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Measurement of X-Ray Radiation Exposure in Thorax Examinations at Radiology Installation of Wajak Husada General Hospital

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Abstract

The Study aims to measure radiation exposure on X-ray aircraft on chest radiography at the Radiology installation at Wajak Husada General Hospital. Measurements were carried out on the X-ray source tube and in the X-ray room environment at Wajak Husada General Hospital. This research aims to determine the value of radiation exposure and whether the examination room is safe for workers and the general public. Data collection in this research was direct observation in the radiology examination room; then, radiation exposure using a survey meter at points around the X-ray room. The highest exposure to X-ray aircraft was in the control panel room, which was 0.19 μSv/h or 0.88 mSv/y and was still below the dose limit value set by the Regional Head of Bapeten Regulation Number 4 of 2020, namely the dose limit value for workers of 20 mSv/ year and the community it is one mSv/year, concluded that the X-ray aircraft and environment are suitable for use and safe to occupy to implement radiology services.

INTRODUCTION

Radio diagnostics is very important to diagnose a disease using ionizing radiation [1]–[3]. Excessive ionizing radiation hitting human body tissue can cause detrimental effects [4]. These side effects can be minimized by implementing aspects of radiation protection around the radiation source [5]. According to PERKA BAPETEN Number 4 of 2020, which regulates radiation protection and safety in the use of nuclear energy, radiation workers may not receive a radiation dose exceeding 50 mSv per year, and the average per year must not be more than 20 mSv, while the general public may not receive more than one mSv per year because however, radiation will have biological effects which include non-stochastic and stochastic effects [6]–[8].

Radiation protection efforts need to be made to reduce the damaging effects of radiation due to radiation exposure [9]–[11]. Therefore, to prevent radiation exposure, it is necessary to have materials that can prevent the possibility of radiation leaks to achieve occupational health and safety [8], [12], [13]. Thus, the measurements were carried out to carry out occupational safety and health activities in ionizing radiation through radiation protection measures to minimize the radiation exposure received by radiation workers or the public around the examination room [14], [15]. The Radiology Installation Examination Room at Wajak Husada General Hospital is adjacent to the delivery room, and it is feared that receiving too high radiation will endanger the health of those in the room. This requires special monitoring regarding radiation that may leak into other rooms. Because to the left of the radiology examination room is the delivery room, radiation protection for patients must be taken into account so that the dose limit value (NBD) is not exceeded, following Bapeten Regulation No. 4 of 2020. The basis for conducting this research is that there is a need for radiation protection for work safety for patients or the public in general and workers or operators, especially in radiology examination rooms [6], [8], [16], [17]. The novelty of this research is that radiation exposure in the radiology examination room of RSUD Wajak Husada does not exceed the standards set by Perka Bapeten no. 4 of 2020. This research can support learning and help visualize learning about radiation physics—the radiation measurement tool application in teaching radio physics diagnostics.

METHOD

This research is a quantitative descriptive—the population from all patients with a thorax examination. The author made observations and measurements at the research location. The objects of this research are the walls, doors, and Pb glass in the examination room of the Radiology Installation at Wajak Husada General Hospital. This research uses tools to support the examination, including X-rays and a surveymeter. Figure 1. shows the photo of the radiology examination rooms and Surveymeter. Figure 2. shows the design of the radiology examination room structure of Wajak Husada General Hospital. Data collection techniques in this research are observation, measurement, and documentation. The measurement points are outside the walls of the radiology room, namely A (front wall), B (left side wall), C (back wall), D (right side wall), E (wooden door), and F (Pb glass window). In the early stage, it is measured first before the examination and subsequent measurements during the radiology examination.

Figure 1. The photo of radiology examination rooms and Survey meter.

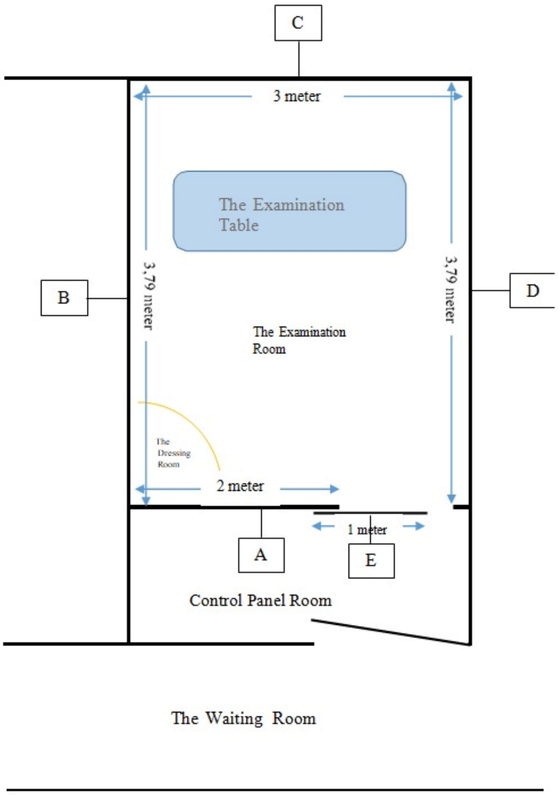

Figure 2. The structural design of radiology installation at Wajak Husada General Hospital

RESULT AND DISCUSSION

Based on observations and research they carried out regarding radiation exposure in the examination room of the Radiology Installation at the Wajak Husada General Hospital as well as measurements of radiation exposure carried out at various predetermined points in the radiology examination room at the Radiology Installation of the Wajak Husada General Hospital. Structural radiation protection of the radiology examination room, then the results are recorded in Table 1.

Table 1. Radiology installation room design

Room Point	Size		
	Length (m)	Thickness (m)	Height (m)
A	2.000 ± 0.080	0.200 ± 0.003	3.400 ± 0.070
B	3.790 ± 0.090	0.200 ± 0.003	3.400 ± 0.070
C	3.000 ± 0.070	0.200 ± 0.004	3.400 ± 0.080
D	3.790 ± 0.070	0.200 ± 0.003	3.400 ± 0.070
E	1.000 ± 0.030	0.180 ± 0.004	2.050 ± 0.070
Radiation sign	Red light indicates radiation is present.		
	Radiation symbol: present		

Radiation Exposure Measurement Results in the Radiology Installation Examination Room at Wajak Husada General Hospital. A (front wall), B (left side wall), C (back wall), D (right side wall), E (wooden door), and F (Pb glass window). The instrument used to measure the radiation exposure rate is a Surveymeter. Measurements using exposure factors in thorax examinations used in each examination room. The results of the measurements obtained data are in Table 2.

Table 2. The results of the measurements obtained data.

Room Point	Examination	Background Dose (μSv/h)	Exposed Dose (μSv/h)	Measurement Results (μSv/h)
A	Thorax	0.09 ±0.001	0.11 ± 0.002	0.02 ± 0.002
B	Thorax	0.09 ±0.002	0.16 ± 0.003	0.07 ± 0.003
C	Thorax	0.09 ±0.001	0.16 ± 0.002	0.07 ± 0.002
D	Thorax	0.09 ±0.003	0.11 ± 0.004	0.02 ± 0.004
E	Thorax	0.09 ±0.004	0.10 ± 0.001	0.01 ± 0.001
F	Thorax	0.09 ±0.002	0.28 ± 0.003	0.19 ± 0.003

According to Bapeten Regulation No. 4 of 2020, the minimum size of the installed X-ray aircraft room must follow the manufacturer's X-ray aircraft technical specifications or international standard recommendations or have the dimensions listed, namely 4 x 3 x 2.8 (length x width x height) m. Based on the results of researchers' observations of the radiology examination room at the Wajak Husada Hospital Radiology Installation, which is 3 x 3.78 x 3.4 (length x width x height) m, the room is following the minimum limits for conventional radiology examination rooms stated in the Perka Bapeten No. 8 of 2011.

Then, in Bapeten Regulation No. 4 of 2020, the room walls for all types of X-ray aircraft are made of 25 cm red brick or concrete with a 2.2 g/cm3 density. The X-ray room door must be lead-coated with a certain thickness of 20 cm or equivalent to 2 mm of lead (Pb). The walls of the radiology examination room at Wajak Husada Hospital are concrete with a thickness of 20 cm. This requirement has met Bapeten Regulation No. 4 of 2020. The door size is 1 x 2.05 (length x height) m and coated with lead (Pb) according to the standard of Bapeten Regulation No. 4 of 2020. Radiation signs in the Radiology Installation examination room at RSUD Wajak Husada are available on the door and have met the requirements according to Bapeten Regulation No. 4 of 2020. One of the factors that are considered in radiology services is radiation protection.

Radiation exposure rate measurements were conducted in the Radiology Installation examination room of Wajak Husada General Hospital using a survey meter measuring instrument with a 107 μSv/hour calibration factor. Measurements were made at 6 points: A (front wall), B (left side wall), C (back wall), D (right side wall), E (wooden door) and F (Pb glass window). The measurement position was outside the wall of the examination room.

This measurement uses a thorax examination technique with a thorax exposure factor of 61 kV and 10 mAs—the radiation exposure measurement (Exposed Dose) from the room radiation measurement (Background dose) result. The background dose is the ambient Dose obtained before irradiation in the natural environment from electronic devices or the sun. Then, the exposure dose is the Dose obtained after exposure. Then, the results are compared with the dose limit value contained in Bapeten Regulation No. 4 of 2020, whether classified as safe for workers and the general public.

According to the Head of Bapeten Regulation number 4 of 2020, the dose limit value for radiation workers should not receive radiation doses exceeding 50 mSv per year, and the average per year should not exceed 20 mSv, while the general public should not receive more than 1 mSv per year. This measurement uses an examination technique often used at Wajak Husada Hospital, namely the thorax examination. The results of radiation exposure measurements carried out at measurement points A, B, C, D, E, and F showed no radiation exposure leaks at several points.

Based on the measurement results obtained in measuring radiation exposure in the examination room, it is still in units of mSv/hour and then converted to mSv/year; according to the author, 6 points are considered safe for workers and the public because the results of measuring radiation exposure at point A are 0.18 mSv/ y, point B and point C are 0.61 mSv/y, point D is 0.018 mSv/y, point E is 0.08 mSv/y, and point F is 0.88 mSv/y and is considered safe for workers and the public because the results of measurements of radiation exposure do not exceed the dose limit value for workers of 20 mSv/year and for the public of 1 mSv/year according to Bapeten Ka Perka number 4 of 2020. Radiation protection is a quantification of the dose limits that are permitted to be received by workers or the general public with actions taken to reduce the damaging effects of radiation due to radiation exposure [11], [18], [19]. BAPETEN determines the maximum threshold that can be accepted by radiology officers and the public so as not to cause detrimental genetic and somatic effects due to the use of nuclear energy in one period of time [4], [7], [20]. For this reason, officers who use radiation equipment when carrying out their work must use radiation protection equipment to protect themselves from excessive radiation rays [9], [21], [22].

CONCLUSION

This research concludes that the results of measuring radiation exposure in the radiology examination room at Wajak Husada General Hospital at point A were 0.18 mSv/y, points B and C were 0.61 mSv/y, point D was 0.18 mSv/y, point E is 0.08 mSv/y, and point F is 0.88 mSv/y. The results of radiation exposure measurements in the radiology examination room at RSUD Wajak Husada at 6 points did not exceed the standards set by Perka Bapeten no. 4 of 2020, so radiation exposure at six measuring points safe for workers and the public because it did not exceed the predetermined dose limit value.

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