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PERSONNEL EXPOSURE DURING CEREBRAL ANGIOGRAPHY

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INTRODUCTION

THE exposure of radiologists to x-rays depends to a great extent on the type of examinations conducted. In the majority of radiological investigations, the radiologists and other personnel retire out of the x-ray rooms during exposure. By proper planning of x-ray rooms, personnel exposure can be reduced to insignificant levels. In some procedures, however, the radiologists remain inside the x-ray rooms. These procedures are fluoroscopic investigations and special examinations which require that the contrast medium be injected manually.

A large number of factors such as field size, beam orientation, exposure time and kilovoltage, protective devices used, and the position of the radiologist, affect the level of his exposure. For example, studies on personnel exposure during cardiac catheterisation by Wold *et al.* (1971), Malsky *et al.* (1971), Ardran and Fursdon (1973) and Stacey *et al.* (1974) have shown that exposures of the neck and head varies from undetectable levels to over 60 mR per examination. The recommendations that were subsequently made ranged from the necessity to rotate medical personnel and restrict the workload, to just paying careful attention to radiation protection details.

In the Department of Neurosurgery, General Hospital, Kuala Lumpur, most of the radiological examinations are conducted in the x-ray rooms situated in the department itself. There was some concern over the exposure of personnel who remained inside x-ray rooms during special examinations. More than one-third of these examinations were in cerebral angiography and a study was made in July 1978 to determine the exposure of personnel.

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PROCEDURE AND EQUIPMENT

The contrast medium is injected manually and directly by the percutaneous technique. As fluoroscopy is not required, all assisting personnel leave the x-ray room before radiography is commenced. The neurosurgeon (or medical officer) alone remains standing beside the patient and is exposed during serial radiography. Biplane radiographs are taken with separate anterior-posterior and lateral tube-film-changer systems. Normally eight films are exposed for each side examined. The x-ray machine has a 125kVp, 1000 mA generator, using three phase power with full wave rectification. The exposure settings were at 65 - 75 kVp and 64 80 mAs. The total filtration is 2 mm aluminium. The focus film distance is 90 cm, and the focus skin distance is between 60 - 70 cm. The field size at the film is 20 cm x 25 cm. Elema Schonander serial changes are used.

The neurosurgeon wears a lead apron of 0.5 mm lead equivalent in thickness. A lead rubber sheet of 1 m by 1.3 m and 0.5 mm lead equivalent, with a portion cut off to fit over the neck of the patient is lowered vertically from the ceiling just before exposure. This lead sheet reduces exposure to the parts of the body not shielded by the lead apron.

DOSIMETRY

Personnel monitoring films in their badges were used as dosemeters. These films were calibrated by exposing a set of films to x-rays at 80 kVp, 3 mA tube current, 80 cm focus film distance and 3 mm aluminium total filtration. These factors were chosen so that the quality of the x-ray beam matches the side and backscatter from the patient which was harder, as shown by Keane and Spiegler (1951). The calibration films were exposed side by side with the 35 cm^3 ionisation chamber of the 37D Pitman dosemeter which had been compared to a Baldwin Farmer

secondary standard dosemeter. A set of calibration films were developed together with the test films using standard procedures for monitoring films. The value of two milliroentgens was taken as the threshold of detection and all readings were recorded to the nearest milliroentgen.

RESULTS

The films were positioned as follows: on the forehead, on the dorsum of the hand, at the gonadal area under the apron, and on top of one foot. The results are presented in Table I.

Table 1

Radiation exposure of neurosurgeons at various parts of the body during cerebral angiography

		Dr. A	Dr. B	Dr. C	Dr. D	Dr. E
Total number of radiographs monitored		190	146	93	48	37
total dose for one month	forehead	4	12	6	3	2
	dorsum of hand	82	152	77	2	33
	foot	2	6	3	< 2	< 2
	gonads (under apron)	< 2	< 2	< 2	< 2	< 2
dose per exam.	forehead	0.4	0.7	1.2	1	1
	dorsum of hand	7.5	1.3	15.4	0.7	16.5
	foot	0.2	16.8	0.6	<0.7	< 1

The threshold of detection was taken to be 2mR.

Note: < means less than.

DISCUSSION AND CONCLUSION

A comparison with similar investigations by Santen *et al.* (1975) and Riley *et al.* (1972) is given in Table II. The exposures measured are of the same order of magnitude. Slightly lower exposures for the forehead were measured although the neurosurgeon stands nearer the patient's head when the percutaneous technique is used. This lower exposure can be attributed to the lead sheet hung from the ceiling and justifies the extra precaution taken.

Exposure of the gonads were below 2 mR for up to 190 exposures (Dr. A, Table I) although the hands and forehead have received appreciable exposures. Similarly, Riley reported less than 2 mR for 600 exposures in selective cerebral arteriography. These results once again raises the question where the regular personnel monitoring badges should be worn. If they are worn under the lead apron, the dose to the hands will be underestimated by as much as over 70 times and the dose to the eyes by 6 times. The International Committee on Radiation Protection has recommended a Maximum Permissible Dose for the hands of only 15 times that for the gonads.

Taking into consideration that the greatest exposures occur during angiography and over two-thirds of the radiological examinations are in angiography, this study shows that the neurosurgeons at the General Hospital, Kuala Lumpur would be exposed to doses below the Maximum Permissible Doses as recommended by the International Commission on Radiation Protection.

Table II

Radiation exposure of the hand and forehead of Neurosurgeons per cerebral angiographic examination

	This investigation	Santen *et al.*	Riley *et al.*
Dose to hand in mR	0.7 — 16.8	0.7 — 1.3	7.4
Dose to forehead in mR	0.4 — 1.3	0.7 — 4.8	5.8

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