	0,01	0,0
Nurse 1	24	0,2	0,11	0,10
Nurse 2	20	0,2	0,01	0,0
Nurse 3	52	0,4	0,02	0,01
Nurse 4	63	0,7	0,04	0,01
Nurse 5	34	0,3	0,02	0,01
Nurse 6	58	0,4	0,02	0,01
Nurse 7	5	0,9	0,05	0,02
Nurse 8	26	1,4	0,18	0,13
Nurse 9	-	5	0,3	0,1
Nurse 10	45	0,4	0,02	0,01
Nurse 11	22	1	0,06	0,02
Nurse 12	16	0,3	0,11	0,10
Nurse 13	34	0,2	0,01	0,0

Results from Hospital 2. The hospital was monitored in three months.

Hospital 2 Staff	Number of Performed Procedures (3 months)	Estimated Eye Doses (mSv)	Effec.Doses Niklason w.o. thyroid shield (mSv)	Effec.Doses Niklason with thyroid shield (mSv)
Cardiologist 1	41	2,5	0,15	0,050
Cardiologist 2	53	1,6	0,47	0,42
Cardiologist 3	45	2	0,31	0,24
Cardiologist 4	51	6	0,45	0,22
Cardiologist 5	56	1,2	0,35	0,32
Cardiologist 6	34	0,2	0,11	0,10
Cardiologist 7	84	5	0,58	0,39
Nurse 1	139	9	0,82	0,47
Nurse 2	106	5	0,49	0,30
Nurse 3	109	6	0,55	0,32
Nurse 4	150	2	0,21	0,14
Nurse 5	150	5	0,58	0,39
Nurse 6	159	5	0,68	0,49
Nurse 7	191	9	0,82	0,47

Conclusions

The results show that the effective doses to the staff at the two cardiology departments are relatively low, even when the Niklason algorithm is used to include the doses to the parts of the body that are not covered by the lead apron. The annual dose limit of 20 mSv corresponds to 5 mSv in three months or 1,7 mSv in one month, respectively, and these values are far from being exceeded.

Except from one person, the projected yearly doses to the eyes of the staff are below the current annual

dose limit of 150 mSv, corresponding to 37,5 mSv in three months and 12,5 mSv in month, respectively. In April 2011, ICRP has recommended a new dose limit for equivalent dose to the lens of the eye of 20 mSv in a year, i.e. 5 mSv in three months or 1,7 mSv in one month, and the doses received by part of the staff are above these new recommendations. This implies that the doses to the eyes of the staff at cardiology departments should be followed closely in the future, for example by use of dosimeters placed on the

shoulders over the lead apron. It might also be necessary to require lead glasses during fluoroscopy.

There is no simple correlation between the doses and the number of performed procedures.

It was not possible to complete the monitoring of the doses to the hands of the workers with ring TLD dosimeters, because of the challenges of maintaining sterility. This part of the study was interrupted after a few days.

1. Niklason et al., "The Estimation of Occupational Effective Dose in Diagnostic Radiology with two Dosimeters", Health Phys. 1994 Dec;67(6):611-5