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Relationship of Cadmium Content (CD) Blood to Creatinine Levels Serum Dnd Glomerular Filtration Rate (Lfg) Metal Casting Worker

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Abstract

Metal casting workers are workers at risk of exposure to heavy metals cadmium. Clinical and laboratory evidence suggests that cadmium exposure is highly toxic by inhalation and may lead to decreased renal function. The purpose of this study was to determine the association of cadmium content in blood to serum creatinine and the estimated glomerular filtration rate. This research uses analytic observation method with Cross Setional approach. The sample size in this research is 30 samples taken from Ceper foundry industry of Klaten Regency, Central Java. Atomic Absorbtion Spectrophotometer (AAS) is used to measure blood levels of cadmium, spectrophotometers to measure serum creatinine levels, and to calculate glomerular filtration rate estimation values using Cockcroft and Gault formulas. Data analysis using Chi Square and logistic regression. Results from the study showed an association between cadmium in blood (P -Value = 0.001) against serum keratinin levels. and there was no correlation between cadmium content in blood (P -Value = 0, 576) against glomerular filtration score estimation value. Thus, cadmium levels in the blood are associated with serum creatinine levels, checkup madical needs to be done to determine the health conditions of the workers, as well as to reduce exposure to cadmium by modifying workplace ventilation and using personal protective equipment.

Keywords: Cadmium, serum creatinine, Glomerular filtration rate

1.0 INTRODUCTION

In the era of globalization requires the implementation of occupational health and safety in every workplace, including in the informal sector, for it needs to be developed and enhanced promotion and prevention efforts in order to reduce the lowest possible risk of disease arising from work or work environment. In the course of day-to-day work, workers in various sectors will be exposed to the risk of occupational diseases. These risks range from the lightest to the most severe, depending on the type of work (Anis, 2014). Ceper districts is one of the central metal foundry industries located in Klaten district, Central Java province. From generation to generation, there is an average worker in metal casting industry using traditional techniques, ranging from transporting and sorting jobs to metal powder as raw material, mold making work (mall) with sand coating, casting work, and finishing work. At the time of the melting process is done air, in the room becomes very hot and many particles of dust and sparks coming out of the heating stove. This is exacerbated by the lack of adequate exit ventilation to enable workers to inhale the combustion gas continuously. In doing the work, no worker uses personal protective equipment, even eating and drinking is also done at work (Rosariastuti, 2004:4)

The group of metal casting workers in Klaten district certainly needs to get health attention, considering the amount that cannot be said a little. In the process of casting metals other than to produce products also produce heavy metals such as Cd, Cr, Ni and Pb, this is a risk that is quite harmful to the health of the traditional metal foundry workers, given the side effects of heavy metals produced have the properties of power high toxicity (Rosariastuti, 2004:4). One of the dangers to be considered in connection with the metal casting industry is the exposure of cadmium. Because such heavy metals have potential negative effects on human health. Cadmium is one of the heavy metals from the metal melting process, acute cadmium poisoning usually occurs due to cadmium oxide vapor and from cutting of cadmium metal or a cadmium-containing metal mixture (Sugiharto, 2015:4).

OSHA estimates that 300,000 workers are exposed to cadmium in the United States. Worker exposure to cadmium may occur in all industrial sectors but mostly in manufacturing and construction. Workers may be exposed during metal smelting and refining, and manufacturing batteries, plastics, coatings, and solar panels. The Ni-Cd battery recycling industry is evolving into attention for cadmium exposure. Electroplating, metalworking, welding and painting are operations associated with cadmium exposure. Workers involved in landfill operations, recycled

electronic components, or plastic recycling may be exposed to cadmium. Workers of compost and scavengers are also potentially exposed to dust that may contain cadmium. Burning municipal waste is another source of cadmium exposure (OSHA < 2004)

These studies have found that even very low cadmium levels can have adverse effects on the kidneys. WHO currently states that 200 µg / g of wet weight level in the kidneys causes adverse changes in 10% of the population. The kidneys are the organs of the body that play a major role in maintaining body fluid homeostasis. To maintain the body's fluid homeostasis, the kidneys perform the excretory function of producing urine. The kidney part that plays a role in the process of formation of urine is a nephron which is a functional unit of the kidney. Nephrons consist of glomeruli, proximal tubules, henle ansa, distal tubules and collecting tubules and peritubular capillaries of capillaries around the renal tubules. The one kidney consists of 1.3 million nephrons, which means there are about 2.6 million nephrons in a person's body (Kikuchi, 2002)

2.0 RESEARCH METHODS

The type of research is Explanatory Research, with Cross sectional approach. Samples taken from the population are all population sampled or total population, because all respondents are only 30 people. Blood sampling was assisted by Ceper district health center officer. Primary data used in this research was obtained by distributing questionnaires to respondents to know the variable of individual factor and worker factor, beside that primary data also obtained from result of laboratory examination for cadmium content in blood was done at hall Large Environmental Health Engineering and Disease Control and for serum creatinine inspection conducted at Health Laboratory hall Yogyakarta, as well as secondary data containing a list of names of workers who worked metal casting Data analysis To know the correlation of significance as hypothesis testing criteria between cadmium content in blood, serum creatinine level and estimated value of glomerular filtration rate used Chi Square test and logistic regression

3.0 RESEARCH RESULT

3.1 Description of Research Variables

Based on the results of the study, respondents who were not exposed to cadmium were 21 respondents (70%), while cadmium exposure was 9 respondents (30%), normal creatinine or 0.7-1.2 mg / dl of 23 respondents 76,7%), while the creatinin content is not normal as much as 7 respondents (23,3%), Calculation of estimated value of normal glomerular filtration rate or > 70 mL / min / 1.73 m² counted 14 respondents (46,7%), abnormal glomerular filtration rate of 16 respondents (53.3%)

Tabel 1. Respondents Distribution

No	Variables	n = 30	%
1	Cadmium in the blood		
	a. exposed	9	70
	b. not exposed	21	30
2	Serum creatinine		
	a. normal	23	76,7
	b. abnormal	7	23,3
3	Glomerular Filtration Rate		
	a. normal	14	46,7
	b. abnormal	16	53,3

3.2 The association between cadmium levels in the blood against serum creatinine levels

Table 2 shows that the proportion of respondents with abnormal creatinine content of 66.7% or 6 respondents exposed to cadmium was greater when compared with respondents who were not exposed to cadmium of 4.8% or 1 respondent. Statistical test results using Chi Square obtained p-Value value of 0.001 (<α = 0.05). This suggests that there is a cadmium relationship in the blood against serum creatinine levels. The result of RP = 14,000 with Confidence Interval (CI) 95% (1,957 - 100,616) then it can be said that respondents exposed to cadmium have a risk of 14,000 times the increase in the amount of creatinine

Table 2: Relationship between Cadmium in blood to serum creatinine levels of metal casting workers

No	Cadmium In the blood	Serum creatinine levels						P Value
		abnormal		Normal		Total		
		n	%	N	%	N	%	
1	Exposed	6	66,7	3	33,3	9	100	0,001
2	Not exposed	1	4,8	20	95,2	21	100	
	Jumlah	7	23,3	23	76,7	30	100	
IDR= 14,000		95% CI = 1,957 – 100,616						

3.3 Relation Blood levels of cadmium to the estimated value of filtration rate of glomerulus metal casting workers

Table 3 shows that the proportion of respondents with an estimated value of abnormal glomerular filtration rate was 47.6% or 10 respondents who were not exposed to cadmium while respondents exposed to cadmium were 66.7% or 6 respondents. Statistical test results using Chi Square obtained p-Value value of 0.576 ($> \alpha = 0.05$). This shows that there is no correlation of cadmium content in blood to estimated value of glomerular filtration rate of metal casting workers. Relation Blood levels of cadmium to the estimated value of filtration rate of glomerulus metal casting workers. Table 3 shows that the proportion of respondents with an estimated value of abnormal glomerular filtration rate was 47.6% or 10 respondents who were not exposed to cadmium while respondents exposed to cadmium were 66.7% or 6 respondents. Statistical test results using Chi Square obtained p-Value value of 0.576 ($> \alpha = 0.05$). This shows that there is no correlation of cadmium content in blood to estimated value of glomerular filtration rate of metal casting workers

Table 3 Relationship of cadmium content in blood to estimated value of filtration rate of glomerulus of metal casting workers

No	Cadmium In the blood	Glomerular filtration rate						P Value
		Abnormal		Normal		Total		
		n	%	N	%	N	%	
1	Exposed	6	66,7	3	33,3	9	100	0,576
2	Not exposed	10	47,6	11	52,4	21	100	
	amount	16	53,3	14	46,7	30	100	
IDR= 1,400		95% CI = 0,735 – 2,666						

Blood levels of Cd (Cd-B) are considered the primary biomarkers of new exposures, the relative effects of body Cds may be more important or even dominant in previously exposed individuals and in people who have accumulated large amounts in their bodies. The cumulative content of Cd-B is estimated by making repeated measurements in the blood, and more reflecting total exposure and is used to identify the risk for kidney damage (Kikuchi, 2002). From the statistical test obtained cadmium image in blood to serum creatinine level. From the data of research result using bivariate analysis of Chi Square relation between cadmium content in blood to serum creatinin got significance value ($p = 0,001$). This means there is a cadmium relationship in the blood with serum creatinine levels where the value ($\alpha < 0,05$). The analysis results also obtained $RP = 14,000$ value means: respondents with abnormal creatinine have a risk of 14,000 times for exposure to cadmium compared with workers who have creatinine levels norm. In a healthy person with low Cadmium exposure, there was a strong correlation between Cadmium in the kidneys and urine, especially on serum creatinine (Akerstrom, 2013), whereas a study conducted by Septiono Bangun on the association of Cadmium content with creatinine using the Pearson correlation test showed that there was no correlation with the value of Correlation coefficient ($r < 0,349$ (Akerstrom, 2013).

Creatinine is a muscle protein product that is the end result of muscle metabolism that is released from muscles at almost constant speed and excreted in urine at the same rate. Creatinine is excreted by the kidney through a combination of filtration and secretion, its concentration is relatively constant in the plasma from day to day, greater than normal levels suggest a renal impairment. A doubling of serum creatinine levels indicated a 50% reduction in kidney function, as well as a triple increase in creatinine levels suggesting a 50% decrease in renal function (Corwin, 2001)

From the statistical test obtained cadmium image in blood to the estimated value of glomerular filtration rate. From the data of research result using bivariate analysis with Chi Square relationship between cadmium content in blood to estimated value of glomerular filtration rate got significance value ($p = 0,576$) It means there is no correlation value of estimated glomerular filtration rate to cadmium in blood where value ($\alpha > 0, 05$). this study is different from that of Young Hwangbo et al., showing that there is a correlation between blood cadmium content to estimated glomerular filtration rate with p-value value 0.048 (Hwangbo, Weaver, Plaza, Guallar, Lee, and AnAcien, 2011)

Long-term exposure to cadmium can also damage the renal glomerular membrane, leading to the excretion of high molecular weight proteins such as albumin, gamma globulin (IgG and IgA), and alpha2-macroglobulin. Decreased glomerular filtration rate and increased serum creatinine concentration associated with cadmium dose, and showed glomerular dysfunction. Glomerular dysfunction can develop after exposure has ended. While most researchers have shown that tubular proteinuria occurs prior to glomerular dysfunction in cadmium-exposed workers, recent studies suggest that subtle defects in the glomerular barrier function may precede tubular interference. Some researchers believe that elevated urine albumin concentrations in cadmium-exposed workers are not a sign of glomerular damage, but are primarily caused by tubular dysfunction (Penney, 1993).

These studies have found that even very low cadmium levels can have adverse effects on the kidneys. WHO currently states that 200 $\mu\text{g} / \text{g}$ of wet weight level in the kidneys causes adverse changes in 10% of the population. The kidneys are the organs of the body that play a major role in maintaining body fluid homeostasis. To maintain the body's fluid homeostasis, the kidneys perform the excretory function of producing urine. The kidney part that plays a role in the process of formation of urine is a nephron which is a functional unit of the kidney. Nephrons consist of glomeruli, proximal tubules, henle ansa, distal tubules and collecting tubules and peritubular capillaries of capillaries around the renal tubules. The one kidney consists of 1.3 million nephrons, which means there are about 2.6 million nephrons in a person's body (Price and Wilson, 2006)

The kidneys cannot regenerate new nephrons, so when kidney damage occurs, or the aging process, there is a decrease in the number of nephrons. At age 40, the number of functioning nephrons is reduced by about 10% every 10 years and by the age of 80 years only 40% of the nephrons are functioning. This situation is not life-threatening because there is adaptation to the remaining nephrons in excreting water, electrolytes and metabolic waste (Price and Wilson, 2006)

The effects of cadmium on the treatment of renal creatinine should also be considered. In addition to filter in the glomeruli, creatinine is secreted by the proximal tubule, Filtration means the kidneys in this case the glomerulus filtering the blood entering the glomerular capillaries to pass through the filter of the glomerular filtration membrane. Reabsorption is the re-absorption of the filtrate (filtrate) substances still required by the body from the renal tubules to the peritubular capillaries. Secretion is the excessive discharge of substances from the body (peritubular capillaries) to the renal tubules (Saryadi, 1994). Acute exposure to cadmium smoke can cause flu-like symptoms, with chills, fever, and muscle pain in the back and hands. If the respiratory system has not been damaged, symptoms may disappear within a week. The respiratory tract is one of the cadmium entry pathways into the body, inhaling cinders of cadmium fiber rapidly leading to renal obstruction and respiratory problems that can be fatal (Sugiharto, 2015).

4.0 CONCLUSION

There were 21 respondents (70%), while cadmium exposure was 9 respondents (30%), normal creatinine or 0.7-1,2 mg / dl were 23 respondents (76,7%), while creatinine abnormal as much as 7 respondents (23,3%), Calculation of normal glomerular filtration rate value > 70 mL / min / 1.73 m² counted 14 respondents (46,7%), while abnormal glomerular filtration rate was 16 respondents (53,3%), the result of SPSS analysis showed that there was a correlation between blood cadmium concentration to serum creatinine level with p-Value 0,001 ($\alpha < 0,05$), and no correlation of blood cadmium value to estimated glomerular filtration rate p- Value 0.576 ($\alpha > 0.05$)

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1.0