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by Niken Sekarningrum

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[1]Niken Sekarningrum, [2]Soedjajadi Keman, [3]R Azizah
[1]Master Program Study, Environmental Health Department, Public Health Faculty
Airlangga University, Surabaya, Indonesia
[2,3]Environmental Health Department, Public Health Faculty, Airlangga University, Surabaya, Indonesia
Email: nikensekar.ningrum@yahoo.co.id

ABSTRACTS :

Gamma radiation exposure is induce immunosuppresive against the immune system. The aim of this study was to analyze the effects of gamma radiation exposure to reduction monocyte count and serum level of IFN-γ in industrial radiography workers. The method of the study was an observational research with longitudinal study design. Eleven industrial radiography workers were included in this study. Gamma radiation exposure was measured by using Pocket Gamma Dosimeter. Laboratory tested for monocyte count were using Differential Cell Count method and serum level of IFN-γ was using ELISA method. The result showed that gamma radiation exposure was not exceed dose limited value (NBD) *PerkaBAPETEN No. 4 Year 2013* the mean dose was 0,0088500 mSv. There was no difference among lymphocyte monocyte count (t-value = 0,811) and serum level of IFN-γ (t-value = 0,286) in industrial radiography workers before and after working NDT activities. Characteristics of respondents significantly influence to decreased these dependent variables were history of the disease (infection), nutritional status, and duration of exposure. It is concluded that gamma radiation exposure decrease of monocyte count but not significantly influence to decrease of serum level of IFN-γ. It is suggested to increase partisipation for refresh training, more improving health's workers through consuming of nutritious food (more low purine and fat) and water, doing sport regularly, and also doing enough rest.

KEY WORDS : *Industrial Radiography, Gamma Radiation, Monocytes,IFN-γ*

1. INTRODUCTION

Human's desire to have a prosperous, happy, peacefull, and peace in life is realized through of developing of science and technology. One of its effeorts is use of radiation. Uses of radiation can be applied in various activities, such as : energy, industry, medicine, agriculture, archeology, and others[18]. Industrial radiography is utilization of radioactive sources or called radioisotope. Radioisotope can be used for industrial radiography techniques, gauging techniques, tracer (tracing) techniques, and electron activation analysis techniques.

Definition radiation based on Peraturan Pemerintah Republik Indonesia No. 33 Tahun 2007[8] are :
"Radiasi adalah gelombang electromagnetik dan partikel bermuatan yang karena energi yang dimilikinya mampu mengionisasi media yang dilaluinya"

Industrial radiography activities aimed to investigate the inside of an observed object, such as testing the quality of welding's connection. Industrial radiography are applied to development of high technologies industries and has been used as one of the requirements achieve quality production. Industrial radiography including Non Destructive Test (NDT) activities with sources of gamma radiation, such as : Iridium-192 (Ir-192), Cobalt-60 (Co-60), and Selenium-75 (Se-75) which contained within device gamma camera. Development of industrial radiography technology, prior using X-ray radiation, but generally at now have switched using gamma radiation because the device are easy to use and does not require a power source.

Gamma radiation impact to human health, specially radiographer and population around the activities. Radiation is also one aspects of the physical pollution that can damage of human health and other living creatures [18]. Uses of radiation can cause negative effects on the biological aspects, such as : somatic, genetic, and stocastic effects [10].

Data from United State Energy Atomic Commision (USEAC) reported in 1960-1968 that 152 cases accident work, including 59 cases caused by the use of radiography. The cause of the accident are : operator error (68%), procedural error (8%), equipment damaged (15%), and others (9%) [7].

Blood cells have different radiosensitivities. Leucocytes are cells that have a high radiosensitivities, particularly lymphocytes. In addition, platelets also be decreased after radiation a few days to weeks then eritrocytes until a few weeks later. Therefore, a decrease lymphocyte cell count can be used to estimate the severity of which may occur as a result of acute radiation exposure in radiation workers [16].

Ionizing radiation rated reduced immune system [17]. The body which exposed by radiation may result in inhibition of cell growth and proliferation entirely immune system [2]. Gamma radiation exposure is induce immunosuppresive and play a role in

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imbalance of cytokine expression of T helper (Th)1 and Th2 [6]. Th cell number can be decreased 60% compared with control group after being exposed to radiation at a dose 4 Sv [1]. The negative impact in immune response suppresion will cause susceptible to infection including and increased risk of cancer induction [1].

Gamma radiation to whole body irradiation with a low dose 40 mSv (miliSievert) and dose rate 0,052 mSv/h in 24 hours for 5 days trial, showed changes in level of IFN-γ (gamma Interferon) [12]. Gamma radiation exposure also causes a decrease in gene expression mesenggger Ribonucleic Acid (mRNA) IFN-γ after 3 hours but reverse to increases mRNA expression of Interleukin-4 (IL-4), IL-5, IL-10, and TNF-α (Tumor Necrosis Factor-alpha) [5].

Statistical analysis of the limitations of epidemiology between the dose-response received by workers and the mechanism of radiation exposure on the health process requires for improvement in futher understanding. Therefore, scientific research on understanding the health effects has been made a priority for 2009-2013 by UNSCEAR at the 65th session. Research is needed more emphasis on the health effects of low-dose radiation exposure to workers against the risk of cancer and genetic effects [17].

2. METHODS

The method of this study was an observational research with longitudinal study design. Eleven industrial radiography workers were included in this study Radiografer Level (RT) I, RT II, and Radiation Protection Officer (PPR) with inclusive criteria male, willing became respondents, and did not have a history of anemia. Laboratory tested for monocyte count were using Differential Cell Count method and serum level of IFN-γ was using ELISA method.

3. RESULT

Characteristics of respondents in industrial radiography workers can be seen in Table 1.

Tabel 1. Characteristics of Respondents

Characteristics of Respondents	n	%
Age		
20-25	2	18,18
26-30	4	36,36
31-35	1	9,09
36-40	3	27,27
>40	1	9,09
Mean ± SD	30,45 ± 7,50	
History of the Disease (Infection)		
Have	6	54,55
Didn't have	5	45,45
Mean ± SD	1,45 ± 0,55	
Knowledge of Radiation Protection		
Good	11	100
Poor	0	0
Mean ± SD	620,73 ± 26,94	
Nutritional Status		
Underweight	0	0
Normal	4	36,36
Overweight	2	18,18
Obese	5	45,46
Severely Obese	0	0
Mean ± SD	23,50 ± 2,75	
Duration of Exposure		
<8 hours	9	81,82
≥8 hours	2	18,18
Mean ± SD	8,09 ± 1,30	
Working Experience		
<5 years	9	81,82
≥5 years	2	18,18
Mean ± SD	3,91 ± 2,47	

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Path analysis was showed that characteristics of respondents significantly influence to decreased these dependent variables were history of the disease (t-value -2,35), nutritional status (t-value 1,97), and duration of exposure (t-value 2,62).

Gamma radiation esposure measured by personal effective dose of industrial radiography using Pocket Gamma Dosimeter. Dose measurement results can be seen in Table 2.

Tabel 2. Personal Dose in Industrial Radiography Workers

Gamma Radiation Exposure (mSv)	Lowest	Highest
	0,00526	0,01666
Mean ± SD	0,00885 ± 0,00350	

Tabel 2 showed that personal dose both lowest and highest dose was not exceed dose limited value (NBD) by *Peraturan Kepala Badan Pengawas Tenaga Nuklir No. 4 Tahun 2013* NBD per 3 months is 5 mSv[9].

Monocyte count are measured by ADVIA 120/2120 tools with Differential Cell Count Method. The normal percentage of monocyte 2-8% of total leucocyte. Monocyte count in industrial radiography workers before and after working NDT activities can be seen in Table 3.

Tabel 3. Monocyte Count in Industrial Radiography Workers at Before and After Working NDT Activities

Monocyte Count (%)	Before Working		After Working	
	n	%	n	%
<2	0	0	0	0
2-8	10	90,91	11	100
>8	1	9,09	0	0
Mean±SD	5,59 ± 1,39		5,67 ± 0,75	

Monocyte count at berfore working for lowest count was 3,80% and higest count was 8,80%. Moreover monocyte count at after working for lowest count was 4,50% and higest count was 6,80%. Monocyte count in industrial radiography workers can be seen in figure 1. Based on statistical analysis with Paired Sample t Test showed t-value (0,81)>0,05 means there was no significant difference in monocyte count at before and after working NDT activities.

Serum level of IFN-γ are measured by Human IFN-γ Elisa Kit with ELISA Biotin Double Antibody Sandwitch Method. The normal level of IFN-γ 0-188 pg/ml. Serum level of IFN-γ in industrial radiography workers before and after working NDT activities can be seen in Table 4.

Tabel 4. Serum Level of IFN-γ in Industrial Radiography Workers at Before and After Working NDT Activities

Serum Level of IFN-γ (pg/ml)	Before Working		After Working	
	n	%	n	%
0-188	10	90,91	9	81,82
>188	1	9,09	2	18,18
Mean ± SD	88,98 ± 7,86		87,28 ± 7,74	

Serum level of IFN-γ at berfore working for lowest level was 39,35 pg/ml and higest level was 316,45 pg/ml. Moreover serum level of IFN-γ at after working for lowest level was 41,45 pg/ml and higest level was 284,90 pg/ml. Serum level of IFN-γ in industrial radiography workers can be seen in figure 2. Based on statistical analysis with Paired Sample t Test showed t-value (0,29)>0,05 means there was no significant difference in serum level of IFN-γ at before and after working NDT activities.

Path analysis was showed that there is a significant correlation of gamma radiation exposure to decreased monocyte count (t-value 2,25 > 1,96). Whereas gamma radiation exposure has no significant correlation to decreased serum level of IFN-γ (t-value -0,18).

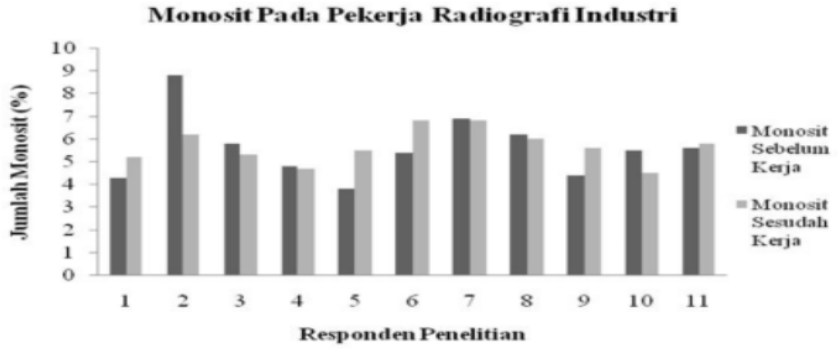

Fig 1. Tendency of Monocyte Count Distribution in Industrial Workers

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Fig 2. Tendency of Serum Level of IFN-γ Distribution in Industrial Workers

Figure 1 showed that monocyte count in generally workers is at normal range 2-8%. Figure 2 showed that serum level of IFN-γ in generally workers is at normal range 0-188 pg/ml.

4. DISCUSSION

Distribution of monocyte count in this study has tendency to decrease after working NDT activities but based on path analysis there was no significant difference monocyte count before and after working in industrial radiography workers. Monocytes are immune system which respond to infection due to exposure to bacteria and foreign object. Monocyte respond slowly during the acute phase of infection and inflammation. Monocytes can lyse particles of foreign object larger [14]. Changes in monocytes become characteristic through inflammatory [13].

This decline trend of monocyte count in accordance with theory that radiation exposure causes a change immune system. Blood cells can be decreased 60% compared with control group after being exposed to radiation at a dose 4 Sv [1]. But this decline trend of monocyte count different from preceding research showed that there was significant difference in monocyte count in the group of medical radiographer dirrectly contact with radiographer non dirrectly contact [15]. The absence of differences in monocyte count in industrial radiography workers due to monocyte count both before and after working NDT activities were still in normal range of monocytes. Whereas, this decline trend in accordance with the statement that radiation exposure can cause cell death or inhibited of mitotic stem cells activation. Inhibition of mitotic stem cells activation impact to decrease blood cells count. The decrease of monocyte impact to decrease the number of macrophage are known has function as phagocytosis, antigen presentation, enzym expression, and secretion of cytokines [3].

Distribution serum level of IFN-γ in this study has tendency to decrease after working NDT activities but based on path analysis there was no significant difference serum level of IFN-γ before and after working in industrial radiography workers. This results was not based on theory that gamma radiation exposure is induce immunosuppresive and play a role in imbalance of cytokine expression of T helper (Th)1 and Th2 [6]. Pro-inflammatory cytokines is the component which is most react immediately and quickly during the cells being exposed to radiation [15]. IFN-γ is a pro-inflammatory cytokine that is needed at the beginning of the inflammatory reaction in cellular immune response [4]. IFN-γ also has a major function to activate macrophages. The presence of infammatory signals stimulate macrophage to bind into blood vessel, out of the blood vessels and move to the site of inflammation to kill target cells [11]. These cytokine levels will continue to be suppressed until foreign object can be eliminated [15].

The absence of differences in serum level of IFN-γ in industrial radiography workers due to serum level of IFN-γ both before and after working NDT activities were still in normal range of serum level of IFN-γ.

Based on path analysis was showed that there was not a significant correlation of gamma radiation exposure to decreased serum level of IFN-γ. This results in accordance with the opinion that gamma radiation exposure may activate the phosphorylation path signal of STAT-1 (Signal Transducer and Activator of Transcription) for stimulate Concanavalin A, causing decrease IRF-1 (Interferon Regulatory Factor). Decrease of IRF-1 modulate to IFN-γ. This leads to decrease mRNA expression of IFN-γ up to 40% [6]. Uses of STAT pathway due to cytokine receptor for IFN-γ deficiency during inflammation [15].

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5. CONCLUSION

Gamma radiation exposure decrease of monocyte count significantly but not significant influence to decrease of serum level of IFN-γ in industrial radiography workers.

6. SUGGESTION

Increase partisipation for refresh training every 5 years once (particularly for PPR) and other industrial radiography workers are advised to follow trainings about protection and radiation safety by accredited training institution. Moreover, its recommended to more improving health's workers especially ownership both medical history of infections and non infections disease through consuming of nutritious food (more low purine and fat) and water, doing sport regularly, and also doing enough rest.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5