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Original Research

Assessing respiratory exposure to harmful evaporations in a manufacturing company

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Introduction: Using Hypochlorite Sodium in producing bleaches in order to disinfect and shine surfaces has been an ordinary method since 200 years ago. 10-15% solutions with PH=13 have been used for industrial purposes and 5% solutions with PH=11 have been used for domestic use. AIHA (American Industrial Hygienists Association) has announced the maximum standard exposure to this substance equal to 2mg/m3 in a period of 15 minutes. It should be noted that, based on material safety data sheet and NFPA rating explanation guide, the mentioned substance is mildly unstable (code 1), carries oxidation hazard (ox), and serious respiratory hazard (code 3).

Methods: This survey has been conducted with statistical society of 39, average age of 29.82±3.66 and work experience of 2.46±6.02 who were exposed to Hypochlorite Sodium in 2019. The reference of analyzing the data include medical check-up inventory, spirometry FEV1, FVC, and FEV1/FVC relativity, using SPSS ver16, and T-test.

Results: The statistical society (39 participants) had a normal distribution, with a very pleasant correlation amounts in (FEV1/FVC, FVC, FEV1) considering sig=0.13, andless possibility than (P≤0.05). therefore, the amounts before and after FEV1, and FEV1/FVC, had a meaningful difference statistically, however, taking the amount of sig=0.68 into account which was P≤0.05, no meaningful difference was observed for FVC amounts before and after respiratory exposure to Hypochlorite Sodium.

Conclusion: Considering the reduction in amount of FEV1, and FEV1/FVC among the workers of the manufacturing site who were exposed to Hypochlorite Sodium, they are likely to have pulmonary obstruction, and therefore they are required to be changed in position and location of their jobs, and also appropriate ventilation system must be installed in the location of Hypochlorite Sodium evaporations. Keeping in mind the instability and corrosiveness of Hypochlorite Sodium, all employees had better use respiratory masks (preferably FFP3 in case of dusty materials), proper face shields, anti-acid gloves, anti-acid overalls, and chemical resistant boots.

Keywords: Respiratory exposure assessment, Occupational Asthma, Hypochlorite

Sodium, Bleach, FEV1, FVC, FEV1/FVC, CANCER.

Introduction

Using Hypochlorite Sodium in producing bleaches in order to disinfect and shine surfaces has been an ordinary method since 200 years ago [1]. 10-15% solutions with PH=13 have been used for industrial purposes and 5% solutions with PH=11 have been used for domestic use [2][3].

AIHA (American Industrial Hygienists Association) has announced the maximum standard exposure to this substance equal to 2mg/m3 in a period of 15 minutes. The nasty and gross smell of Hypochlorite Sodium is because of Hypochlorous Acid (HOCL), for which no standard exposure has been mentioned in international resources [4].

As a result of mixing Hypochlorite Sodium with water, Sodium, Hypochlorite, and Hydroxyl ions are produced. Hydroxyl ions have the ability to oxidize organic compounds in addition to altering the acidity of water [5].

$$NAOCL + H2O \leftrightarrow NAOH + HOCL \leftrightarrow NA + OH + H + OCL$$

Most of international resources have mentioned in the reactivity part of the NFPA rating explanation guide, that Hypochlorite Sodium is oxidizing and corrosive, in the hygiene part its mild health hazard [6][7], and in some health hazard resources, serious health hazard is mentioned [8]. In the conducted investigations in this regard, in case of accidental ingestion of Hypochlorite Sodium, the most common symptoms are going to be nausea, vomit, coughing, etc. Accidental ingestion of 1.5 glasses of this substance no longer required endoscopy, and conventional medicines have had an acceptable result [9]. It should be added that in cases of inhalation of Hypochlorite Sodium evaporations, no abnormal growth in the pulmonary cells were observed on rats and mice; however, toxicities symptoms were observed after exposure to Chlorine evaporations caused by decomposition of Hypochlorite Sodium. In similar studies, while cleaning toilets, kitchens, etc. due to extreme exposure caused by combination of bleaches containing Hypochlorite Sodium or Ammonia, with acidic launders, Chlorine gas will be evaporated, which is the most frequent and ordinary reason of poisoning in housewives [10]. Recent occupational studies have revealed that the possibility of suffering from asthma is more probable in female employees who are working in homecare production sites [11][12]. Considering the mentioned explanations, we have been studying and assessing the Hypochlorite Sodium exposure influences on employees between 2013 and 2017.

Materials and Methods

This survey has been conducted with statistical society of 39, average age of 29.82±3.66 and work experience of 2.46±6.02 who were exposed to Hypochlorite Sodium in 2019. Since spirometry is the most affordable, yet the most effective method of analyzing pulmonary [13] insufficiencies, and also is one of the most important tools in screening pulmonary diseases, and measures volumes and capacities of lungs, we have chosen it as the resource of collecting data for this research [14]. The most important respiratory capacity variations in diagnosing diseases include: FEV1 (the amount of air exhaled strongly from the lungs in one second) [15] and FVC (the amount of air exhaled after the FEV1) and the relativity of these two [16][17]. According to the scientific investigations in Iran, reduction in amount of FEV1 and FEV1/FVC can indicate a gradual blockage, and reduction in amount FEV1 and stability of the mentioned parameter indicates can indicate a pulmonary limitedness disease [18]. Therefore, the data collected from the spirometry check-ups is used as the reference of the survey. It should also be mentioned that based on the legislation of labor office and ministry of health, the standard working hour for an employee is 7.33 hours a day, and 44 hours a week; while during conducting this research, working hours and over time has been taken into

account [19]. Data analysis has been done by SPSS ver16, and T-test.

Results

The results and amounts achieved through pollution measurement has been precisely and accurately calculated. (The devices were already calibrated and in real situations two samples of Hypochlorite Sodium were measured). The results showed that the amounts were within standard limit, and spirometry indexes FEV1, FVC, and the relativity FEV1/FVC was exploited from medical check-up data(Table 1).

No.	Spirometry index	sample	Average age	Work experience	amounts	Correlation	T distribution	sig
1	Former FEV1	39			3.68 ± 0.75	0.894	2.618	0.13
	Latter FEV1				3.53 ± 0.72			
2	Former FVC				4.51 ± 0.93	0.913	1.876	0.68
	Latter FVC				4.39 ± 0.94			
3	Former FEV1/FVC				78.92 ± 4.56	0.873	3.706	0.001
	Latter FEV1/FVC				77.45 ± 5.19			

Table 1: Data analysis of employees' spirometry tests before 2013 and after 2017 regarding Hypochlorite Sodium exposure.

The results are as follows:

- The average age of target group who were exposed to Hypochlorite Sodium was 25.82± 3.66 at the beginning of the experiment in 2013, and equated to 29.82± 3.66 at the end of the survey.

- The average work experience of the target group was 2.46± 2.02 in the beginning of the survey in 2013, and it was 6.46± 2.02.

- Considering the number of participants surpassed 30, therefore the data had a normal distribution.

- The exploited amounts (the former and latter FEV1, FVC, and FEV1/FVC) had a very pleasant correlation.

- Keeping in mind that sig=0.13, and since P≤0.05 indicates a meaningful difference among the data, therefore, the amount of former and latter FEV1, and FEV1/FVC in exposure to Hypochlorite Sodium had a meaningful difference.

- Considering that the amount of sig=0.68 surpasses the amount of P≤0.05, the amount of FVC before and after exposure to Hypochlorite Sodium had no meaningful difference statistically.

In conclusion,taking the collected data into account, as well as the remarkable reduction of FEV1, and FEV1/FVC (as mentioned earlier, the reduction of these two parameters indicates blockage diseases) among the workers in a homecare manufacturing site who are exposed to Hypochlorite Sodium, we can conclude that these employees are suffering from a blockage disease. It is

suggested that besides further examination of their health, required actions must be taken into consideration in order to change their work stations and also proper ventilations must be installed in the locations. The results from this study are suggested to be carried out along other similar surveys [11][12]. however, considering the statistical society of this research (39 participants) and the specificity of their exposure to Hypochlorite Sodium, we can conclude that these results are best applicable to creation of occupational asthma caused by the exposure to this substance. Also considering the instability and corrosiveness Hypochlorite, it is crucial to use proper respiratory masks (at the time of exposure to Hypochlorite Sodium powder, using FFP3 mask, and at the time of exposure to Hypochlorite Sodium evaporation, using full face, or half-face shield with yellow taped filters, based on NIOSH [19], EN 371 , and EN 141 2000), anti-acid gloves, anti-acid overalls, and chemical resistant boots. The employer is required to supervise full and proper use of the mentioned PPE, and take necessary disciplinary actions against all violators. Based on similar investigations, Salbotamol spray had better be used in future medical check-ups to ensure avoiding occupational asthma [19]. The important factor is that using bleaches and cleaning materials is used completely irregularly especially in case of their mixture with other materials, without even using proper ventilation, by housewives in order to clean houses (the ventilation system installed in restroom is not adequate enough which causes the hypochlorite Sodium evaporations to enter the respiratory system). Therefore, more studies need to be taken into consideration for this stratum of society. Also based on the same studies, users of these bleaches, are in danger of suffering from asthma and other respiratory symptoms, just like all employees who are exposed to Hypochlorite Sodium evaporations [20][21][22]. Besides holding an appropriate hygiene plan for using Hypochlorite Sodium, it is essential to execute a convenient emergency response plan, since this substance is instable, and has a strong oxidizing power; therefore, if it is mixed with strong and instable acids, it will turn into decomposition followed by releasing heat which increases the risk of fire [23]. Eventually it is noted that no sign of cancer caused by Hypochlorite Sodium was observed in the target group. Based on the above article, the results form this survey fully comply with the results from IARC (International Agency research on Cancer). This agency has categorized Hypochlorite Sodium (including liquids and solids) as category 3 carcinogenic (not carcinogenic to humans.) [24][25][26][27][28][29].

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