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Potential scattering radiation exposure for radiation workers on eye in the cath lab room

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Abstract. The scattering radiation of radiation workers especially the eyes on fluoroscopy examination relatively large. Therefore, the potential for receiving radiation exposure for radiation workers needs further evaluation and analysis. This study aims to evaluate the potential of scattering radiation received by radiation workers on the eye. The method was placing the surveyor with a variation of height 150, 160, 170 cm from the floor in a position representing such a doctor (radiation worker) when performing catheter surgery. Irradiation includes 3 modes namely cine, 1-minute, and 4-minutes fluoroscopy. The results of scattering radiation exposure at an altitude of 150 cm at 10-seconds mode cine, 1-minute, and 4-minutes mode fluoroscopy is 6.18-18.96 μSv , 1.10-16.73 μSv , 6.03-15.12 μSv , respectively. The results of scattering radiation exposure at an altitude of 160 cm at 10-seconds mode cine, 1-minute, and 4-minutes mode fluoroscopy is 1.52-69.18 μSv , 2.97-58.49 μSv , 11.23-14.36 μSv , respectively. The results of scattering radiation exposure at an altitude of 170 cm at 10-seconds mode cine, 1-minute, and 4-minutes mode fluoroscopy is 0.91-1.06 μSv , 2.97-58.49 μSv , 7.28-68.14 μSv , respectively. In conclusion, the use of cine mode at 160 cm height from the floor was the best setting for radiation workers (doctors).

1. Introduction

The scattered radiation of radiation workers, especially the eyes, on the fluoroscopy examination in the cath lab room is very large. So that the potential for receiving radiation exposure for radiation workers needs further evaluation and analysis.

The eye is one of the organs in the body that is sensitive to radiation, damage to the eye can be seen in the sensitive part, namely the eye lens. The points of eye lens cloudiness can be detected after exposure to radiation of about 500 mGy, this damage is accumulative and can progress to blindness due to cataracts [1]. International Commission of Radiological Protection (ICRP) Publication number 118 of 2012 recommends a decrease in value. The dose limit value (NBD) of the eye lens for radiation workers from 150 mSv to 20 mSv in one year, and in a certain year does not exceed 50 mSv [2].



Radiation effects and radiation protection measures are currently a major concern, due to awareness of the long-term consequences (life-time risk) for both patients, radiation workers and the general public around them [3-5]. According to Dragusin et al. (2011), interventional radiology workers should pay more attention to the radiation dose used during cardiology or interventional radiology procedures. One of the effects of radiation that needs to be considered is the effect of radiation received by radiation workers on the eye organs [6].

In interventional radiology, radiation workers have the potential to get higher exposure to scattered radiation due to the radiation workers work closer to the patient and radiation sources. The other factors lead the radiation workers in interventional radiology to receive doses that exceed the threshold due to the high workload. Therefore, it is necessary to monitor scattered radiation in the room using a survey meter and evaluate the potential of scattering radiation received by radiation workers on the eye.

2. Methods

2.1 Measurement of scatter radiation in cathlab room using a survey meter

Collecting data was conducted in the interventional radiology room at the Kraton Pekalongan Hospital. It was begun by placing the survey meter in a position that simulates the radiation worker being at the time of the procedure, and placing a 20 cm solid water phantom on the patient table to simulate the patient's position (Figure 1).

The Pehamed CD Gam 1 survey meter (Pehamed, Germany) was installed and adjusted at 150 cm, 160 cm, 170 cm from the floor. Then, the survey meter was placed in radiation worker positions. However, the angle of survey meter was in 7 angles. It was -45° , -30° , -15° , 0° , 15° , 30° , and 45° (shown in Figure 2). The angles were measured by a protractor. During the treatment, the monitor can move according to the treatment being carried out. Therefore, the angles chosen in this study are in accordance with the direction of the doctor's eye when doing treatment. Then, scan with variations in time during one minute, four minutes, and cine fluorography for 10 seconds.

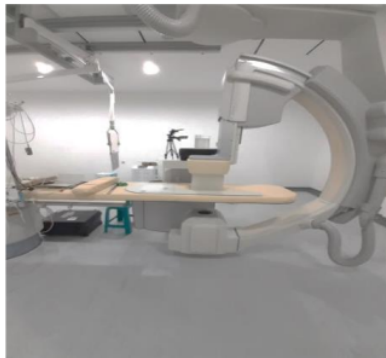


Figure 1. layout position of phantom

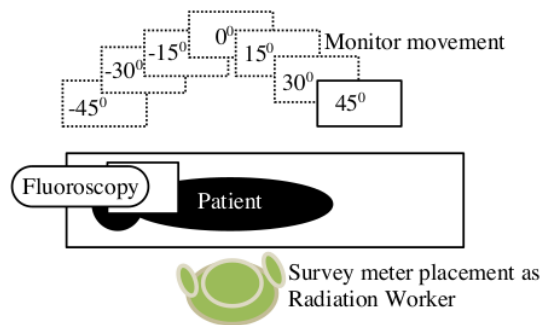


Figure 2. layout position of Survey meter. The survey meter was placed in the same position. However, the angle of survey meter was different.

3. Results and discussion

3.1 Measurement of scattered radiation in 1 minute fluoroscopy mode

The results of exposure to scattered radiation at a height of 150 cm in 1-minute fluoroscopy mode obtained a lower and a higher value which is 1.10 and 16.73 μSv , respectively (Figure 3). At a height of 160 cm in 1-minute fluoroscopy mode obtained a lower and a higher value which is 2.97 and 58.49 μSv , respectively. at a height of 170 cm in 1-minute fluoroscopy mode obtained a lower and a higher value which is 2.97 and 58.49 μSv , respectively.

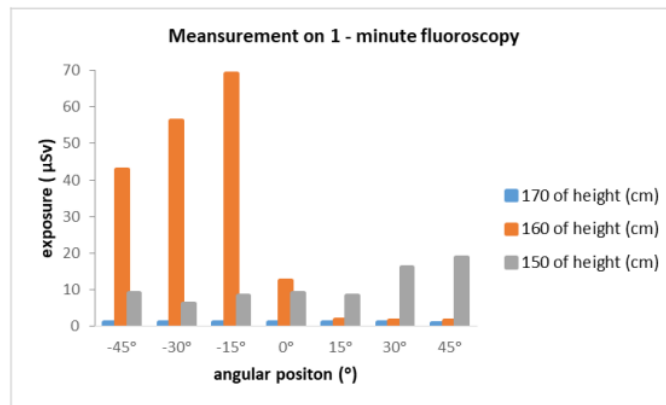


Figure 3. radiation exposure of one-minute fluoroscopy with different heights and angles

3.2 Measurement of Scattered Radiation in 4 minute Fluoroscopy mode

The 4-minutes fluoroscopy at 150 cm produced a lower and a higher value of scatter radiation which is 6.03 and 15.12 μSv , respectively (Figure 4). At 160 cm produced a lower and a higher value of scatter radiation which is 11.23 and 14.36 μSv , respectively. At 170 cm produced a lower and a higher value of scatter radiation which is 7.28 and 68.14 μSv , respectively.

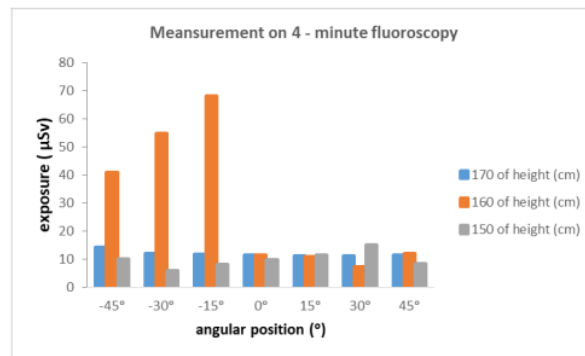


Figure 4. radiation exposure of four-minute fluoroscopy with different heights and angles

3.3 Measurement of scattered radiation in 10 second cine fluorography mode

The scatter radiation exposure at 150 cm cine fluorography obtained a lower and a higher value which is 6.18 and 18, 96 μSv , respectively. At 160 cm cine fluorography obtained a lower and a higher value which is 1.52 and 69, 18 μSv , respectively. At 170 cm cine fluorography obtained a lower and a higher value which is 0.9 and 1.06 μSv , respectively.

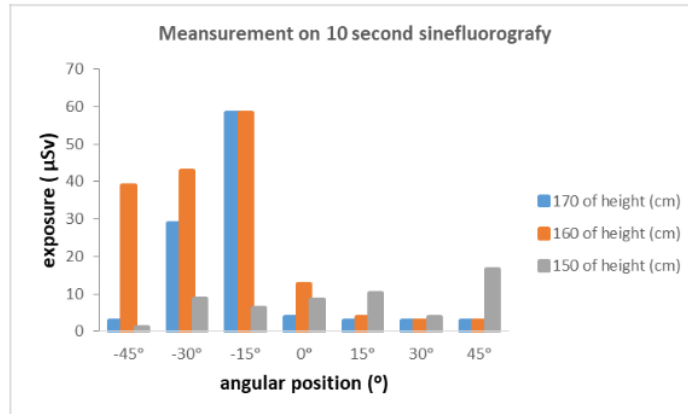


Figure 5. radiation exposure of cine fluoroscopy with different heights and angles

The result of the survey reading was that the closest 3 angles (-45°, -30°, and -15°) got the highest potential dose of exposure compared to 4 angles (0°, 15°, 30°, 45°) the x-ray tube position. A height of 160 cm received the highest radiation exposure. The difference of 150 cm and 160 cm at 3 angles obtained 33 and 60 μSv in cine fluorography mode, respectively. The highest difference of radiation exposure in cine fluorography mode at a height of 160 and 170 cm is 41 and 68 μSv , respectively. The highest difference of exposure to radiation in 1-minute fluoroscopy mode at a height of 160 and 170 cm was 26 and 56 μSv , respectively. The highest difference of exposure to radiation in 4 minutes in fluoroscopy mode at a height of 160 and 170 cm is 0 and 35 μSv , respectively. The highest difference of exposure to radiation in 1-minute fluoroscopy mode at a height of 160 and 150 cm was 37 and 52 μSv , respectively. The highest difference of exposure to radiation in 4 minutes in fluoroscopy mode at a height of 160 and 150 cm was 30 and 59 μSv , respectively. U kara et al. (2015) obtained that a doctor at a distance of 0 cm from the patient's table received a dose exposure rate of 0.06 $\mu\text{Sv/h}$ and a daily radiation exposure of 2 $\mu\text{Sv/h}$ in interventional radiology [7].

4. Conclusions

The measurement of scatter radiation exposure for radiation worker has been done with the different height. The best position of radiation worker was known as 10 seconds cine mode at 160 cm height. The reason is due to the scatter radiation that received by radiation worker was not exceed the dose limit value.

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