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ANALYSIS OF SCATTERED RADIATION DOSE IN CARDIAC CATHETERIZATION EXAMINATION IN THE CATHLAB ROOM USING TLD

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ABSTRACT

About 75% of the information humans receive visually or through the eyes. However, the eye cannot detect all types of light, including X-ray radiation. There are parts of the human body organs are very sensitive to X-ray radiation, because of the risk of damaging tissues and triggering causing ery, infertility or cataracts. Today, X-rays have become the backbone of the development of radiology equipment, especially for producing. One of them is C-Arm equipment technology, which is able to image three-dimensional patient objects in real time with fluoroscopy techniques. This study aims to obtain and evaluate the effective radiation dose received by medical personnel working in the cathlab room area when radiation workers during cardiac catheterization is performed. The results show operator area; the effective dose received was 0.000 mSv, doctors ranged from 1.136 to 3.608 mSv, while nurses ranged from 0.194 mSv to 2.270 mSv, while radiographers ranged from 0.074 mSv to 0.126 mSv, while patient entrance and exit areas ranged from 0.00 mSv to 0.0127 mSv, while nurses in and out of medical personnel ranged from 0.005 mSv to 0.057 mSv, Measurements on the floor near the radiation source/floroscopy range from 0.036 mSv to 0.074 mSv. Cathlab indoor wall measurement results range from 0.031 mSv to 0.103 mSv. Within 1 year, the dose in the operator room is 0.00 mSv, the dose received by doctors ranges from 230.4 to 1209.5 mSv/hour, radiographers between 128.2 mSv to 1812.4 mSv and nurses between 115.2 mSv to 2448.2 mSv. In the area of the patient entrance and exit between 0.00 mSv to 38.8 mSv, the area of the patient entrance and exit between 72.00 mSv to 82.2 mSv, and the floor area near the radiation source/floroscopy between 518.2 mSv to 1065.2 mSv, as well as the inner wall area of the cathlab chamber between 44.6 mSv to 148.32 mSv. It was found that; The effective dose received in one year received by doctors, nurses and radiographers who work close to radiation sources (floroscopy) results are higher than the dose value set by PERKA BAPETEN No. 8 of 2011 which is 20 mSv and ICRP 203 which is 500 mSv per year.

Keywords: *C-Arm, effective dose, fluoroscopy, cardiac catheterization, critical organ dose*

INTRODUCTION

The cardiac catheterization procedure is carried out in a special room, namely the cardiac catheterization laboratory room or better known as the Cath Lab. The main equipment used in the cardiac catheterization room is X-ray fluoroscopy *(Medical X-Ray Imaging*ng, 2023). This tool functions as a guide for the doctor so that the catheter can be placed in the right position. This tool can show the process of carrying out medical procedures such as bone surgery or other internal parts of the human body in real time (Fadli, 2023).Fluoroscopy technology*C-Arm*works by passing X-ray beams through the patient's body.This technology has the ability to display images of objects in three dimensions from various sides and positions continuously. Objects can be seen more clearly and completely, thereby minimizing errors in predicting the location of objects, making diagnoses and other medical procedures. C-Arm is also an accurate method for performing blood vessel radiography (coronary angiography) (Muzilman & Ari, 2021)**.**

The use of X-rays in imaging equipment technology has great benefits in the health sector. However, on the other hand, there is a risk if the radiation exposure dose used exceeds the permitted safe limits (Sihite & Siregar, 2022). Among them are that it can cause cancer in the future, effects on cataract tissue, skin redness and hair loss, possible reactions related to intravenously injected contrast agents (Hidayatullah, 2017). Therefore, the radiation dose used and received by radiation workers must still be controlled or limited. The Nuclear Energy Supervisory Agency (BAPETEN) has issued regulation Number 5 of 2016 concerning radiation safety in the production of consumer goods *(Regulation of the Head of the Nuclear Energy Supervisory Agency Number 5 of 2016 concerning Radiation Safety in the Production of Consumer Goods*en, 2022). Article 23 states: for radiation workers, the dose received by eye lenses must not exceed 20 mSv per year on average for 5 (five) consecutive years, and 50 mSv in 1 (one) particular year. As is known, the effects of radiation caused by the eye organs can cause damage to the eye organs, such as causing cataracts and damage to other eye organs (Ilyas & Yulianti, 2014).

The problem that is often found in the field is that many radiation workers do not comply with and ignore radiation protection principles and procedures when operating fluoroscopy equipment. Therefore, it is necessary to conduct a study to evaluate the radiation dose received by radiation workers working in the Cath-Lab room when carrying out interventional radiology procedures and vascular heart catheterization, both therapy and diagnosis, especially towards the vital organs of the eye which are very sensitive to X-ray radiation.

RESEARCH METHODS

Material

This study uses a quantitative method, where in this study the absorbed dose was measured in the area of the patient entrance and exit room, operator/radiographer room, medical officer entrance and exit room, inner wall area, floor area near the fluoroscopy examination during a pacemaker examination. for doctors and nurses who work in radiation areas, it is measured using a Thermo Luminescence Dosimeter (TLD).

Equipment

The initial step is to prepare the C-Arm aircraft, then install the TLD in the area around the operator/radiographer working room, patient entry and exit room, medical officer entry and exit room, wall area in the Cathlab room, floor area near the fluoroscope, doctor, radiographer and nurse area. work before a coronary angiography examination is carried out. After the examination is complete, the TLD is issued and read at the Dosimeter Laboratory, BATAN

Method

1) To find out the dose value recorded in the TLD, read it using the Harshaw Model 3500 TLD Reader. The TLD is entered into the TLD reader, then the reading results are displayed graphically on the computer screen. The reading process requires a maximum temperature of 2200C for the TLD-100H and 2600C for the TLD 100 and a minimum temperature of 500C.
2) Before the TLD-100H and TLD-100 were used for research, an annealing process was carried out with the aim that the dose previously recorded on the TLD-100H and TLD-100 was erased until it was close to 0.
3) Annealing Process on TLD-100H
   The TLD-100H annealing process is carried out in an oven. The TLD is arranged in an aluminum container and then placed in the oven by heating the oven from room temperature to 200oC. After the temperature reaches 200oC, leave it for 10 minutes then turn off the oven, so that the TLD can be cooled to room temperature by opening the oven door.
4) TLD-100 annealing process
   The TLD-100 annealing process is carried out in a furnace. The TLD is arranged in an aluminum plate container and then inserted into the furnace with a preheating temperature of room temperature (28oC) to 400oC with a time required of approximately 15 minutes.

   Then let it sit after the temperature reaches 400oC within 1 hour. After the TLD is heated, in the next process the furnace temperature will automatically drop from 400oC to 100oC in approximately 2 hours, then the furnace is opened to make the cooling process faster. After cooling, the annealing process is then carried out in the oven. The method is almost the same as the TLD-100H. The difference is the length of the heating pause in the oven before cooling. If the TLD-100H reaches a temperature of 200oC, a 10-minute rest period is given before the oven is turned off and cooled down, but for the TLD-100 it requires a heating time of 1 hour and the rest of the process is the same.

RESULTS AND DISCUSSION

The research is carried out starting from inserting a catheter into the artery with the help of X-ray guidance. The reception of the dose that will be studied uses two different types of TLD (Thermoluminisence Dosimeter), namely 10 TLD-100 packages and 10 TLD-100H packages, plus one TLD-100 package and one TLD-100H package that will be used. as background. In this study, 10 samples were taken for Percutaneous Coronary Intervention (PCI) examination.

This research was carried out by attaching a TLD-100 to each TLD-100H around the eyes of doctors and nurses when examining patients with Percutaneous Coronary Intervention (PCI) cases. Measurements are carried out to determine the dose to the eye organs without using glasses. The exposure factor setting used in this study is an automatic exposure factor with different kV and mAs values for the thickness of the object to be seen in the arterial selection process by inserting a catheter accompanied by contrast. Then, after the Percutaneous Coronary Intervention (PCI) examination is carried out, the TLD that has been used will be read using the TLD reader in the Dosimetry Laboratory. After conducting research and calculating the dose value obtained from the TLD, the equivalent dose and effective dose are calculated. The results of administering the dose to the radiographer operator's area if it is in the room indoor and outdoor Pb glass protectors are presented in Table 1.

Table 1. Receive doses using protective Pb glass, operator's room

Sample	External Dosage (mSv)	Internal Dosage (mSv)	Reducing the Use of Pb Protective Glass	Effectiveness	Dosage Receipt
1	2, 710(±0,1334)	0,11(±0,0720)	2,59(±0,1791)	95,55%	4,45%
2	0,194(±0,0372)	0,05(±0,0250)	0,14(±0,0609)	95,23%	4,77%
3	0,213(±0,0,0276)	0,017(±0,0020)	0,196(±0,0255)	95,82%	4,18%
4	0,401(±0,0366)	0,007(±0,0084)	0,397(±0,0449)	95,84%	4,16%
5	0,258(±0,0222)	0,18(±0,0106)	0,078(±0,0268)	94,23%	5,77%
Average	0,753(±0,0461)	0,0728(±0,0212)	0,680 (±0,0597)	95,63%	4,37%

The use of Pb glass in the radiation protection operator's room during examinations or certain medical procedures carried out by medical personnel (radiographers) will be able to reduce the effective dose by 95.63%. The percentage of dose received by officers if they wear protective Pb glass is only 4.37% of the effective dose (external/direct dose) received when carrying out the examination Percutaneous Coronary Intervention (PCI).

Doses Received by Medical Personnel

This radiation dose was measured during percutaneous coronary intervention using the Philips C-Arm device at the Cath Lab Installation at Hermina Hospital, Depok. Based on the calculation results, it can be seen that the effective dose value for exposure to the eye organs of doctors and nurses varies according to the length of the examination. The length of time the procedure takes for each patient is not the same, and really depends on the patient's condition. In this study, the number of patient samples involved was 10 people (Stahl et al., 2016).

The effective dose received by doctors is between 1,136–3,608 mSv, and nurses receive 0.194–2.27 mSv (Hiswara, 2023). Meanwhile, the effective dose received by the radiographer ranges from 0.074–0.126 mSv and the patient entry and exit area receives a dose of 0.055–0.057 mSv and the patient entry and exit area receives a radiation dose of 0.000 mSv – 0.0124 mSv, the floor area near the fluoroscope is 0.036 – 0.074 mSv and operator area of 0.000 mSv. This value is still categorized as within safe limits and is still far below the tolerance limit set by PERKA BAPETEN No. 8 of 2011, namely 20 mSv.

According to the International Commission of Radiological Protection (ICRP) 103, within 1 year, the dose in the operator's room is 0.00 mSv, the dose received by doctors ranges from 230.4 to 1209.5 mSv/hour, radiographers between 128.2 mSv to 1812 .4 mSv and nurses between 115.2 mSv to 2448.2 mSv. In the patient entrance and exit area between

0.00 mSv to 38.8 mSv, the patient entrance and exit area is between 72.00 mSv to 82.2 mSv, and the floor area near the radiation / fluoroscopy source is between 518.2 mSv to 1065.2 mSv, as well as the inner wall area of the cathlab room between 44.6 mSv to 148.32 mSv, different if using personal radiation protection by wearing protective glasses (10). If the effective dose received by the eye is multiplied over a period of 1 year, the resulting dose is between 0.0365 – 0.3285 mSv/hour for doctors and 0.0109 – 0.1460 mSv/hour for nurses (Dianasari & Koesyanto, 2017).

CONCLUSION

From the results of the research and discussion described above regarding the doses received by doctors and nurses during Percutaneous Coronary Intervention examinations, it was concluded that the effective dose received within 1 year, the dose in the operator's room was 0.00 mSv, the dose received by doctors was around 230 mSv. .4 to 1209.5 mSv/hour, radiographers between 128.2 mSv to 1812.4 mSv and nurses between 115.2 mSv to 2448.2 mSv. In the patient entrance and exit area between 0.00 mSv to 38.8 mSv, the patient entrance and exit area is between 72.00 mSv to 82.2 mSv, and the floor area near the radiation / fluoroscopy source is between 518.2 mSv to 1065.2 mSv, as well as the inner wall area of the cathlab room between 44.6 mSv to 148.32 mSv.

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