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Testing the Radiation Dose Exposure Rate in the CT-Scan Room of Radiology Installation of Private Hospitals in Kudus City

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ABSTRACT

According to KEPMENKES RI No. 1014 / MENKES / SK / XI / 2008, radiation exposure measurements in the Radiology Installation room must be carried out periodically at least once a year. In one of the Radiology Installation of private hospitals in Kudus city, the implementation of radiation exposure rate testing of CT-Scan was last done in 2014. The purpose of the study was to determine the procedure for testing the radiation dose exposure rate and the results of testing the radiation dose exposure rate in the CT-Scan room. Data collection methods by means of observation, direct experimentation and documentation. Tests were conducted at 5 points around the CT-Scan room using a surveymeter, each point was measured 3 times. The test results in units of µSv / hour were converted to mSv / year. Furthermore, it was compared with KEPMENKES No.1014 of 2008 regulation that radiation exposure should not exceed the limit of 1 mSv/year. The measurement results of the radiation dose exposure rate at points A, B, D, and E did not leak. The exposure rate value obtained at points A, B, D and E is 0 mSv/year. While the measurement results of the radiation dose exposure rate at point C experienced leakage. The exposure rate value obtained at point C is 1.84 mSv/year.

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1. INTRODUCTION

Quality assurance is a program that includes management used to ensure excellence in health services through systematic collection and evaluation of data. Quality control includes collimator testing, X-ray testing, X-ray plane leak testing, grid fit testing, X-ray cassette leak testing and one of them is radiation dose exposure rate testing [1]–[3].

Radiation dose exposure is a quantity to express the intensity of X-rays that can produce ionization in the air in a certain amount. The radiation exposure rate is the exposure (dX) per unit time (dt), expressed in units of x-rays per second or x-rays per minute [4], [5].

Measurement of radiation exposure in the Radiology Installation room must be carried out periodically at least once a year (KEPMENKES RI No. 1014 / MENKES / SK / XI / 2008). Efforts that can be made to ensure the safety and health of radiation workers are by fulfilling the requirements of the radiology room, namely the X-ray examination room without fluoroscopy with a power of 125 kV with a size of 4 m long, 3 m wide, 2.8 m high and the walls of the room are made of red brick with a thickness of 25 cm (twenty-five centimeters) or concrete with a thickness of 20 cm (twenty centimeters) or the equivalent of 2 mm (two millimeters) of lead (Pb) and the door of the X-ray room is coated with lead with a certain thickness. Thus, the radiation level around the X-ray room does not exceed the dose limit value of 1 mSv/year (one millisievert per year) [6]. Radiation exposure is the radiation received by humans or materials, whether intentionally or not, which comes from internal or external radiation [4].

The radiation exposure received by workers over a period of time must be below the prescribed dose limit value. The permissible dose limit value for an individual is the dose accumulated over a long period of time or the result of a single irradiation, which according to current knowledge, contains a negligible possibility of somatic or genetic damage, in addition, the dose size is such that any effects that often occur are limited to mild consequences, so that they will not be considered unacceptable by the person irradiated and by the medical authority. The annual dose limit value for radiation workers is 10 mSv (ten millisievert) per year or 0.2 mSv (zero point two millisievert) per week. Meanwhile, the annual dose limit value for members of the public is 0.5 mSv (zero point five millisievert) per year or 0.01 mSv (zero point zero one millisievert) per week [7].

Survey meters are used to measure dose rate or radiation intensity directly. Surveymeter is absolutely necessary in any work that uses radioactive substances or other ionizing radiation sources so that each worker knows or can estimate the radiation dose he will receive after carrying out these activities. The surveymeter must be portable, easy to carry in radiation survey activities in all fields[8]–[10].

Gamma surveymeter is a tool used to measure the dose rate (intensity) of radiation directly. Surveymeter is absolutely necessary in every job that uses radioactive substances or other ionizing radiation sources so that each worker knows or can estimate the radiation dose he will receive after carrying out activities [8], [11], [12].

In one of the Radiology Installations of private hospitals in the city of Kudus, the size of a single slice CT-Scan with a size of 4.9 m long, 4.6 wide, 4 m high, 25 thick walls installed in 2007. The radiation exposure of the CT-Scan was last tested in 2014 with a result of 1.35 mGy/100mAs using a surveymeter and has never been tested again until now. This has exceeded the minimum testing rules from KEPMENKES RI No. 1014 / MENKES / SK / XI / 2008, which is at least once a year.

2. METHODS

This research is a quantitative study with an observational approach. Data collection by observation, direct experimentation, documentation[13], [14]. Direct experiments were conducted by measuring the radiation exposure rate using a surveymeter at points A-E and each point was measured three times and then the average was calculated. The measurement results are recorded at each point that has been used in the hospital radiology installation. There are 3 variables used in this study. Independent variable is the measurement of radiation exposure rate. Dependent variable is the test result of radiation exposure rate. Control variables are wall thickness, exposure factor, surveymeter.

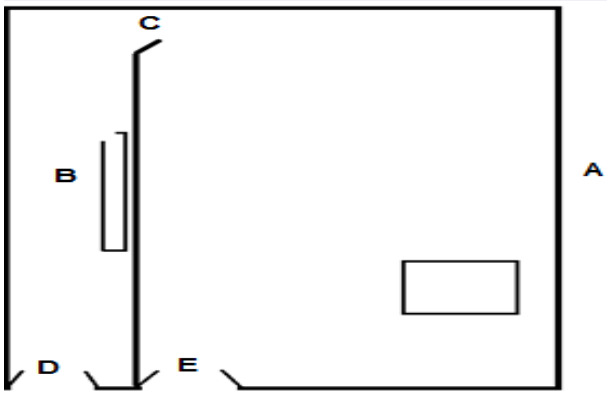

Figure 1. Plan of CT-Scan Room in Measurement 5 point area (1-5)

Description:
1. Measurement area A is behind the wall of the CT-Scan room with the Obstetrician's Room
2. Measurement area B behind the Operator's Room
3. Measurement area C behind the door dividing the CT-Scan room with the Operator's Room
4. Measurement area D behind the door of the CT-Scan room attendant
5. Measurement area E behind the door of the CT-Scan room patient.

Data processing is done by measuring the radiation dose rate at the Radiology Installation of the Hospital, then processing the data from the measurement of the radiation dose rate by calculating the radiation dose rate that has been obtained by testing at 5 measurement points, where each point is done 3 times and entered in the test table form that has been provided and then multiplied by the calibration factor of the surveymeter tool 1.02 for units of µSv / h. Then converted in units of mSv / year. Then converted in units of mSv/year.

Data analysis was carried out by calculating the average radiation dose rate results obtained from the converted measurement results and then comparing with the radiation dose limit value in the CT-

Scan room according to the tolerance limit according to KEPMENKES No. 1014 of 2008 which is 1 mSv / year (one millisievert per year).

3. RESULTS AND DISCUSSION

The procedure for testing radiation dose exposure rates in hospital radiology installations first prepares tools and materials and then carries out the procedure for testing steps. Preparation of tools and materials including CT-Scan, surveymeter, apron, calculator, stationery (book, ballpoint pen), test table form. The procedure for testing the radiation dose exposure rate in the CT-Scan room of the Hospital Radiology Installation is as follows:

1. Turn on the CT-Scan and position the head phantom on the examination table with the aiming point at Glabella, horizontal longitudinal indicator light on the intra pupillary line by selecting the routine brain protocol using an exposure factor of 120 kV 260 mAs.
2. Determining the points to be tested include point A of the wall of the CT-Scan room with the obstetrician's room, point B of the operator's room, point C of the door dividing the CT-Scan room with the operator's room, point D of the CT-Scan room attendant door, point E behind the CT-Scan room patient door and preparing the measuring instrument, namely the surveymeter. The surveymeter is checked for battery and calibration certificate before use.
3. Turn on the surveymeter measuring instrument by pressing the ON button on the surveymeter panel wait until a few moments then press the MODE panel to set the unit to the smallest scale of µSv / hour.
4. Wearing an apron before conducting the radiation dose exposure rate test.
5. Position the phantom head and on the examination table set the indicator light according to the object.
6. Perform scanning and during scanning, measure the radiation dose exposure rate using a surveymeter at the tested points, namely point A to point E.
7. Each point is measured three times and written in the prepared radiation dose exposure rate test measurement data table.
8. The measurement results at each point are multiplied by the calibration factor of 1.02 for units of µSv/hour and then the average is calculated and converted into units according to the applicable tolerance limit of mSv/year.
9. The next step is to analyze the average results of all measurement points and determine the average results of the largest and lowest measurements.

Based on the results of data collection obtained through measuring the radiation dose exposure rate with a surveymeter in the CT-Scan room of the Hospital Radiology Installation directly, the following results were obtained:

Table 1. Measurement of Radiation Dose Exposure Rate In The CT-Scan Room Of The Radiology Installation of The Hospital

Testing Point	Measurement I (µSv/hour)	Measurement II (µSv/hour)	Measurement III (µSv/hour)
A	0	0	0
B	0	0	0
C	1	1	1
D	0	0	0
E	0	0	0

Measurement of radiation dose exposure rate was carried out at 5 points and each point was measured three times. Measurements were made using units of mSv/year, so the calibration factor used was 1.02.

Table 2. Average Results of Radiation Dose Exposure Rate Measurements In The CT-Scan Room Hospital Radiology Installation

Testing Point	I	II	III	Average (µSv/hour)
A	0 x 1.02	0 x 1.02	0 x 1.02	0
B	0 x 1.02	0 x 1.02	0 x 1.02	0
C	1 x 1.02	1 x 1.02	1 x 1.02	1.02
D	0 x 1.02	0 x 1.02	0 x 1.02	0
E	0 x 1.02	0 x 1.02	0 x 1.02	0

According to the Decree of the Indonesian Minister of Health No.1014/MENKES/SK/XI/2008 the radiation level around the CT-Scan room does not exceed the dose limit value of 1 mSv/year (one millisievert per year). The measurement results of radiation exposure rate using units of µSv/hour are then converted into units of mSv/year to compare the tolerance limit according to the provisions that have been set with the data obtained.

Table 3. Average Measurement Results of Radiation Dose Exposure Rate Testing In The CT-Scan Room of The Hospital Radiology Installation

Measurement Point	**Average result (µSv/hour)**	**Conversion result (mSv/year)**	**Description**
A	0	0	safe limit
B	0	0	safe limit
C	1.02	1.84	exceeds the safe limit
D	0	0	safe limit
E	0	0	safe limit

Based on the table of radiation dose exposure rate measurements that have been averaged and converted above, it is found that points A, B, D, and E obtained an exposure of 0 mSv/year, point C obtained an exposure of 1.84 mSv/year. Testing the radiation dose exposure rate that obtained the highest result was point C which is the door dividing the CT-Scan room with the operator's room at 1.84 mSv/year.

According to the Decree of the Minister of Health of the Republic of Indonesia No. 1014/MENKES/SK/XI/2008 concerning the standards of diagnostic radiology services in health care facilities, radiation exposure measurements in Radiology Installations must be carried out periodically at least once a year, and carried out by officers from the institution itself or outside institutions that are experts in diagnostic radiology[15]–[17]. Testing the radiation exposure rate in the Radiology Installation of the Hospital has not been in accordance with the provisions of the Decree of the Minister of Health of the Republic of Indonesia No.1014/MENKES/SK/XI/2008.

According to the Decree of the Minister of Health No.1014/MENKES/SK/XI/2008 on the standard of diagnostic radiology services in health care facilities, the measurement of radiation exposure around the CT-Scan room does not exceed the dose limit value of 1 mSv/year (one millisievert per year). The measurement results of radiation exposure rate testing conducted in the CT-Scan room showed the radiation dose exposure rate at point A obtained an exposure of 0 mSv/year, point B obtained an exposure of 0 mSv/year, point C obtained an exposure of 1.84 mSv/year, point D obtained an exposure of 0 mSv/year, and point E obtained an exposure of 0 mSv/year.

After obtaining the results of research in the CT-Scan room at the Hospital Radiology Installation that the Dose Limit Value (NBD) of the measurement results at each point A, B, D and E are still within the tolerance limit, while at point C radiation leakage exceeds the tolerance limit used by 1.84 mSv/year according to the Decree of the Minister of Health of the Republic of Indonesia No.1014/MENKES/SK/XI/2008. Solutions for areas that experience radiation leakage in unsafe conditions, including the addition of lead thickness of the door behind the operator room and CT-Scan room that leaks.

4. CONCLUSION

The exposure rate testing procedure includes preparing a surveymeter, head phantom, apron, ballpoint pen, measurement result form and calculator. Then position the head phantom on the examination table with an exposure factor of 120 kV, 260 mAs. Determine the measurement points at points A, B, C, D, and E then measure the radiation exposure rate using a surveymeter, each point is done 3 times the exposure. After obtaining the results from all points then each measurement point is multiplied by the calibration factor of 1.02 and averaged. The results of measuring the radiation exposure rate at 5 points in the CT-Scan room using a surveymeter are still below the applicable tolerance value of KEPMENKES 1014 of 2008 but at point C there is radiation leakage because the test value of the exposure rate exceeds the tolerance limit of 1.84 mSv / year, while the test results at measurement points A, B, D, and E are 0 mSv / year, not experiencing radiation leakage.

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