Conference Paper

Measurement of Scattered Radiation Dose Around Radiology Unit at Dr. Saiful Anwar Hospital, Malang

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Abstract

The measurement of radiation dose in diagnostic radiology and radiotherapy is considered to be some critical factor+s in optimizing radiation protection for healthcare practitioners, patients and public. This article presents the overview of an average radiation dose measurement in public area around Radiology Unit in Dr. Saiful Anwar Hospital (RSSA), Malang. The critical radiation dose recommendation from BAPETEN is below 50 mSv/year for healthcare practitioners and below 5 mSv/year for public area. This radiation dose measurement was done outside the CT Scan room, radiotherapy Cobalt-60, brachytherapy and fluoroscopy room, and X-ray room, using RGD 27091 survey meter. The measurement of radiation background was held while all instruments producing radiation were in standby position. The average value of radiation background around radiology unit was 0.83 μSv/h. The lowest dose rate measurement was 0.6 μSv/h at CT scan area, and the highest dose rate measurement was 3.57 μSv/h, which was in front of the brachytherapy unit's door. The measurement results show that the scattered radiation dose around radiology unit is lower than the critical radiation dose recommendation from BAPETEN.

Keywords: radiation, scattering, radiation dose

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1. Introduction

Medical radiation is commonly used in clinical diagnosis and treatment; however, improper use can result in serious damage to the human body [1, 2]. The use of X-ray and gamma ray has extended and become very important in both diagnostic radiology imaging and radiotherapy. Nowadays, radiology seems to be a necessary procedure in diagnosis and treatment of patients. X-ray examinations have several clinical advantages. In a lot of ways, it has preserved its priority over other diagnostic methods. In most cases, X-ray is the first choice of the diagnostic algorithm examination. In fact, X-ray examination is still the most frequently used modality [3].

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Scattered photons are radiations that change in direction as a result of interaction with some media. These scattered photons are detrimental to contrast the image, reduce accurate representations of human anatomy, and increase the patients and workers dose [4, 5]. The scattered radiation occurs when the photon scatters to the side or is reflected 90° from the initial photon beam. The back scattered radiation is when the photon scatters is in a backward direction from the initial primary beam, at either 180° or at various angles [4].

Ionizing radiation has, since its discovery, proved to be able to bring the human population tremendous benefits when used in medicine, but as ionizing radiation is associated with risks due to stochastic and deterministic effects, it is necessary to consider the protection of patients from potential harm [2]. Unnecessary exposure of patients can arise from medical procedures that are not justified for a specified objective, application of procedures to individuals that are not justified on the basis of their conditions, and medical exposures that are not appropriately optimized for the situation in which they are used. This can lead to unnecessary risks due to stochastic effects. Unintended exposure of patients can arise from unsafe design or use of medical technology, leading to deterministic effects. Radiation protection of patients is intended to protect from both unnecessary and unintended exposures [1]. The critical radiation dose recommendation from BAPETEN referring to ICRP is below 50 mSv/year for healthcare practitioners and below 5 mSv/year for public area [6].

2. Methods

The scattered radiation dose measurement was performed in radiology unit at dr. Saiful Anwar Hospital (RSSA). This measurement was done outside the CT Scan room, radiotherapy Cobalt-60, brachytherapy and fluoroscopy room, and X-ray room, using Rontgen Gamma Ray Dosimeter (RGD 27091). RGD 27091 is battery-operated dosimeter and the dose rate meter provided with an ionization chamber. It is used for measuring continuous roentgen and gamma rays. This device is applicable for measuring pulsed roentgen rays in the dose rate mode as well. Its high measuring sensitivity, low dependence on energy and direction of the probe allow for reliable measurements. Besides its main application as a precision radiation protection dosimeter, the device can also be used as a dosimeter for high dose rates because it has wide measuring range.

The measurement for all rooms was done in the fixed point, that is usually crossed by medical staff, radiographer or the patient guardian or is usually called public area.

The dose value in each point is made from the average of five repetitions from measurement in the same point but different patient, because the measurement was done simultaneously while the source of radiation operated. Measurement of background radiation was held while the source of radiation in standby position. The point of background radiation measurement was near the source of radiation inside the room, and the value of background radiation was the average value of measurement in each room.

3. Result

The scattering radiation doses at different point in radiology unit of dr. Saiful Anwar Hospital (RSSA) were measured. By using RGD 27091 dosimeter, the scattered radiation doses at the public area (outside diagnostic room) were detected. The average indoor background radiation in radiology unit RSSA was 0,83 μSv/h. The measured background radiation in Brachytherapy and fluoroscopy unit was 1 μSv/h, in radiotherapy Cobalt-60 was 0.7 μSv/h, in the CT Scan unit was 1.01 μSv/h and in the X-ray unit was 0.63 μSv/h. The results of measurement at several point are as follow:

3.1. CT scan room

CT Scan room is located in the first floor of radiology unit at the back office of radiology. The measurements are located in six point, see Figure 1:

- Point A is located in the backside of the door linked the operator room.
- Point B is located in the operator room.
- Point C is located in the entrance door.
- Point D is located in the east side radiation source linked to the radio diagnostic corridor.
- Point E is located in the south side of radiation source.
- Point F is located in the west side of the room's wall.

The result of measurement at CT scan area can be seen in Table 1. The highest measurement is 1.85 μSv/h at point A and the lowest is 1.13 at point E.

3.2. Result of dose rate measurement in CT scan area

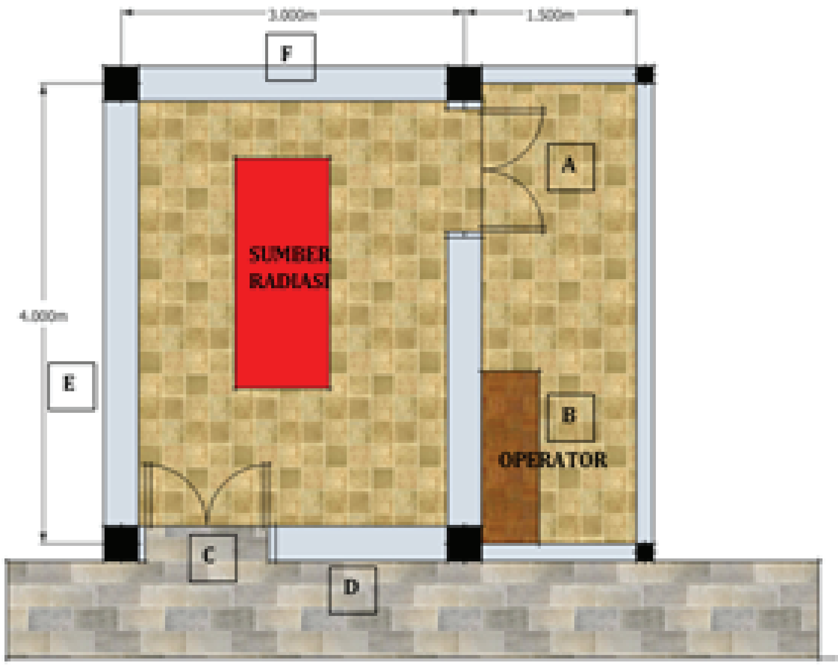

Figure 1: Point of measurement at CT Scan area.

Table 1

No.	Position	Dose Rate (μSv/h)
1	A	1.85
2	B	1.48
3	C	1.36
4	D	1.38
5	E	1.13
6	F	1.21

3.3. Radiotherapy Cobalt-60

The dose rate measurement in radiotherapy unit is located in second room of radiotherapy Cobalt-60. The source of radiation comes from gamma rays. The point of measurement is as seen in Figure 2.

- Point A is located in the operator room.
- Point B is in the west side of the room's wall.
- Point C is located in the north side of the room's wall.
- Point D is located in the east side of the room's wall.

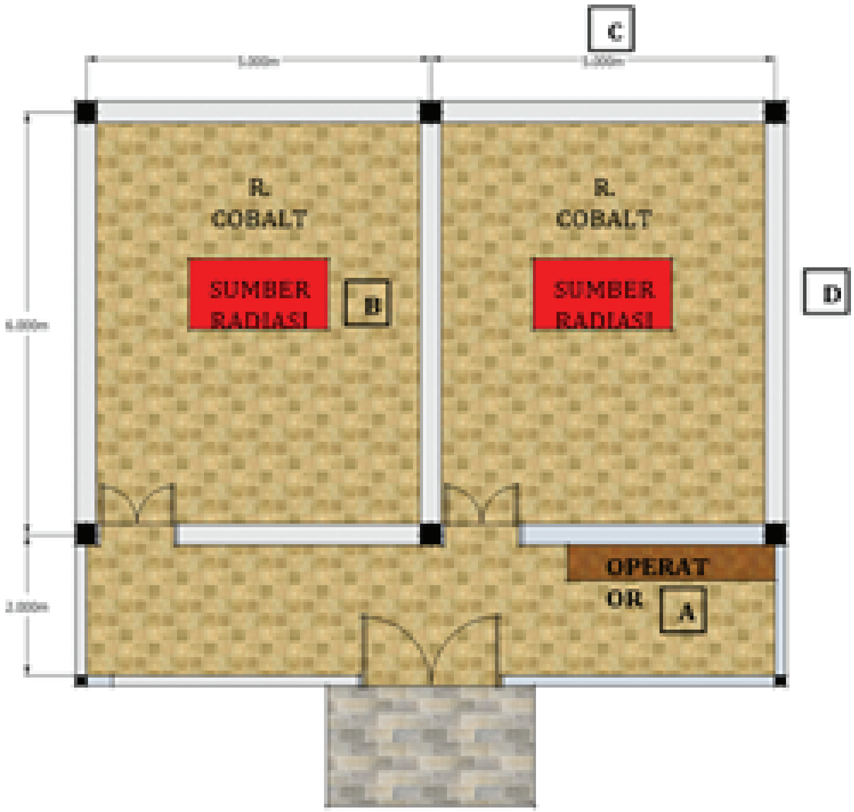

Figure 2: Point of measurement at radiotherapy Cobalt-60 area.

The result of measurement from gamma rays scattering in radiotherapy unit can be seen in Table 2.

3.4. Result of dose rate measurement in radiotherapy Cobalt-60 area

Table 2

No	Position	Dose Rate (μSv/h)
1	A	1.068
2	B	1.066
3	C	1.032
4	D	1.066

3.4.1. Brachytherapy and fluoroscopy area

The source of fluoroscopy comes from X-ray radiation. At this area, the measurement was done in six points, see Figure 3. Point A is located in entrance room, point B is located in operator room, point C is located in the north side of the room's wall, point D is located in the east side of radiation source, point E is located in east side, point F located in the south side. The background radiation was measured inside the room at point E, and the result of measurement was in 1 μSv/h.

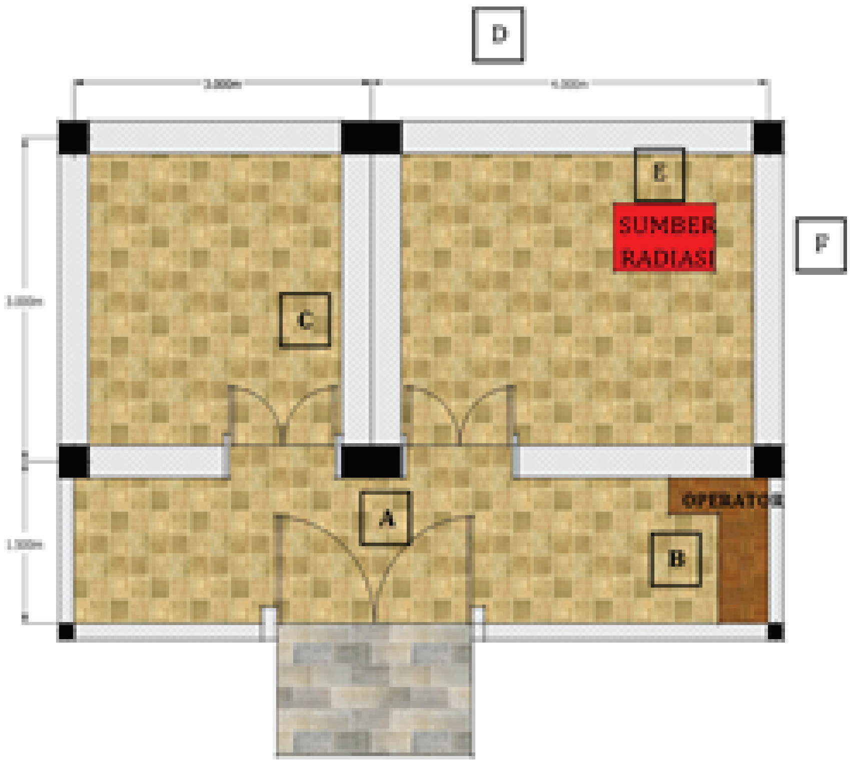

Figure 3: Point of measurement at brachytherapy and fluoroscopy area.

The result of dose rate measurement in brachytherapy and fluoroscopy unit can be seen in Table 3.

3.5. Result of dose rate measurement in brachytherapy and fluoroscopy area

3.5.1. X-ray area

The measurement of X-ray area was done in five points, see Figure 4., point A is located in the operator room, point B is located in the west entrance, point C is located in the

TABLE 3

No.	Position	Dose Rate (μSv/h)
1	A	3.57
2	B	0.64
3	C	0.75
4	D	1.27
5	E	0.97
6	F	0.75

north side of the room's wall, point D is located in the east side of the room's wall. Point E is located in the south entrance.

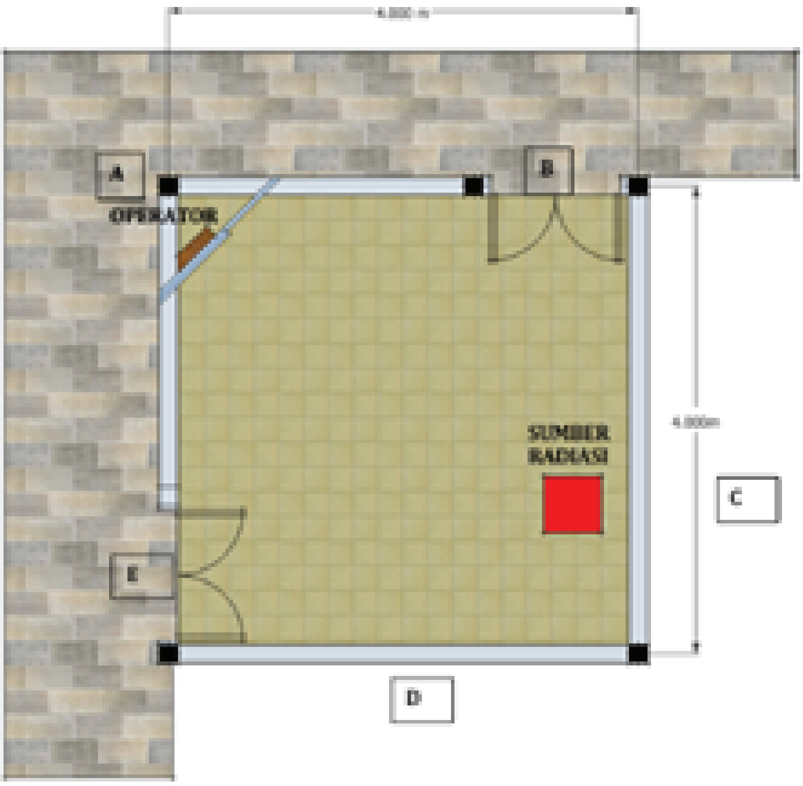

Figure 4: Point of measurement X-ray area.

The result of dose rate measurement in X-ray area can be seen in Table 4.

3.6. Result of dose rate measurement in X-Ray area

Table 4

No.	Position	Dose Rate (µSv/h)
1	A	3.57
2	B	0.64
3	C	0.75
4	D	1.27
5	E	0.97
6	F	0.75

4. Discussion

According to the limits of exposure radiation for medical staff mandated by the BAPETEN referring to ICRP, the effective radiation dose should not exceed 100 mSv in five years and the effective dose in a single year should not exceed 50 mSv and 5 mSv for public area [1, 6]. The construction of radiology unit in RSSA were made from brick and cement with the thickness of 20 cm for X-ray, and 30 cm thickness for gamma ray. The entrance door and operator door were coated using 2 mm lead, and for the window were coated using 5 mm glass lead. The construction was based on radiation protection for medical staff and public area.

The dose rate measurement outside CT Scan room was about 1.13 to 1.85 µSv/h. The lowest value was point E that was located in the operator desk, while the highest value was point A that was located in the door linked to the operator room. Point A was the nearest position from the source of radiation. The public area around CT Scan room was located at point C and D (Figure 1). The result from measurement around radiotherapy room was about 1.032 to 1.068 µSv/h. In this area, the dose rate was lower than other area of which the source of radiation is gamma ray. It means that the protection of radiation in this area is good for public service. The dose rate measurement around brachytherapy and fluoroscopy area was about 0.64–3.57 µSv/h. The lowest value in this area was at point B (the operator desk) and the highest value was at point A at the entrance door (Figure 3). At the X-ray area, all of the measurement shows that the value was below 1 µSv/h. At this area, the public area was point A, B and E (Figure 4).

However, radiation exposure is a sensitive topic among medical personnel and public area. Fortunately, according to the present results, the value of scattered radiation dose around radiology unit in RSSA is about 0.6 – 3.57 µSv/h lower than ICRP and BAPETEN recommendation. The value of scattered radiation was attenuated to the background radiation level. Additionally, since radiological technicians wear lead clothing during exposure, they need not be concerned. In the present work, the experiments were conducted in an operating room, and the scattered radiation doses from exposure in real situations were measured. The data of scattered radiation attenuation in a space when being exposed were established, which will enrich professional knowledge of radiation safety for clinical radiological technicians and provide useful data for radiological students.

5. Conclusions

The scattered radiation doses around radiology unit of dr. Saiful Anwar Hospital were detected using RGD 27091 dosimeter. During the experiment, the area that was investigated is around CT scan unit, brachytherapy and fluoroscopy unit, radiotherapy unit and X-ray unit. The source of radiation is not only from X-ray but also from gamma ray. The average indoor background radiation in radiology unit RSSA is 0.83 μSv/h. The value of scattered radiation around radiology unit is 0.6 – 3.57 μSv/h lower than ICRP and BAPETEN recommendation.

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