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AN ANALYSIS TO EFFECT OF DISTANCE AND FLUORO-TIME ON THE WORKER DOSE IN CARDIOVASCULAR INTERVENTION TREATMENTS

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Abstract: This study aims to analyze the effect of distance and fluoro time on increasing workers radiation dose inside Cath Lab room. Also to analyze the differences results of TLD and Pocket dosimeter in determining workers radiation dose. There are 254 data is needed for statistical analysis, 206 data for analyzing the relation of distance and Fluoro-time against dose, and 276 data from Pocket dosimeter plus 6 data from TLD measurements for analysing the differences of dose on Pocket dosimeters and TLDs. From statistical analysis showed that each exposure factor had no effect on worker dose, but simultaneously exposure factor impacted to dose 14,9 % for Operator and 15,5% for Radiographer . In addition, long-time of fluoro-time does not relate to the dose. The trend shows a decreasing of dose along the Fluoro time axis for both distances. Meanwhile, Radiographer tends to receive dose more stable than Operators due to their distance from exposure area. Moreover, Dose recorded on TLD are consistently higher than on Pocket Dosimeter.
Keywords: analysis; effect time; distance; fluoro;

I. INTRODUCTION

Radiation workers, according to the Regulation, is a person who works in a nuclear or ionizing radiation installation who expected to receive an annual dose exceeding general public dose. Maximum dose for workers is 20 mSv for a year while public dose only 1 mSv. [1]. In order to figure out workers radiation dose, some personal detectors are needed. Thermo Luminiscent Detector (TLD) is a standardized detector based on International regulation for discovering radiation dose in workers.

In general, TLD uses thermolunic inorganic crystals such as LiF or CaSO4 which if exposed to radiation will undergo a thermoluminance process. [2]. The other kind of personal detector to discover radiation dose in workers is Pocket dosimeter. This detector is commonly used for comparison to TLD measurements. Radiations exposure are converted into a dose value directly. Pocket dosimeter do not have a personnel number like TLDs, so it can be used interchangeably[3].Three principle of radiation protection is optimizing the shield, distance, and exposure time. Cardiologists, nurses and radiographers have a risk of of getting high radiation dose, because they undergo interventional treatments inside the Cath-Lab room where radiation is exposed. Hence, Cath-Lab workers will wear some Personal Protective Equipments (PPE) made from lead such as apron, thyroid shield, gonad shield, cap, goggle and gloves. Lead will reduce Intensity of radiation exposure. Workers dose also can be reduce by not doing overexpose during the treatments and maintain the distance from Angiographic tubes. [3]. Radiation that is exposed to workers have an impact if it reaches a certain dose. X-rays in certain energy will cause ionization or excitation of atoms inside the human body. Based on the radiation dose, the impact of radiation exposure are stochastic and non-stochastic. Stochastic effects do not cause cell death but cause cell changes, while non-stochastic effects can cause cell death. Stochastic effects have no threshold. and only known after long periods. The higher dose caused higher chance of a stochastic effect. However, severity of stochastic effect does not depend on organ absorption dose. In contrary, Non-stochastic effect occurs when the organ receives a dose that exceeds the threshold and it can be detected in a shorter periods. [5]

Angiography is an advance Fluoroscopy for Interventional Cardiovascular treatments. Unlike conventional Fluoroscopy, Angiography can process video images (cine-imaging). Fluoroscopy in general will display information about accumulated radiation exposure time during the tratments that known as “Fluoro time”. X-ray emitted by the tube then passes through the patient then captured by an image intensifier detector which is 180° away from the tube. Detector captures information about the condition of the heart then processes and displays it on a monitor with a video format (cine-imaging) for direct observation by cardiologists and other radiation workers.[4]

II. MATERIALS AND METHODS

This study aims to analyze the effect of distance and fluoro time on increasing workers radiation dose. Also to analyze the differences results of TLD and Pocket dosimeter in determining workers radiation dose. Based on the research conceptual framework, data will be grated and analysed.

A. Obtaining the data

In this study, the total numbers of data were gathered from 1 September 2019 until 29 February 2020 are 276 data from Pocket Dosimeters measurements and 6 data from TLDs measurements. Number of data will be differents depend on easch research purposes. Table 1 shows that for this study there were three types of data numbers base on research purposes i.e. data for statistical analysis, data for analyze the relation of distance and Fluoro-time against Dose and data for analysing the differences of dose on Pocket dosimeters and TLDs.

Table – I Numbers of data depend on research purposes

Data		Frequency of Data			Total number of Data
		Operators (1 meters)	Scrub (1.5 meters)	Radiographer (3 meters)	
For statistical analysis		114	24	116	254
For analyze the relation of distance and Fluoro-time against Dose		103	-	103	206
For analysing the differences of dose on Pocket dosimeters and TLDs	Pocket Dosimeters	153	-	123	276
	TLDs	4	-	2	6

B. Methodology and conceptual framework

Accordance with research purpose, here the research conceptual framework has been presented on figure 1. The basic research hypothesis is distances-exposure factors function and Fluoro-time- exposure factors function is related to worker dose. To analyze this hypothesis, required data has been gathered from Diagnostic and Intervention Cardiovascular Instalation of Sidoarjo General Hospital.

C. Data analysis

Based on the data collected, statistical analysis accomplished using Anova test. Statistical analysis was performed by grouping data based on worker distance. Workers who are sampled are Operators, Scrubs and Radiographers who have 1 meter, 1.5 meter and 3 meter of distance respectively. The statistical analysis used was T-test and F-test. T-test aims to determine the effect of each independent variable against dependent variable. Meanwhile, F-test aims to determine the effect of the independent variables simultaneously against dependent variable.

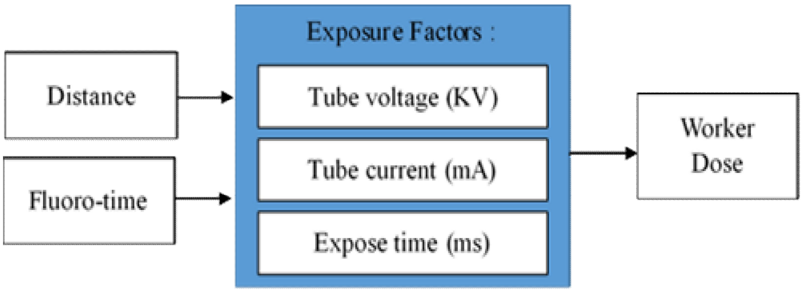

Fig 1. The Research conceptual framework

In this study, the independent variables are tube voltage (KV), tube current (mA), and time (ms), while the dependent variable is worker dose. F-test could also determine the Coefficient of Termination to find out the percentage of simultaneous independent variables against dependent variable. To analyse the relations of dose on distance and fluoro time, 103 data were used for each Operators and Radiographers who had a distance of 1 meter and 3 meters respectively. The Fluoro-time had been sorted from the smallest to the largest values to determine the relation on worker dose. In addition, To analyse comparison of dose on TLDs and Pocket dosimeter is using data of Operator 1, Operator 2 and Radiographer whose always wears Pocket Dosimeter together with TLD while conducting Coronary Angiography.

III. RESULTS AND DISCUSSION

A. Dose to exposure factor relation

First step to undergo this study is doing statistical analysis to exposure factors i.e. tube voltage (KV), tube current (mA) and exposure time (ms). This step analize the relation of exposure factors on dose. Table 2 shows that each of the independent variable has no relation on dose of workers. Then, the independent variable simultaneously have a relation on the dosage of the Operator and Radiographer, while for the Scrub shows the opposite. Coefficient of Termination for Operator and Radiographer are 14.9% and 15.5%, respectively, while Scrub only obtains 6.2%. Hypothesis of the T-test is each of the independent variable has a relation on dose of workers. However, the statistical results show contrary.

Results of statistical analysis showed that each exposure factor had no effect on worker dose. Reason beside this case is exposure factor is not the only one that affects the dose. There are at least five other factors that could affect worker dosage. Those factors are patient size, Source to Surface Distance (SSD), patient to image intensifier distance, collimation and tube projection. The dosage of workers on personal dosimeter is result of the scattering of patient [7]. The factors that previously mentioned could influence dosage of workers because these factors can affect potential of scattering. Alqahtani, 2019 in his research wrote that patients with high Body Mass Index (BMI) potentially create scattering more than patients with the low one [8]. SSD could influence scattering of patient. Workers potentially receive more doses if the position of tube is close to the patient. Adjust patient position close to the image intensifier for reducing scatter dose. In addition, Scattering is potentially higher if the position of tube near workers. In contrary it could be lower if image intensifier placed near workers [7]. Another study said that the Left Anterior Oblique cranial projection (LAO) required an exposure factor five times greater than the standard Right Anterior Oblique (RAO) projection. [9]. Workers who are within one meter of distance potentially receive 0.1% of the dose received by patient. This prosentation formed by patient scattering and a small additional dose from leakage. Using PPE for workers could reduce radiation intensity up to 95 % [7].

TABLE I. - Result of statistical analysis of exposure factors on dose of workers

Worker	Independent Variabel	T-Test		F-Test		Ditermination Coef.
		Sig.	Result	Sig.	Result	%
Operator (1 meter)	Tube Voltage (KV)	0.169	Do not have relation	0.000	Have relation simultaneously	14.9 %
	Tube Current (mA)	0.959	Do not have relation			
	Exposure time (ms)	0.912	Do not have relation			
Scrub (1.5 meter)	Tube Voltage (KV)	0.275	Do not have relation	0.729	Do not have relation simultaneously	6.2 %
	Tube voltage (mA)	0.399	Do not have relation			
	Exposure time (ms)	0.280	Do not have relation			
Radiografer (3 meter)	Tube Voltage (KV)	0.150	Do not have relation	0.000	Have relation simultaneously	15.5 %
	Tube voltage (mA)	0.734	Do not have relation			
	Exposure time (ms)	0.881	Do not have relation			

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B. The relation of Fluoro-time on Dose in different distances

To analysis this case, there are 103 data each for Operators and Radiographers. They always used pocket dosimeter and TLD at the same time is the reason of using their data. Figure 2 shows a graph of relation between and dose. The blue dot is for Operators (1 meter distance) while the red one is for Radiographer (3 meter distance). From the graph, it could be seen that the long-time of fluoro-time does not relate to the dose. In contrary, the trend shows a decreasing of dose along the Fluoro time axis for both distances. Radiographer tends to receive dose more stable than Operators. The highest dose achieved was 3.306 uSv and the lowest one is 0.071 uSv with a fluoro-time is 2.45 minutes and 10.95 minutes respectively. For Operator, the highest dose is 45,260 uSv with 7,217 minutes of Fluoro-time, while the lowest is 1.019 uSv with 17.783 minutes. The gap of dose values for Operators who 1 meter distance is significant compared to radiographers who placed 3 meters away. Operatos have risk to absorb radiation scattering more than other workers. The 2007 ICRP said that worker who placed in around 1 meter potentially absorb 0.1% radiation exposure from the total dose received by a patient. The 1 meter worker mentioned is the position where the operator undergoes the treatment.[7]

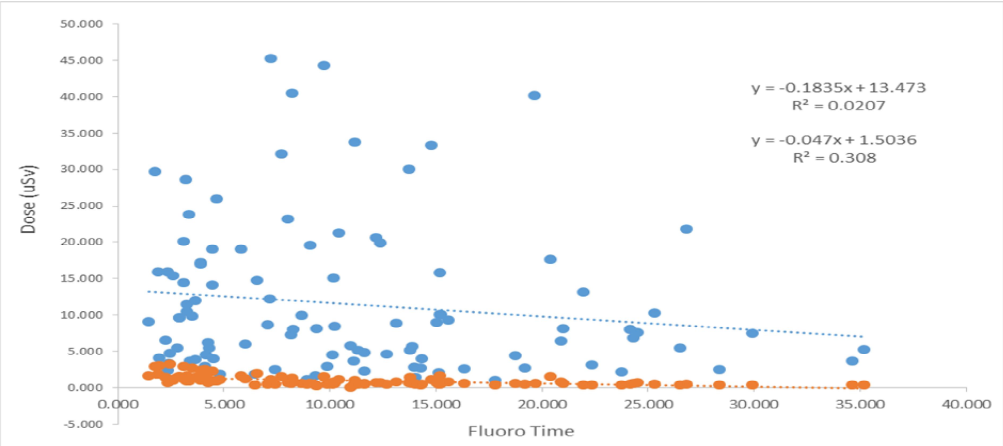

Fig 2. Fluoro-time on dose relation for each Operator (blue bullets) and Radiographer (red bullets)

C. Workers dose on TLDs and Pocket dosimeters

The comparison TLD and Pocket Dosimeter regarding to measure dose workers is shown on figure 3. Dose recorded on TLD are consistently higher than on Pocket Dosimeter. The total Fluoro-time for each worker is 76.193 seconds for the first operator, 63.644 seconds for the second operator and 100.154 seconds for the radiographer. Dose of radiographer is consistently lower than Operators 1 and 2 even has a longest Fluoro-time compared to the two Operators. The reason is Radiografer placed in 3 meters away, while Operators 1 and 2 are 1 meter. Operator 2 who have fewer Fluoro-time received lower doses on both the TLD detector and the pocket dosimeter. Operators 1 and 2 are Cath-lab workers who have the same distance of 1 meter. However, dose on TLD has a high difference between the two compared to the gap on Pocket Dosimeter.

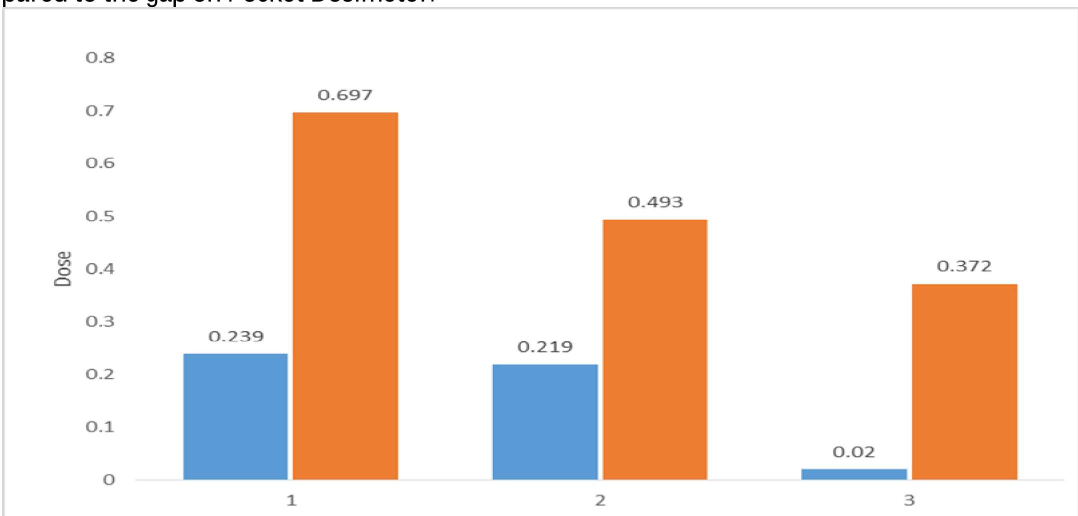

Fig 3. Comparison of the acquisition of TLD and pocket dosimeter doses within 6 months

The gap dose of Operator 1 and Operator 2 from TLD is 0.204 mSv while from Pocket dosimeter is only 0.074 mSv. From TLD report that conducted by BPFK Surabaya East Java, notation of dose workers is written Hp(10), which means the equivalent dose in body tissue at a depth of 10 mm in certain parts of the human body. Materials used for TLD are Lithium Fluororide because of the similarity of this material is close to human organs. Lithium Fluororide has a good energy response and not sensitive to light.

IV. CONCLUSIONS

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