The correlation of exposure to iron dust with the disorders of the nose mucociliary transport time at PT. GGS Factory workers, Medan-Indonesia

Jerry Tobing,* Delfitri Munir, Mangain Hasibuan, Askaroeilla Aboet, Taufik Ashar

ABSTRACT

Background: Iron dust is one of the many irritant substances present in the environment and acts as a pollutant in the air. Exposure to iron dust substances in the air is thought to result in disruption of nasal mucociliary transport when inhaled. PT. Gunung Gahapi Sakiti Medan is one of the companies engaged in iron smelting by employing quite a lot of workers.

Objective: To know the relation of exposure to iron dust to the disturbance of nasal mucociliary transport time among factory workers in PT. Gunung Gahapi Sakiti.

Method: The type of research conducted is an analytical study with crossectional study design.

Results: Of 322 people, a total of 97 workers were selected based on inclusion and exclusion criteria. 18-28 years of age have more nasal mucociliary transport time ≤ 17 minutes, while employees aged 29-39 years and 40-50 years have a nasal mucociliary transport time> 25 minutes. Women have a nasal mucociliary transport time ≤ 17 minutes, while male employees have mucociliary transport time of the nose > 17 minutes. The duration of 1-10 years has a mucociliary transport time of the nose ≤ 17 minutes, whereas those who have worked 11-20 years I have time Nasal mucociliary transport > 17 minutes. Workers on close exposure have a mucociliary transport time > 17 min, while exposure has a mucociliary transport time ≤ 17 min

Conclusions: The nasal mucociliary transport time of employees is prolonged or decelerated with increasing age and duration, and the mucociliary transport time of the nose in male employees is longer than in women. The workplace (location of exposure) also significantly affects the mucociliary transport of the nose.

Keywords: nasal mucociliary, iron dust, irritant substance, iron factory.


INTRODUCTION

Nose is the first line in the airway defense mechanism. The air that is inhaled through the nose is first filtered by the hairs of the nose called vibrissae. The airways are continuously exposed to air and particles that inhaled with the air. The nose has several functions physiologically such as filters and first-line defense which is the most important body protector against unfavorable environments. Nose is also useful in clearing the inspiratory air from dust, bacteria, and viruses through a mechanism called mucociliary transport of the nose. This system consists of layers of mucosa and epithelial, also cilia movement that simultaneously keeps the airway always clean.1

Mucociliary transport in the nasal cavity is a physiological process in which the mucous layer in the ciliated cells moves and this is an important defense mechanism against the physical and biological stresses in the nose, paranasal sinuses, and lower respiratory tract. The foreign particles are inhaled, and the microorganisms are captured by the lenders and transported to the nasopharynx by way of Nasal Mucociliary Activity (NMCA). This process has a protective effect on the upper and lower respiratory system and is considered the first-line defense mechanism in humans. The effect is dependent on several factors, including the number of ciliates and the density and the coordination as well as the number of nasal passages. If this function is disturbed, then the protective effect of nasal cilia may be lost.2

The nasal mucociliary transport system is a system that operates actively and simultaneously depending on the movement of the cilia to induce mucus clumps and foreign objects trapped in when breathing air through the airway transport system. The delay in eliminating inhaled potential pathogenic particles can cause several foreign bodies accumulation including bacteria in the respiratory tract.3

Pollutants from the activities of factory workers such as iron dust and other particles can increase the permeability of the respiratory tract mucosa thus increasing antigen and allergen shrinkage, due to repeated exposure to organic antigen or chemical substance existing work environment. Repeated
inhalation of the antigen promotes immune responses such as inflammation in the interstitial tissues, alveoli, and terminal bronchioles, and one of the most common diseases in occupational societies are hypersensitivity pneumonitis belonging to the respiratory and other infectious diseases. Exposure of nasal mucosa to irritant compounds causes hyper-reactivity of mucous membranes and inflammation of the nasal mucosa. Hyperreactivity, inflammation, ciliary loss and cellular necrosis of the nasal mucosa will disrupt the nasal mucociliary transport, exposure of volatile benzene, toluene and xylene to the nasal mucosa that progressively lead to increased nasal mucosal abnormalities and eventually can lead to loss of cilia and nasal mucosal epithelial cell necrosis.

PT. GGS Medan is one of the companies engaged in iron smelting by employing quite a lot of workers. In work every day, many factory workers do not use personal protective equipment, so it always exposed to various pollutants such as dust, gas and steam iron and if this continues for a long time then cause respiratory system disorders, decreased endurance, and there are various work accidents.

Based on the conditions at PT. GGS Medan which has been described above, researchers interested in doing research with the aim to know the relationship of exposure to iron dust against the nose mucociliary transport time among factory workers in PT. GGS, Medan.

METHOD

The type of research conducted was analytical research with crosssectional study design. Research conducted at PT. GGS Medan, within 1 month since the proposal was approved. Researchers chose this place because PT. GGS Medan was a company engaged in the field of iron smelting. And the researchers also scheduled sampling within 2 weeks because in sampling cannot involve all employees simultaneously, because it can interfere with work rotation of the employees (sample).

Population in this research was all of the factory worker on iron smelting process, that were 322 persons. The sample size was calculated using the proportion sampling formula, and with the inclusion and exclusion requirement, there were 97 samples.

Materials and tools used were: Saccharine Tablets, Stopwatch, Bayonet Tweezers, Nose Speculum and Head Lamp. The way of research and measurement to be performed on the sample was as follows: 1. Samples are examined in a sitting position and asked to drink water and gargle to remove the taste of food waste in the mouth, 2. Samples are recommended to exhale air from the nose to remove or remove nasal secretions, 3. Samples are recommended not to inhale, eat or drink, cough and sneeze when saccharin tablets are laid, 4. A saccharin tablet with a diameter of about 0.5 cm is placed 1 cm behind the anterior margin of inferior conchae, 5. Then the samples are asked to swallow periodically, and a stopwatch is turned on, samples are recommended to swallow every ½ - 1 minute until the patient feels sweet, 6. Time is assessed since saccharin tablets are placed behind the inferior conchae until the first sample once feels sweet. This time is called mucociliary transport time.

The data obtained were analyzed statistically, processed by a computer program and presented in the form of tables and diagrams.

RESULTS

Identity of the Sample

The age of 97 samples shows that the lowest age (minimum) is 19 years and the highest age (maximum) is 45 years. The average age of the sample is 30.63 years with the standard deviation of 5.946; it means that the distribution of data in the samples and proximity of individual data points to the average sample age is 5.946.

Based on descriptive description about the age of the sample above, the age grouping is made based on the average age value of 30.63 years (31 years). Of the total sample is known that age ≤ 31 years is the largest group that is as many as 56 people (57.7%), while those aged > 31 years is the smallest group of 41 people (42.3%).

The sample of the male gender is much more than the sample with the female gender that is as much as 71 people (73.2%) in the male while in women only 26 people (26.8%).

The length of the sample work is grouped based on the longest and the lowest working time, where the sample of the long working 1-10 years is 84 people (86.60%), while the working duration is 11-20 years as many as 13 people (13.4%).

Most of the samples work in the administrative, security and warehouses that categorized in far to the location of exposure with a total of 75 people (77.3%), while those work in the smelting section categorized in near to the location of exposure with a total of 22 people (22.7%).

Mucociliary Transportation Time

Based on the results of the study, it is known that the amount of the sample with the transport time of ≤ 17 minutes (49.5%) and > 17 minutes (50.5%) were almost the same. The measurement point of nasal mucociliary transport time is when the sample tasted sweet for the first time. Obtained that, the lowest nasal mucociliary transport time is 13 minutes and the highest is 27 minutes.
Statistical Analysis Results
Based on Table 1 it is found that factory workers in PT. GGS Medan whose age ≤31 years have more result in ≤17 minutes of nasal mucociliary transport time (62.5%). The employees aged >31 years have more result in >17 minutes of nasal mucociliary transport time (68.3%). Fisher’s Exact test results obtained p-value = 0.004 (<0.05), there was a significant relationship between the age of employees with the mucociliary transport time of the employee’s nose at PT GGS Medan. The risk estimate value at 95% Confidence Interval for age was 0.549 times greater having mucociliary disorders in age >31 years than age ≤31 years characterized by the slowdown of nasal mucociliary transport time with the lower limit = 0.369 and the upper limit = 0.817.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Relationship between Age with nasal mucociliary transport time</th>
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<tr>
<td>Age</td>
<td>Nasal Mucociliary Transport Time</td>
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<td></td>
<td>&gt; 17 minutes</td>
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<tr>
<td>≤ 31 years</td>
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<td>&gt; 31 years</td>
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Based on Table 2 it is known that all women factory workers in PT GGS Medan have a nasal mucociliary transport time ≤ 17 minutes (100%). The male employees have more result in >17 minutes of nasal mucociliary transport time (69%). There was a significant relationship between sex with the time transport of employee’s nasal mucociliary at PT GGS Medan, Fisher’s Exact test results obtained p-value = <0.001 (<0.05). The risk estimate value at 95% Confidence Interval for sex factor was 3.227 times greater having mucociliary disorder in males than females characterized by the slowdown of the nasal mucociliary transport time with the lower limit = 2,281 and the upper limit = 4,567.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Relationship between Gender with nasal mucociliary transport time</th>
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<tr>
<td>Gender</td>
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<td>Male</td>
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Based on Table 3 it is known that the factory workers in PT GGS Medan, who’s with 1-10 years of work duration have more result in ≤17 minutes of nasal mucociliary transport time (54.8%). The employees who have 11-20 years of work duration have more result in >17 minutes of nasal mucociliary transport time (84.6%). There was a significant relationship between the duration of work with the mucociliary transport time of the employee’s nose at PT GGS Medan, Fisher’s Exact test results obtained p-value = 0.015 (<0.05). The risk estimate value at 95% Confidence Interval for the duration of work was 0.535 times greater having mucociliary disorders in 11-20 years of work duration than 11-20 years of work duration, characterized by the slowdown of nasal mucociliary transport time with the lower limit = 0.384 and the upper limit = 0.744.

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<tr>
<th>Table 3</th>
<th>Relationship between duration of work with nasal mucociliary transport time</th>
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<tr>
<td>Duration of work</td>
<td>Nasal Mucociliary Transport Time</td>
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<td>1-10 thn</td>
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<tr>
<td>11-20 thn</td>
<td>11</td>
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Based on Table 4 it is found that factory workers in PT GGS Medan who have to work in near categories to the location of exposure have more result in >17 minutes of nasal mucociliary transport time (72.7%). The employees who have to work in far categories to the location of exposure have more result in ≤7 minutes of nasal mucociliary transport time (56%). There was a significant relationship between the location of exposure with the mucociliary transport time of the employee’s nose at PT GGS Medan, Fisher’s Exact test result obtained p-value = 0.028 (<0.05). The risk estimate value at 95% Confidence Interval for the location of exposure was 1.653 times greater having mucociliary disorders in near categories to the location of exposure to the far category that characterized by the slowdown of nasal mucociliary transport time with the lower limit = 1.151 and upper limit = 2.373.

The overall factor of age, sex, duration of work and work place correlated significantly with nasal mucociliary transportation time in PT.GGS Medan.

Thus, the nasal mucociliary transport time of the employee’s nose will decrease or progressively along with the increasing of age and duration of work. The Nasal mucociliary transport time of male employees are longer than women. The workplace...
(location of exposure) also significantly affects the nasal mucociliary transport.

**DISCUSSION**

**Age**

Based on the results of the study note that the samples aged between ≤ 31 years are the highest percentage (57.7%). Most of the employee age at PT. GGS showed at productive age, and nasal mucociliary transport times showed a significant association with the age of the employee, statistical analysis used Fisher’s Exact test with \( p \)-value = 0.004. The results of this study support a theory that one of the factors that affect mucociliary transport time is age. The nasal mucociliary transport time increases with age. Transport of the nasal mucociliary slows with age. The slowing of nasal mucociliary transport is very significant at age over 60 years. In the age period of the 6th and 7th decades the nasal mucosa will change. With age, the nasal mucosa becomes atrophy and begins to lose the submucosal glandular gland and goblet cells, as well as decreased microvascular flow, resulted in a slowing of nasal mucociliary transport.

**Sex**

Based on the results of the study, most of the employee gender at PT. GGS were men (73.2%), it could be related to the work of melting process of the iron, so that it is more suitable for men. The results showed that the nasal mucociliary transport time showed a significant relationship with employee sex, where statistical analysis used Fisher’s Exact test with \( p \)-value = <0.001. By research of Yudhanto (2015) that the most gender of refueling workers were men (71.1%) than the women (28.9%).

**Duration of work**

Based on the results of the study, most of the employee at PT. GGS showed 1-10 year of work duration (86.6%), it could be assumed that iron dust exposure as a job impact has not been long enough. The result of the research showed that the duration of work factor was significantly related to nasal mucociliary transport time, where the statistical analysis used Fisher’s Exact test with \( p \)-value = 0.015. According to the research of Yudhanto (2015) that there is a correlation between the duration of work with the nasal mucociliary transport time. The results of Spearman correlation test showed \( r = 0.578 \) with \( p = 0.001 \), which means there was a positive correlation with moderate correlation strength and statistically significant. Similar to Soemadi et al. (2009) found that nasal mucociliary transport time in the group of wooden furniture employees was longer compared to the nasal mucociliary transport time in non-wooden furniture employees. The exposure of dust as a pollutant substance for respiratory tract through the nose will reduce transport time mucociliary nose. According to the research of Suherman (2013), there was a positive correlation between the duration of work with nasal mucociliary transport time on silver handicrafts workers in the production department at Kotagede, Yogyakarta with very strong correlation power. Duration of work play a more dominant role in the nasal mucociliary transport time compared with other variables.

**Location of Exposure**

Based on the survey results revealed that the percentage of samples that work in the far category to the locations of exposure (administration, warehouse, and security) is highest (77.3%) than the samples that work in near category to the locations of exposure (22.7%). The results showed that the location of exposure was significantly related to nasal mucociliary transport time, where the statistical analysis used Fisher’s Exact test with \( p = 0.018 \). A Research of the correlation between silver dust exposure with nasal mucociliary transport time conducted by Suherman (2013) in Kota Gede Yogyakarta, showed a positive and very strong correlation between silver dust exposure with nasal mucociliary transport time. The workers that exposed directly to silver dust have a longer nasal mucociliary transport time than the workers that not exposed directly to silver dust. Other studies conducted by Zein et al (2015) in the leather industry workers found that there was a significant difference between the mean time of nasal mucociliary transport time in tanneries of the leather industry workers than the non-workers, where the nasal mucociliary transport time for exposed workers was more longer than those not exposed.

**CONCLUSIONS**

The Nasal mucociliary transport time in PT. Gahapi Sakti’s employees are between 7 - 21 minutes. There is a significant relationship between employee age and nasal mucociliary transport time. Based on Fisher’s Exact test with \( p \)-value = 0.004 (<0.005), which means increasing age of employee will progressively slowing the mucociliary transport time of nose. There is a significant relationship between sex and nasal mucociliary transport time. Based on the Fisher’s Exact test with \( p \)-value <0.001 (<0.005), which means the nasal mucociliary transport time of female employees is faster than men. There is a significant relationship between the
length of working duration with the nasal mucociliary transport time. Based on the Fisher’s Exact test with p-value = 0.015 (<0.005), which means the longer the employee’s working duration will further slowing the nasal mucociliary transport time. There is a significant relationship between the location of exposure and the nasal mucociliary transport time. Based on Fisher’s Exact test with p-value = 0.018 (<0.018), which means the closer to the location of exposure (direct exposure) it will further slow the nasal mucociliary transport time.

**SUGGESTION**

Exposure to iron dust on employees of PT. GGS need to be handled, so it can minimize the nasal mucociliary transport time slow down by recommending to wear personal protective equipment in the form of masks. Need further research to know the factors or circumstances that can improve the function of nasal mucociliary transport.

**REFERENCES**

3. Punagi AQ, Ahmad A. Local immune system in sinonasal mucus, Department of Ear Nose Throat Surgery Head and Neck Surgery. Faculty of Medicine Hasanuddin University/Dr. Wahidin Sudirohusodo, Makassar. Review article. Wadi Husada Medical and Health Journal Vol.1 No.33; 2014.
4. Husaini. Exposure relationship CO, SO2, NO2, iron vapor and iron dust with lung function disorder and metabolism of a metal artisans serum. Doctoral Program of Medical Science and Health. Post Graduate Program of Faculty of Medicine, Gadjah Mada University. Yogyakarta; 2014.
14. Zein DF, Bahrudin M, Setiawan I. Differences in nasal mucociliary transport time in leather industry workers compared to non-workers. Faculty of the Medicine University of Muhammadiyah Malang; 2015.

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