

Chrome Hole Dermatitis Due To Work Habit Of Electroplating Workers In Candi, Sidoarjo, Indonesia

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Abstract—Objectives: Electroplating industry using hexavalent chromium (Cr^{6+}) for main ingredient to metal plating. Chromium when contact with skin can cause dermatitis. This study aimed to analyze chrome hole dermatitis on electroplating workers due to their work habit in one of electroplating industry in Sidoarjo. **Methods:** This is a qualitative descriptive study using cross sectional design. Data was collected by questionnaire, observation sheet, interview guides and diagnosis sheet. Using the total population of 10 respondents working on electroplating industry in Sidoarjo. The work habits are age, work division, working period and using of PPE. **Results:** Chrome hole dermatitis occurs to workers at all age range (0.225), only occurs to coating works division (0.632), mostly occurs to workers with more than 5 years working period (0.650), and using of PPE are not much help (0.343). **Conclusions:** The incidence of chrome-hole dermatitis in the electroplating industry occurs to workers with coating work division and more than 5 years working period. **Suggestions:** Electroplating industry's owner and government of Sidoarjo should pay more attention to work division of coating and long period workers in order to minimize the health effect of chromium in electroplating workers.

Keywords— work habit; worker; electroplating; dermatitis

I. INTRODUCTION

Indonesian government supports the development of processing industry, especially the basic metal industry sector, through Ministry of Industry. The Ministry of Industry supports development program of local resource-based metal industry, as a prospects of the national metal industry in the future will be excellent in terms of current demand. In 2013 the growth of the basic metal industry sector reached 6.93%. This number is increase when compared to the year 2012 which grew by 5.8% [1].

Electroplating industry is a business or activity that processes metal to be given coating of chemicals in the form of zinc, galvanized, silver, gold, brass, copper, nickel and chromium layer, which can change the physical, mechanical and technological properties of a metal material, and aims to improve the properties mechanically a metal, protecting the metal from corrosion and to beautify the look of the metal [2].

Chromium coating materials used, can result in health impacts on workers. Reference [3] was the first claimed that

industrial workers using chromium dichromate chemicals may experience skin ulceration after working for several months. In addition, when chromium is in contact with skin, especially at hand skin, it can cause skin burns, blistering of the skin and skin ulceration, commonly referred to as chrome hole skin ulceration. Ulceration is only found in industries that use chromium chemicals.

Research in Tegal District claimed that the use of chromium chemicals in electroplating can cause impaired renal function. It was concluded on the basis of examination of chromium levels in the worker's urine in the range 6.00 to 11.0 mg or exceeded the allowable value [4].

The occurrence of irritant contact dermatitis in electroplating workers in Sugihwaras Village, Candi Subdistrict of Sidoarjo Regency which is characterized by skin disorders such as itching, redness, stinging and peeling and identified the existence of clinical signs such as papules, erythema and likenifikasi. This is because workers do not use PPE in conducting electroplating process [5].

The chromium coating process itself uses electroplating techniques that can have an impact on workers, as is the study conducted in China. The study claimed that there is hexavalent chromium pollution occurring at the chromium coating site using electroplating techniques. It is known based on the concentration of hexavalent chromium in erythrocytes in 157 electroplating workers, which is significantly higher than that of unexposed workers in the chromium plating process using electroplating techniques [6].

Exposure to long-term chromium and nickel chemicals can cause health impacts under study of the micronucleous state of buccal cells. This happens to electroplating workers in India with a working period of more than 10 years. Various studies have shown that in electroplating processes using chromium can have a health impact on workers, especially workers involved in the electroplating process. This happens because in the electroplating process there is a hazard in the form of chromium chemicals, in which if contact with workers can cause various health impacts as mentioned earlier [7].

Chromium in a biological element is usually present in the trivalent form (Cr^{3+}), in which is an essential substance needed by the body. Therefore, it is an unsafe condition if humans are exposed directly by hexavalent chromium (Cr^{6+}). This because chromium in hexavalent form is 500-1000 times more toxic than chromium in trivalent form [8].

Chromium hexavalent (Cr^{6+}) is more soluble than trivalent chromium (Cr^{3+}) when in contact with the skin, as it is able to enter the skin 10,000 times faster. When it enters the blood, hexavalent chromium (Cr^{6+}) is degraded into trivalent chromium (Cr^{3+}), but it is not as significant in the gastrointestinal tract as rapidly hexavalent chromium (Cr^{6+}) enters the skin. On the skin exposure pathways that have a high risk for exposure are industrial workers, because of frequent direct contact with the skin, especially in chemical manufacturing industries such as electroplating [9].

Some types of hexavalent chromium (Cr^{6+}), such as chromium trioxide (chromic acid), potassium dichromate, potassium chromate, sodium chromate and sodium dichromate are highly caustic chemicals and can cause skin burns through skin contact. The resulting wound can cause the absorption of other chemicals including chromium to enter the body. When chromium enters the kidney, through injury or ulceration due to exposure to chromium itself, acute nephritis occurs with albuminuria, oliguria and polyuria. But this does not happen to a worker with a good immunity. Skin burns, blistered skin and skin ulceration, commonly referred to as chrome holes, are caused by skin contact with chromium solution, coupled with exposure to chromium in the form of steam and mist which may cause similar effects. There are known cases of skin ulcers in the form of buccal cavities (the sides of the cheeks of the back teeth) as well as the chrome holes on the skin, which also result from observations in the electroplating industry, in which have poor gas exhaust pipes, resulting in high concentrations of chromium trioxide fumes [3].

Based on the description, the researcher wanted to know how the electroplating industry impact, in view of the exposure of chromium chemicals used through the work habit of electroplating workers and the dermatitis incidence in the electroplating workers. Therefore this study aims to analyze work habit and dermatitis incidence in electroplating workers CV X in Sidoarjo.

II. METHOD

This research is a descriptive research that is observational. This study uses cross sectional design, because it examines the work habit as an estimate of independent variables and the incidence of chrome hole dermatitis on electroplating home industry workers as a dependent variable performed in a given time [10].

The population in this study is all workers in electroplating home industry CV X which amounted to 10 workers. The research was conducted in electroplating home industry CV X in Sidoarjo, as the location of study population. All research data is primary data with data collection techniques as follows: 1) Observation. Observe worker activity on series of electroplating process, based on observation sheet. 2) Questionnaire. Conducting interviews to respondents based on research instruments in the form of questionnaires and interview guides. 3) Examination of hand skin condition by occupational physician. Inspect the skin condition of the worker's hands performed by the occupational physician, and record it on the examination sheet to determine the presence of chrome hole dermatitis experienced by the worker.

The instrument used in this research is an observation sheet containing details of electroplating process, chromium

exposure inlet (port of entry) and use of personal protective equipment (APD). A questionnaire containing the individual factors affecting the entrance pathway of chromium exposure and the acute health effects felt by workers. The examination sheet that contains the working skin condition of the worker is chrome hole dermatitis. Last is an interview guide which contains questions about the production process, the use of chromium in the process, the duration of chromium use during production and the hazards that can be caused by chromium.

This study has received approval from the ethics commission, related data collection procedures in the form of questionnaires, observations, interviews and examination of skin conditions of the hands of workers conducted by occupational physicians.

III. RESULTS

A. Overview Electroplating Home Industry CV X in Sidoarjo

CV X electroplating industry is located in Durungbanjar Village, Candi District, Sidoarjo Regency, more precisely in Banjarpoh Hamlet. Included in the southern part of the District of Temple with the northern boundary is adjacent to the Village of Sumokali, the east is adjacent to the Village Kedungkendo, the south bordering Tulangan District and the west by the village of Durungbendo.

Electroplating industry CV X is a home industry that uses electroplating techniques and uses chromium chemicals in electroplating. Production run by CV X, made on order. A typical home industry character as electroplating industry CV X is a production process that still has not paid attention to the safety and health of workers, although it has been using modern electroplating machine technology.

Home industry electroplating CV has 10 permanent workers divided into 2 divisions, namely polishing and coating. In the polishing division there are 4 workers, while in the coating division there are 6 workers. All workers are men who come from around CV industry home industry, with age more than 20 years. Inter employees have different working periods, mostly for 3 years, same as home industry age, but others have more than 5 years working period, ie workers who have previously worked in electroplating field, before working in CV X in Sidoarjo.

B. Work Habit Of Electroplating Workers In Home Industry CV X Sidoarjo

Characteristics of electroplating workers CV X in Sidoarjo by age group, it is known that in the age range of workers mostly ie 26-35 years as many as 5 workers or by 50%. With age 46 years as many as 3 workers or by 30% and at least 17-25 years as many as 2 workers or by 20%.

Most of the electroplating workers of CV X have age in the adult range. A small number belong to the old age range, which has the age of 47 years, 50 years and 62 years. But there are also workers included in the young age range, there are 2 workers with age respectively 21 years and 24 years. When reviewed from the risk level, older workers are at risk of being affected by chemicals used in electroplating more than workers of young and old age. It is related to the immune

system, in which the older age sesepekerja, then the body power will decrease [11].

If reviewed by sex, all CV X electroplating workers are male, so there is no variant on gender. Based on other studies, according to Miaratiska (2014) states that, female workers have a greater risk to suffer from dermatitis, because it has a longer metal contact. Contact with metals for women occurs not only in the coating industry, but also in everyday life that requires women to contact with cookware mostly made of metal. Such cookware is usually coated with nickel or chromium chemicals. But in this study the overall worker is male, so there is no difference in sex-related conditions. All workers have the same level of exposure.

In the production section, there are two divisions of work namely polishing and coating. The polishing section consists of 4 workers and the coating section consists of 6 workers. In electroplating CV X there are 2 division of work division, namely polishing (early stage before metal coated) and coating. In the polishing division, which is done is ready-layered iron polishing with grinding and immersion in HCl solution after grinding. It aims to remove the residual rust on metal after grinding. While in the coating division there is immersion in sodium or soda solution, adhesive solution, nickel plating and chromium coating.

Workers working in each division are fixed. But in one division workers can switch to what they do. For example there are workers who do not enter on the chromium coating section, then other workers in the coating division should replace it, which is important as long as the electroplating production process is running.

The work period of electroplating workers CV X varies, and most are workers with 3 to 4 years working period of 4 workers (40%). Furthermore, there are 3 workers (30%) who have a working period in the range of 1-2 years and the last one has a working period of 5 years of 3 workers (30%, each has worked in the electroplating field for 9 years, 12 years and 20 years).

Longer working periods cause workers exposed to chemicals in electroplating for longer. Therefore, the longer the worker working, the risk to suffer the health effects of exposure to these chemicals will be greater. As the study in India states that when the duration of exposure to chemicals in electroplating increases, the health impact also increases significantly [7].

Personal protective equipment (APD) that should be used by electroplating workers such as gloves (neoprene and thick cotton), long-sleeved shirts or trousers, as well as shoe bots. Electroplating workers CV X in Sidoarjo use these personal protective equipment, but some workers do not use it completely. The most common protective equipment used is latex gloves, used by 90% of workers. Next is the shoe bots used by 60% of workers. While long-sleeved clothing or trousers are only used by 30% of workers only.

C. Chrome Hole Dermatitis In Electroplating Workers CV X in Sidoarjo

1) The Relationship between Age and the Chrome Hole Dermatitis

TABLE I. DERMATITIS OCCURRENCE BY AGE AT ELECTROPLATING WORKERS CV X IN SIDOARJO YEAR 2015

Age Category	Chrome Hole	
	(-)	(+)
17-25	1	1
26-35	2	3
36	2	1
Total	5	5
	10	
Contingency Coefficients	0.225	

^a Primary data 2015

The result of cross tabulation between age difference and chrome hole ulceration has contingency coefficient of 0.225. This means that there is a weak correlation between the age difference and the incidence of chrome hole ulceration. The point is, regardless of the age of the worker, it remains likely to suffer from chrome hole ulceration, so that no specific age can lead to chrome hole ulceration.

As is known from Table 1 which shows that, there is a uniform distribution between the number of workers who tested positive for chrome hole skin ulceration with the number of workers in each age group. The age group with the largest number of workers, has a positive number of workers with chrome hole ulceration with the highest number. While the age group with fewer numbers of workers, has a smaller number of workers with chrome hole ulceration.

2) Relationship between Division of Work with Chrome Hole Dermatitis

TABLE II. CHROME HOLE DERMATITIS ACCORDING TO DIVISION OF WORK IN ELECTROPLATING WORKERS CV X IN SIDOARJO YEAR 2015

Works Division	Chrome Hole	
	(-)	(+)
Polishing	4	0
Coating	1	5
Total	5	5
	10	
Contingency Coefficients	0.632	

^b Primary data 2015

The result of cross tabulation between job division difference and chrome hole ulceration event has contingency coefficient 0,632. This means that there is a strong correlation between the division of labor with the incidence of chrome hole ulceration.

In Table 2 it is known that the ulcerated skin of chrome hole is entirely derived from the coating division and none comes from the polishing division. This can happen because chromium exposure occurs only in the coating process. While the process of polishing, exposure to chemicals that exist is HCl, which is done in the stage after the polishing done by using the grinding. Therefore workers in the polishing division no one suffers from chrome hole skin ulceration.

In the coating process, there are 5 workers with chrome hole ulceration. This can happen because the division of work division that remains only on polishing and coating. Whereas in the coating division itself, each worker may

alternate parts of each coating process, provided that it remains in the coating division, and the coating process remains in place. For example, if one of the workers is licensed, the other worker will take over the part of the process undertaken by the licensed worker. Therefore each worker in the polishing division has the same possibility of exposure to chromium.

3) Relationship between Work Period and Chrome Hole Dermatitis

TABLE III. CHROME HOLE DERMATITIS ACCORDING TO WORK PERIOD IN ELECTROPLATING WORKER CV X IN SIDOARJO YEAR 2015

Work Period (year)	Chrome Hole	
	(-)	(+)
1-2	1	2
3-4	4	0
5	0	3
Total	5	5
	10	
Contingency Coefficients	0.650	

^c. Primary data 2015

The result of cross tabulation between the difference of working period and the incidence of chrome hole ulceration has a contingency coefficient of 0.650. This means that there is a strong correlation between the differences in employment and the incidence of chrome hole ulceration.

In Table 3 it is known that, most workers who tested positive for chrome hole ulceration have more than 5 years of work in electroplating. A total of 3 workers who have a working period of more than 5 years, all declared positive experiencing chrome hole skin ulceration. This happens because of longer service life, causing workers exposed to more chromium chemicals than workers with less service life. So the chances of workers to suffer from chrome hole ulceration is greater.

However, the work span of 1-2 years also includes workers with chrome hole ulceration of 2 workers. According to the occupational physician, the worker has allergies, so that although the work period is still small, but when contact with chromium chemicals will cause reaction on the skin of the worker.

According to occupational doctors, chrome hole skin ulceration, can occur more rapidly in some workers who have allergies on the skin. This happens because, allergies in the immune system excessive reaction when the body in contact with allergens, in this case the chemicals.

4) Relationship between PPE Use and Chrome Hole Dermatitis

TABLE IV. CHROME HOLE DERMATITIS ACCORDING TO THE USE OF PPE IN ELECTROPLATING WORKERS CV X IN SIDOARJO YEAR 2015

Using of PPE	Chrome Hole	
	(-)	(+)
Without gas mask	2	1
Gloves and boots	3	3
Only bots	0	1
Total	5	5
	10	
Contingency Coefficients	0.343	

^d. Primary data 2015

The result of cross tabulation between difference of APD usage with chrome hole ulceration has contingency coefficient 0,343. This means that there is a weak correlation between the difference in use of PPE and the incidence of chrome hole ulceration.

IV. CONCLUSION

In the CV X home industry electroplating in Sidoarjo, most workers are in the 26-35 years age range, all of which are male, divided into 2 divisions: polishing using grinding and coating using chromium, most of which have a working life of 2 - 3 years but there are more than 5 years, and use the APD in the form of gloves and shoes bots but rarely use long-sleeved shirt or trousers and no one uses a mask. The incidence of chromium hole dermatitis in the electroplating industry occurs to workers with coating work division and more than 5 years working period.

REFERENCES

- [1] H. Kusuma, "Industri Logam Berperan Kembangkan Ekonomi Nasional," in press.
- [2] P. Gautama, "Mengenal Cara Electroplating," in press.
- [3] Syracuse Research Corporation, Toxicological Profile For Chromium Handbook, 2000.
- [4] E. Sudarsana, S. Onny, Suhartono, "Hubungan riwayat pajanan kromium dengan gangguan fungsi ginjal pada pekerja electroplating di kabupaten Tegal," Jurnal Kesehatan Lingkungan Indonesia, vol. 12, no. 1.
- [5] N. Miarastika, "Analisis kadar nikel limbah cair dan gangguan kesehatan kulit pekerja home industry elektroplating di desa Sugihwaras kecamatan Candi kabupaten Sidoarjo," unpublished.
- [6] XH. Zhang, X. Zhang, ZP. Yang, CX. Jiang, XB. Ren, Q. Wang, and YM. Zhu, "Hexavalent chromium pollution and exposure level in electroplating workplace," Chinese Journal Of Industrial Hygiene And Occupational Diseases, vol. 30.
- [7] S. Qayyum, A. Anjum, and AU. Jawed, "Effect of nickel and chromium exposure on buccal cells of electroplaters," Toxicology and Industrial Health 28(I) 74-82.
- [8] GF. Nordberg, AF. Bruce, N. Monica, and TF. Lars, Handbook On The Toxicology Of Metals (3rd Edition). USA : Academic Press, 2007.
- [9] J. guertin, A. James, and P. Cynthia, Kromium (VI) Handbook. Independent Environmental. Florida: Technical Evaluation Group (IETEG), 2005.
- [10] J. Mukono, Epidemiologi Lingkungan (Environmental Epidemiology). Airlangga University Press: Surabaya.