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The quantity and leukocytes components as biological dosimeters on the radiation workers at Radiology Installation Sanglah General Hospital Denpasar, Bali-Indonesia

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ABSTRACT

Introduction: Radiation monitoring program is applied to all the radiation workers using physical dosimeter, in the TLD form, badge films, and others. The monitoring of the biological aspect is called biological dosimeter as an indicator of the organ damages that caused radiation exposure, especially on the radiation workers in the radiology installation Sanglah General Hospital are not much studied. These study aims are determining the quantity and leukocytes components differences that caused environmental radiation exposure in direct contact radiation and direct non-contact radiation workers.

Method: The research data was obtained through the blood test at Sanglah General Hospital Denpasar with diffraction count method. The extent of the leukocyte component is determined by the absolute count method. The population in this study were 70 people with the total sample were 35 direct radiation workers (30 radiographer people, five medical physicists) and 35 direct non-contact radiation workers (12 nurses, 18 administrative personnel, five medical records).

Results: All the blood cell quantity values (hemoglobin-HGB, RBC-erythrocyte, leukocyte-WBC), as well as the percentage of WBC components (basophil-Baso, eosinophil-Eos, Neotropifil-Neo, lymphocytes -Lymph and Monocyte-Mono) for radiation workers and non-radiation workers in the normal range. However, there is a significant difference in hemoglobin component between radiation workers and non-radiation workers, others blood parameter (RBC, WBC, and leukocyte component) doesn't show any significant difference between two group worker.

Conclusions: Long time in the radiation field area which increases the deterministic effect the cells of the human body response. Primarily, biological indicators of radiation as a dosimeter are used.

Keywords: Blood cell, dosimeter, biology of radiation

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INTRODUCTION

The increasing public demands for radiation services has been responded by Sanglah General Hospital Denpasar, using the advanced medical of the radiology equipment for diagnostic and therapy. Potentially, the radiation workers receive radiation exposure due to work with equivalent dose amounts which may exceed or near of the limit value dose are permitted, in the case of an accident due to incorrect working procedures.[5] Radiation monitoring programs are applied to all the radiation workers using physical dosimeters, TLD, badge and another film.[11] The monitoring of biological aspects is based on the biological parameters of a biomarker as an indicator of the body damage due to radiation exposure.[13]

The quality of radiation services is supported by knowledge and special skills to ensure the safety of radiation workers and patients.[5,6] Radiation exposure can harm the circulatory system routine (hematology), especially white blood cells (leukocytes). Bone marrow is the target organ of the blood-forming system because exposure to high doses of radiation will result in death within a few weeks.[1] This is due to a sharp decline in the number of basal cells in the bone marrow.[12] A dose of about 0.5 Gy in bone marrow can lead to suppression of the formation of blood cell components such as red blood cells (erythrocytes), white blood cells (leukocytes) and blood platelets (platelets), resulting in a decrease.[1,4,8] The number of lymphocyte cells decreased within a few hours after radiation exposure, while the number of granulocytes and platelets also decreased but in a longer time, several days or weeks.[5,7] While the decrease in the number of erythrocytes occurs more slowly, a few weeks later. The absolute/total number of absolute lymphocyte cell counts can be used to estimate the severity that a person may suffer from acute radiation exposure.[10]

The individuals exposed to death as a result of infection due to decreased leukocyte count or from unstoppable bleeding due to decreased platelet count for the high doses. For a while, the leukocytes are very sensitive to the effects of ionizing radiation that would cause biological changes in tissues in the form of direct, destructive action on macromolecules biologic and indirect response through DNA that results in radiation workers.[1] Lymphocytes are known to be the most radiosensitive blood cells, followed by granulocyte cells, platelets, and erythrocytes as the cells most resistant to radiation. Some biological components will change radiation exposure as a direct result of radiation damage and in response to cell repair or regeneration processes. Hematopoietic dosimeters commonly used as indications of radiation exposure are the counts of absolute lymphocytes, neutrophils, placebo, and red blood cells. Whereas the biological dosimeter that has been considered reliable in estimating and showing actual deterioration is in the absolute count of peripheral blood lymphocytes.[6] The method can be used to estimate the dose of radiation exposure that received by individual radiation workers.[10] So it is necessary to monitor the biological aspect called biological dosimeter for the radiation workers at Radiology Unit in Sanglah General Hospital Denpasar.

Table 1 Research sampling descriptions

Sample Characteristics	Frequency	Percentage
Radiation Workers		
Medical Physicist	5	14.3%
Radiographer	30	85.7%
Non-Radiation Workers		
Nurses	12	34.3%
Administrative personnel	18	51.4%
Medical record worker	5	14.3%

METHODS

Populations and Samples

Populations in this research are Radiology workers at the Sanglah General Hospital; they are 70 peoples. The 35 peoples are direct radiation workers (30 radiographers, five medical physicists) and 35 peoples are direct non-contact radiation workers (12 nurses, 18 administrative personnel, five medical records). The method of sampling with simple random, i.e.all the populations have equal opportunity and freedom to be taken as a sample.

Data Sampling Procedures

The blood sample was taken from venous blood in radiation workers taken from one vein cubiti as much as 2-3cc then mixed with anticoagulation (EDTA) so as not to thicken.Bundle bonds are mounted on the upper arm to clarify the vein.The location of the vein was cleaned with 70% alcohol and allowed to dry. After the blood into the tube to the desired volume, the needle is ready to be unplugged. The container is released, and the hand is stretched.

The quantity and leukocytes components calculation was done to calculate the number of leukocytes, the blood droplets are sucked with pipettes right up to the 0.5 line, then wipe the tip of the pipette with tissue paper. Furthermore, calculating the various leukocytes components, taken one drop of blood alone. Then the blood is dripped on the glass object using smearing. Calculation of leukocyte quantity and its components are done in the laboratory at the Sanglah General Hospital Denpasar.

Data Processing and Analysis

Data processing started from the editing, coding, entry and tabulating stage was done with SPSS (Statistical Product and Service Solutions) program

Table 2 The age ranges (years) of the radiation and nonradiation workers

Workers Specification		Age Ranges (Year)					
Radiation Workers	Non Radiation Workers	21-30		31-40		41-50	
		Frequency	%	Frequency	%	Frequency	%
Medical Physicist		2	40	1	20	2	40
Radiographer		9	30	15	50	6	20
	Nurses	2	16.7	6	50	4	33.3
	Administratives personnel	10	55.6	6	33.3	2	11.1
	Medical record worker	1	20	4	80	0	0

Table 3 Test of normality Kolomogorov Smirnov-Z

Variable	p-value
Red Blood Cell	0.857
Hemoglobin	0.162
White Blood Cell	0.093
Basophil	0.126
Neutrophil	0.251
Eosinophil	0.057
Lymphocyte	0.325
Monocyte	0.911

Table 4 The comparison of blood parameters between radiation worker and non-radiation worker

Blood cells	Normal Value	Value Blood Cell Component (Mean ± SD)		p-value
		Radiation workers	Non-Radiation workers	
HGB	13.5 - 17.5 (g/dL)	14.94 ± 1.58	13.99 ± 0.84	0.003
RBC	4.06 - 4.69 (106 /μL)	5.26 ± 0.45	5.11 ± 0.52	0.210
WBC	3.70 - 10.1 (103/μL)	7.16 ± 1.91	7.44 ± 1.41	0.489
Leukocyte Components (%)				
Basophil	0.00 - 1.70 %	0.07 ± 0.03	0.08 ± 0.04	0.415
Neutrophil	39.3 -73.7 %	4.38 ± 1.05	4.39 ± 1.02	0.961
Eosinophil	0.60 -7. 30 %	0.16 ± 0.09	0.16 ± 0.08	0.947
Limphocyte	18.0 - 48.3 %	2.17 ± 0.71	2.25 ± 0.52	0.568
Monocyte	4.40 - 12.7 %	0.52 ± 0.15	0.54 ± 0.13	0.579

for Windows version 17. Furthermore, it was analyzed descriptively, analytical test, firstly done normality test for normal distributed data. To determine the red blood cells, hemoglobin, white blood cell, and leucocyte components differences on the direct contact radiation workers and direct non-contact radiation workers, an independent sample t-test was used with $\alpha = 5\%$.

RESULT AND DISCUSSION

This study used 70 subjects, divided in two group, 35 radiation workers and 35 non-radiation workers. The research was done in Radiology Unit of Sanglah Denpasar Hospital, the research subject as shown in Table 1.

Based on table 1, medical physicist profession as much as 14.3%, radiographer profession as much as 85.7%, nurse as much as 34.3%, administrative personnel as much as 51.4%, and medical record worker as much as 14.3%.

The distribution of research samples for the radiation workers and non-radiation workers is grouped over the age range in the year as shown in Table 2.

Based on table 2, medical physicists have the same number of ages over the age range of 21-30 years and 41-50 years, radiographer are more often with age range 31-40 year (50%), nurses are more often in the 31-40 year age range (50%), administrative personnel are more aged 31-40 years (33.3%), and medical record worker is more in the range of 31-40 years (80%).

The research sampling on the radiation age for non-radiation worker which are in the 31-40 year age range dominated for productive age.The results of the research can be depicted in the age ranges (year) versus HGB blood cell quantity (g / dL), RBC (106 / μL) and WBC (103 / μL)graphs, furthermore the age ranges versus absolute quantity of WBC components such as Basofil, Neutrophil, Eosinophil, Lymphocytes, and Monocytes for radiation workers are shown in figures 1 and 2 respectively.

The age range versus HGB blood cell quantity (g / dL), RBC (106 / μL) and WBC (103 / μL), and age range versus the absolute amount of WBC components such as Basophil, Neutrophil, Eosinophil, Lymphocytes, and Monocytes for non-radiation workers are shown in figure 3 and figure 4, respectively.

Normality test used in this research is Kolmogorov Smirnov-Z test, this test is used to know the distribution of the data of blood component parameters for comparison. Normality test can be seen in Table 3.

According to table 3, all components of the blood parameters have a normal distribution ($p > 0.05$), so t-independent tests are used to compare the components of blood parameters between radiation and non-radiation workers.

The references to the number of normal blood cells are used in this research and comparison between all blood component in radiation, and non-radiation workers are shown in Table 4.

The results of the research compared with normal blood cell values as shown in Table 4, that the radiation and non-radiation workers of blood cell quantity values and percentage of WBC components in the normal range. However, when viewed from the results of research the quantity of blood cells radiation workers have a wider range compared with non-radiation workers, it shows that radiation workers have experienced the effects of radiation that is stochastic. The stochastic effects

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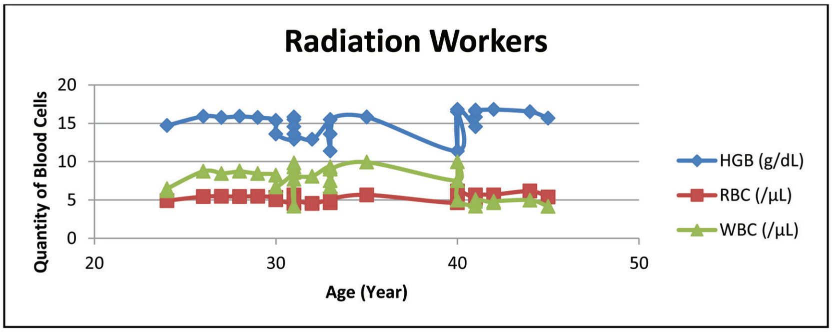

Figure 1 The erythrocytes cell quantity (HGB, RBC) and WBC for the radiation workers

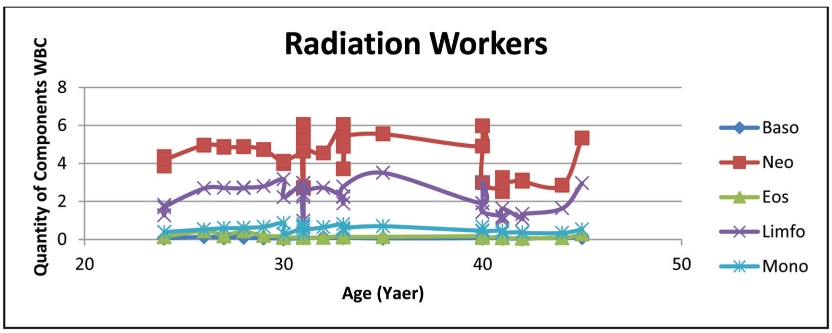

Figure 2 The components absolute quantity leukocyte component for the radiation workers.

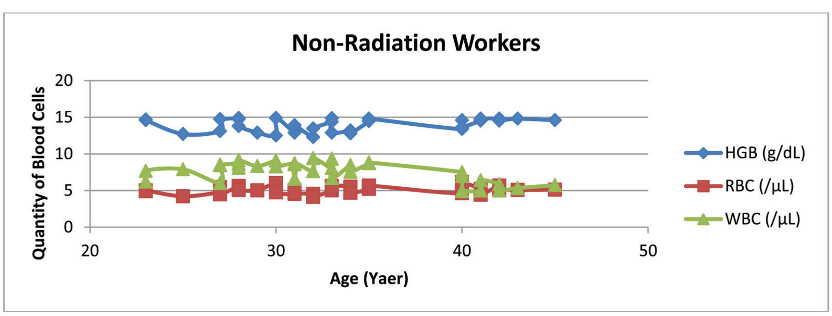

Figure 3 The erythrocytes cell quantity (HGB, RBC) and WBC for the non-radiation workers

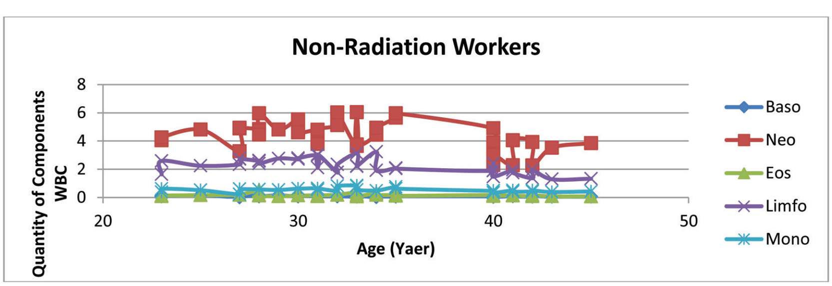

Figure 4 The components absolute quantity of leukocyte component for the non-radiation workers.

are radiation-affected the human body cells that do not require any thresholds to be exceeded. In contrast to the deterministic effect, where this effect will appear when it has exceeded a certain threshold (beyond the normal value). According to Yuwonoet al. study said the ionizing radiation functions as a stimulus and biological effects function as a response, so there is a no-threshold relationship between radiation doses and biological effects, i.e., the biological effects can arise in living organisms.[9]

Comparison of blood parameters in the radiation and non-radiation worker group showed significant differences in hemoglobin component between the radiologist and non-radiologist group (14.94 ± 1.58 vs. 13.99 ± 0.84, $p = 0.030$). While, on other blood components (RBC, WBC, and Leukocyte component) did not show a statistically significant difference between the radiological and non-radiological worker groups ($p > 0.05$). (table 4)

Radiation affects blood cells through the mechanism of DNA damage that will lead to apoptosis of blood cells. This process impairs the activity of DNA Protein Kinase (DNA-PKS), radiation causes inhibition of DNA-PKS causing the occurrence of an anomaly in DNA repair caused by radiation, chromosomal aberrations and increased radiosensitivity.[14]

According to the results of the number of blood cells over the age range of radiation workers and non-radiation workers who are showing the effects of stochastic on the productive age of 31-40 years old are the same. For the age of 21-30 years is still normally caused short time duration of exposure. However, for the age of 41-50 tends to approach the deterministic effect that caused long time duration of exposure. The radiation increased to the deterministic effect throughout human body cells response for long time duration.[12] Therefore, the biological indicators of radiation that can be used as dosimeters in these cases.[2]

CONCLUSION

The research of the blood cells quantity (HGB, RBC, WBC) and WBC components for radiation and non-radiation workers is still in the normal range of blood cell stability. Nevertheless, it has shown a stochastic effect on the blood cells quantity for the radiation workers and in the 41-50 age range has tended to approximate deterministic effects.

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