14_IOP 2016_dampak radiasi.pdf

anonymous marking enabled

Journal of Physics: Conference Series

Analysis of Radiation Impact on White Mice through Radiation Dose Mapping in Medical Physics Laboratory

To cite this article: Madnasri Sutikno *et al* 2016 *J. Phys.: Conf. Ser.* **739** 012124

Analysis of Radiation Impact on White Mice through Radiation Dose Mapping in Medical Physics Laboratory

Madnasri Sutikno [1,a)], Susilo[2] and Riza Arya Wijayanti[3]

[1,2,3]Department of Physics, Faculty of Mathematics and Natural Sciences, Semarang State University, D7 Building, 2nd Floor, Sekaran Campus, Gunungpati, Semarang, Indonesia, 50229

[a)]E-mail : smadnasri@yahoo.com

Abstract. A study about X-ray radiation impact on the white mice through radiation dose mapping in Medical Physic Laboratory is already done. The purpose of this research is to determine the minimum distance of radiologist to X-ray instrument through treatment on the white mice. The radiation exposure doses are measured on the some points in the distance from radiation source between 30 cm up to 80 with interval of 30 cm. The impact of radiation exposure on the white mice and the effects of radiation measurement in different directions are investigated. It is founded that minimum distance of radiation worker to radiation source is 180 cm and X-ray has decreased leukocyte number and haemoglobin and has increased thrombocyte number in the blood of white mice.

1. Introduction

Radiation is a emission process of energy in the forms of waves or particles from radiation sources or radioactive particles [1]. X-ray radiation is an external radiation source which is produced by X-ray tube, a radiation source outside of human body. In the external radiation protection, there are three techniques to control radiation exposure to the radiologist such as by minimizing exposure distance, exposure time and using radiation shield [2].

Syahria et al. (2012) reported that scattering radiation exposure amount will decrease as well as the exposure distance increase [1]. Therefore, the exposure distance is necessary to be given more attentions and the radiologist must know the safe points of their working area.

Specifically, the technicians in the Medical Physics must know comprehensively for the risk of radiation exposure. The accepted radiation dose by radiologist depend on their positions. A mapping of radiation dose in the area of medical physical laboratory is required to determine the safe position for the technician so that they will be more cautious when they work around the X-ray instrument. The radiation is emitted isotropically and as the exposure distance decreases the accepted radiation increase as well.

Some radiation exposures will be scattered emissions when they touch matters. This scattered radiation will increase amount of received radiation doses by radiologist. To avoid this risk, the radiation worker can pose a safe distance of radiation sources [3].

The radiation intensity is defined as radiation amount that penetrates area (cm^2) per second (s). The radiation intensity (I) of spherical surfaces of radius R1 and R2 each is

$$I = \frac{P}{A} \quad (1)$$

$$I_1 = \frac{P}{4\,\pi\,(R_1)^2} \quad (2)$$

$$I_2 = \frac{P}{4\,\pi\,(R_2)^2} \quad (3)$$

Where

I = Intensity (watt/m^2)
P = Power
A = Area of sphere surface

Equation (1) can be subsituted into Equation (2) becomes

$$I_1 : I_2 = \frac{1}{(R_1)^2} : \frac{1}{(R_2)^2} \quad (4)$$

The ratio of radiation intensities equals to inversely ratio of sphere radius [4]. Radiation exposure can cause genetically cell changes on living creatures. One of these changes is chromosome structure change of blood lymphocite [5]. White mice is one of the most frequently mammals used in the research either in medical, pharmacy or biology [6]. The white mice are often used in the experiment laboratory, especially in the biology laboratory, due to their excellencies such as relatively short life cycle, fastly breeding, easily treated in large scale of farming, high amount of genetic variations, well characterized anatomy and physiology, high number of children per birth, high genetic variation, well characterized anatomy and physiology, easy handle, and production and reproduction like human [7].

In many reports of radioteraphy cases, the amount of leukocyte and erythrocyte of the radioteraphy treated patients decreased [8]. Leukocytes play role in maintaining body immune to foreign objects and againts para antigen. It is wellknown that leukocyte is the most sensitive cell to radiation or highest radiosensitivity [9]. Leukocyte is part of body immune system [10]. This research is aimed to investigate radiation impact on the radiologist in Medical Physics Laboratory.

2. Method

2.1. Radiation Dose Map

The radiation level measurement is done around Medical Physic Laboratory. It is measured using analog surveymeter and the result is mapped in the form of distribution contour of radiation level using Software Surfer 10. There are three surveymeter heights of measured points, namely 50 cm, 75 cm, and 150 cm. Based on the mapping result, it can be identified the safe points for radiologist. The minimum safe distance is distance between safe point with radiation source. This safe point is assumed as a point with radiation level lower than 10 µSv/jam. The radiation dose is measured at every distance of 30 cm up to distance of 180 cm to east and west of radiation source as shown in Figure 1. The measurement result on the each height is mapped in the 2D contour to delineate radiation level distribution.

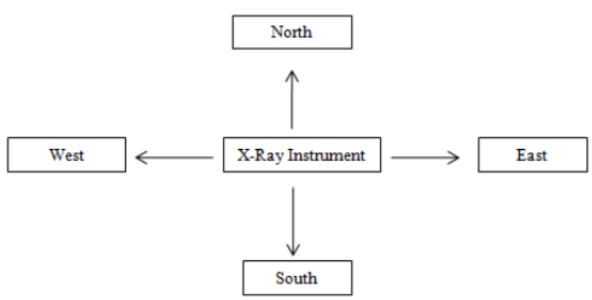

Figure 1. Layout of radiation exposure measurement instrument in the Medical Physics Laboratory.

Journal of Physics: Conference Series **739** (2016) 012124 doi:10.1088/1742-6596/739/1/012124

2.2. Testing of X-ray Radiation Impact on the White Mice

This research uses 12 *Mus musculus* which have weight each ±25 gram and ±2 months old and is divided into four groups, each consists of three white mice. They all are exposed under radiation and detected from different positions as illustrated in Table 1.

Table 1. X-ray Radiation exposure level and measurement direction on the white mice.

Group	Direction	Radiation exposure (μSv/h)
I	Distance: 45cm, Direction: Southeast	10.000
II	Distance: 45 cm Direction: Southeast	2.500
III	Distance: 60 cm Direction: South	500
IV	Distance: 60 cm Direction: west	65

The exposures on the white mice were done for six days, each once exposure per day. The white mice blood is taken in the Biology Laboratory, Semarang State University. The white mice blood was taken of white mice's eye parts due to they have very small blood vessel so that it's blad could be aspirated using hypodermic needle. The lower part of white mice cornea was stabbed using small needle. The white mice blood flowed through needle and poured in the microtube. The white mice blood was tested using blood analyzer in the Ungaran District's Medical Laboratory. The blood was tested to determine amount of leukocyte, erythrocyte, haemoglobin, and thrombocyte at each white mice group during six days.

3. Results And Discussion

3.1. Radiation Exposoure Level Mapping

The measured exposure dose on the surveymeter was recorded using digital camera. The used x-ray equipment in measuring radiation level is x-ray instrument (Mednif SF100BY). The exposure factors which used in measurement is 80kV, 32mA, and 0,5s. The radiation level is measured on the different heights, namely 150cm, 75cm, and 50 cm from X-ray instrument. The data is mapped using Surfer 10 Software as depicted in Figures 2, 3 and 4.

Journal of Physics: Conference Series **739** (2016) 012124 doi:10.1088/1742-6596/739/1/012124

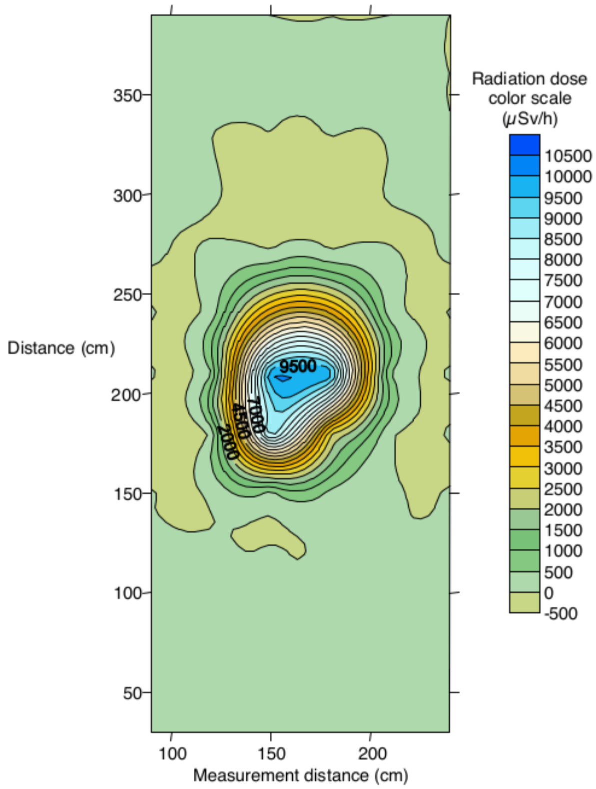

Figure 2. The 2D mapping of radiation exposure level at 150cm height of X-ray instrument tube.

X-ray radiation source poses a coordinate (150,200) cm. In Figure 2, it seems that the further measument distance the lower accepted exposure radiation. The largest of measured radiation exposure is 10.000 $\mu sV/h$, under radiation source which is shown with blue, while the lowest one is 0 $\mu sV/h$, at a distance of 180cm from radiation source coordinate point (150,0) cm for west direction and for east direction at coordinate (150,350)cm which is shown with green colour.

In Figure 3, it seems that X-ray radiation dose at a height of 75 cm equals to 9500 $\mu sV/h$, under radiation source which is shown by red colour in the contour. The lowest radiation dose is found at a distance of 120cm from radiation source point, (150,90) cm, which is shown with light blue.

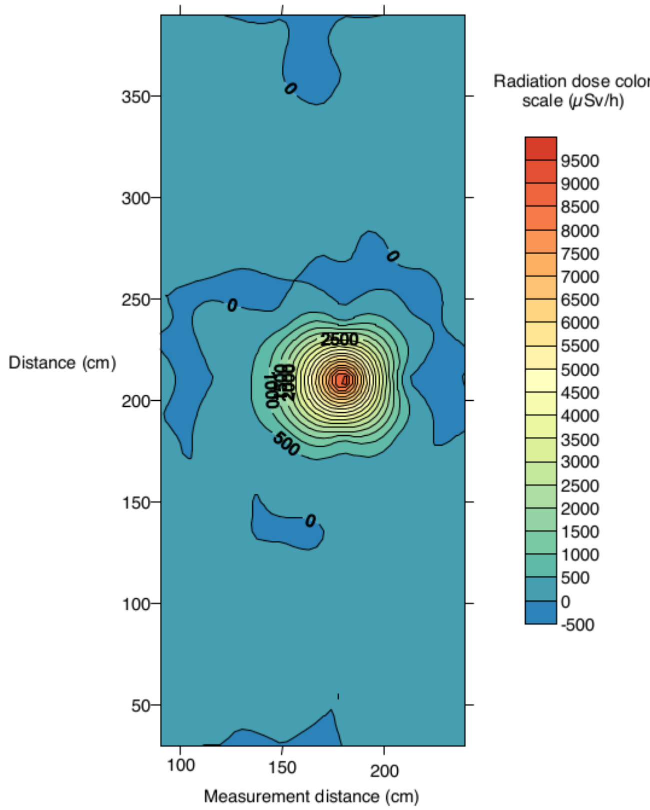

Figure 3. The 2D mapping of radiation exposure levels in 75cm height over X-ray instrument.

In Figure 4, it appears that the highest radiation exposed area, 900 $\mu sV/h$, is shown in scarlet. The detected radiation exposure decreased from 900 $\mu sV/h$ down to 0 $\mu sV/h$ which is indicated by the color change of light to dark. The lowest radiation exposure is detected at a distance of 120cm from radiation source (west zone), (150,90) cm, and east zone, (150,300) cm, which is shown in dark blue. In this research the same exposure factors were used, but the heights are different.

The accepted radiation dose decreased as well as the exposure distance increased. The safe distances to radiation source for radiologist are 180cm (to east) and 120cm (to west).

Based on the decree of the Nuclear Energy Regulatory Agency of Indonesia about operational work safety of radiology diagnostic No. 1-P/KA BAPETEN/IV-199, the safe work point is 3m with radiation dose limit equal to 10 μSv/h and 0,5 μSv/h, for radiation worker and public, respectively [11]. The radiation intensity decreased as well as the exposure distance increased in agreement with [12]:

$$\left(\frac{I_1}{I_2}\right) = \left(\frac{d_2}{d_1}\right)^2 \quad (5)$$

Radiation is emitted of radiation source isotropically [3].

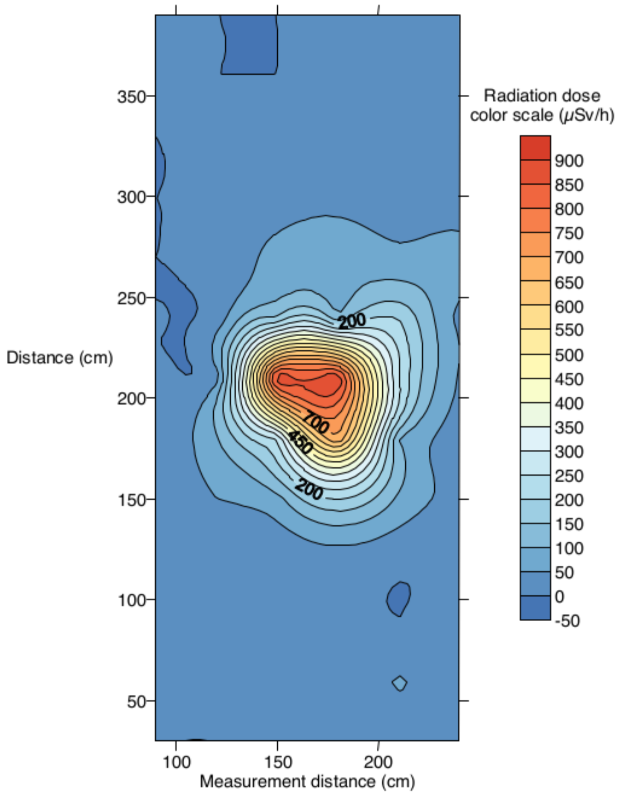

Figure 4. The 2D mapping of radiation exposure at 0 cm height over X-ray instrument.

3.2. Testing of X-ray Radiation Impact on Mus musculus

The testing result of white mice blood is tabulated in Table 2.

Table 2. Testing Result of White Mice.

Group	Radiation exposure (μSv/h)	Hb (g/dL)	∑Leukocyte ($x10^3/mm^3$)	∑Erythrocyte ($x10^6/mm^3$)	∑Trombocyte ($x10^3/mm^3$)
Normal		13-16	6-12,6	7,7-12,5	150-400
I	10.000	17	4,75	11,69	867,5
II	2.500	6,65	3,05	4,245	115
III	500	8,97	2,7	6,42	212,33
IV	65	13,53	8,37	9,56	613, 67

In Table 2, normal haemoglobin content in blood equals to 13-16 g/dL. Post-exposure of radiation, the haemoglobin in the white mice is divided into four groups, the highest haemoglobin content is found in the highest radiation exposed blood (10.000 $\mu sV/h$). The groups II and III have experienced the haemoglobin content in the blood up to under normal condition namely each 6,65 and 8,97 g/dL. Each white mice has different initial haemoglobin content so that it can not be determined a linear correlation between radiation exposure dose with it's last haemoglobin content.

The amount of haemoglobin in the white mice's blood of group IV, 13,53 g/dL, is still in the normal criterion. The amount of leukocyte in the white mice's blood to lower the normal content of haemoglobin for groups I, II and III. The amount of leukocyte in blood for groups I, II, and III equal to 4,75x10^3/mm^3, 3,05 x10^3/mm^3, and 2,7 x10^3/mm^3, respectively. In group IV the amount of leukocyte has been still in normal limit (6-12,6x10^3/mm^3). This occurs due to the group IV was exposed with the lowest radiation dose. The amount of erythrocyte in blood for Groups I (11,69x10^6/mm^3) and IV (9,56x10^6/mm^3) remain stay in the normal limit (7,7-12,5x10^6/mm^3), while for Group II and III they decreased down to 4,24 x10^6/mm^3 and 6,42x x10^6/mm^3, respectively. The normal content of thrombocyte in the range of 140-500 x10^3/mm^3. The thrombocyte contents in the mice blood of Group I increased up to 867,5x10^3/mm^3, Group II decreased down to 115 x10^3/mm^3, Group III remains in normal limit (212,33 x10^6/mm^3) and Group IV increased up to 613,67 x10^6/mm^3.

Radiation has caused deceleration or termination of haematopoiesis process so that reproduction of red blood cells, and erythrocytes, decreased and the amount of leukocyte also decreased. The radiation dose as much as 2 – 10 Gy can destroy hemopoetik (melodysplastic syndrom) which is indicated by the leukocyte decreasing [13].

4. Conclusion

In conclusion, the highest radiation exposure is in nearest position of radiation source, the intensity decreased as well as the the exposure distance increased. It is found that the safe distance of radiation worker to radiation source equals to 180 cm (for measurement from east side) and 120 cm (for measurement from west side). The impact of X-ray radiation to white mice are the leukocyte, erythrocyte and hamemoglobin decreased and inversely the thrombocyte increased.

Acknlowledgment

We thank Mr. Mutaqin, S.Pd. (Technician of Physics Laboratory, Semarang State University) or his technical help and Dr. Suharto Linuwih, S.Pd. (Head of Physics Department, Semarang State University) for his permission.

References

[1] Syahria E Setiawati and Firdausi KS 2012 *Berkala Fisika* **15(4)** 123
[2] Akhadi M 2000 *Dasar-Dasar Proteksi Radiasi (1sted)* (Jakarta: Rineka Cipta)
[3] Ulum MF 2008 *Prinsip Dasar Proteksi Radiasi dalam Diagnostik Proceedings Joint Meeting of the 3rd International Meeting on AZMWC2008 and KIVNAS X PDHI* (Bogor: PDHI)
[4] Fauziyah A, Susilo and Dwijananti P 2013 *Unnes Physics Journal* **2(2)** 1
[5] Alatas Z 2005 *Buletin Alara* **5(203)** 99
[6] Hariadi 2012 *Peluang Jitu Beternak Tikus Putih* (Yogyakarta: Pustaka Baru Press)
[7] Pribadi GA 2008 *Penggunaan Mencit Dan Tikus sebagai Hewan Model Penelitian Nikotin Skripsi* (Bogor: Institut Pertanian Bogor)
[8] Prisyanto R Santoso D.R. Juswono UP & Cahyati Y 2014 *Natural* **B 2(3)** 289
[9] Wardhana WA 1996 *Radioekologi* (1st ed) (Yogyakarta: Penerbit Andi Ofset)
[10] Widyasari E Listyawati S and Pangastuti A 2007 Bioteknologi **4(1)** 13.
[11] Bapeten 2003 *Pedoman Dosis Pasien Radiodiagnostik Keputusan Kepala Badan Pengawas Tenaga Nuklir nomor 01-P /Ka-BAPETEN/ I-03* (Jakarta: Bapeten)
[12] Fosbinder RA and Kelsey CA 2001 *Essentials of Radiologic Science (Int Ed Series)* (New York: McGraw-Hill Education)
[13] Hall EJ 2000 Radiobiology for the Radiologist (5th eds) (Philadelphia: Lippincott Williams)

14_IOP 2016_dampak radiasi.pdf

ORIGINALITY REPORT

9%	8%	6%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.science.gov Internet Source	2%
2	Submitted to Universitas Negeri Semarang Student Paper	2%
3	pure.mpg.de Internet Source	2%
4	Hualiang Zhong, Indrin J Chetty. "Adaptive radiotherapy for NSCLC patients: utilizing the principle of energy conservation to evaluate dose mapping operations", Physics in Medicine and Biology, 2017 Publication	1%
5	media.neliti.com Internet Source	1%
6	Submitted to Universitas Diponegoro Student Paper	1%
7	revues.imist.ma Internet Source	1%
8	Submitted to University of Portsmouth Student Paper	

<1%

9 Botas Sanmartin, Pablo. "Adaptive proton radiation therapy via fast Monte Carlo dose calculation to correct for inter- and intra-fraction motion and geometry changes", 'American Association for Cancer Research (AACR)', 2019 <1%

Internet Source

10 Haisen S Li, Hualiang Zhong, Jinkoo Kim, Carri Glide-Hurst, Misbah Gulam, Teamour S Nurushev, Indrin J Chetty. "Direct dose mapping versus energy/mass transfer mapping for 4D dose accumulation: fundamental differences and dosimetric consequences", Physics in Medicine and Biology, 2014 <1%

Publication

11 K M Oh, Y J Heo, D K Kim, J S Kim, J W Shin, G H Lee, S H Nam. "Improvement of the charge-carrier transport property of polycrystalline CdTe for digital fluoroscopy", Journal of Instrumentation, 2014 <1%

Publication

Exclude quotes On

Exclude matches Off

Exclude bibliography On