

Preliminary Study on Heavy Metals Contents of Gloves and Masks Used by Allied Medical Health Professionals

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Abstract. Allied medical health professionals as Pharmacists, Nurses, Physical Therapists, Medical Technologists among others use gloves and masks in the workplace primarily to prevent spread of infection. The skin and the respiratory tract are passage ways for absorption of contaminants. The study in general aimed to determine the presence or absence of lead, cadmium and chromium in gloves and masks. The collected samples were acid digested and analyzed using Atomic Absorption Spectrophotometry (AAS). Projected blood levels of the heavy metals in the products were mathematically obtained and compared with standard safe limits. Differences among mean values of the heavy metals in each product brands were statistically determined. All analyzed glove and mask brands contained heavy metals lead, cadmium and chromium. All of the analyzed mask brands showed unsafe projected blood levels for lead, chromium and cadmium but only glove brands 2 and 3 had unsafe projected blood levels for lead.

Keywords: toxicology, Atomic Absorption Spectrophotometry, Heavy Metals, Philippines

1. Introduction

1.1. Background and significance of the study

The skin is a primary protective covering of the body. Contaminants can however penetrate the inner body through the skin by dissolving the layer of wax which covers the sebaceous glands. The respiratory tract protects the body from unwanted inhaled substances. But these contaminants may be deposited and eventually absorbed from the lungs into the systemic circulation [1]

Use of masks and gloves are routine practices in the health care system to prevent transmission of diseases from patient to patient to staff [2]. Basic lead carbonate is absorbed by inhalation at 11.6%. All other lead compounds have absorption factors for inhalation between 5 and 10 % [3] Lead vapor or fumes is nearly 100% absorbed by the lungs. Dermal absorption of lead is less than 1% [4]. Cadmium is absorbed at 10-50% by inhalation and 0.5% through the skin [5]. Both hexavalent chromium and trivalent chromium may penetrate the skin to some degree (CrVI>CrIII). Less than 1 percent absorption of hexavalent chromium from water was observed for dosing periods of 5 hours [6]. About 0.5-1% of chromium (III) present in the normal diet is absorbed by the gastrointestinal tract, while chromium (VI) is more readily absorbed by both inhalation and oral routes [7]

Heavy metals in gloves and masks may adversely affect the biosystem. Regular, continuous use of gloves and masks contaminated by heavy metals may result to increased dermal and inhalation al absorptions. These may lead to intoxication. Determination of contaminants in the said product will hopefully inform manufacturers through proper government and non-government agencies and execute procedures to remove or lower it down. Allied health professionals must be able to choose for themselves products to use in the workplace to improve their health and not to jeopardize it.

1.2. Objectives

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This study in general aimed to determine the presence or absence of heavy metals in gloves and masks used by Allied Health Professionals. Specifically, it aimed to determine the exact concentrations of lead, cadmium and chromium in the above said materials. The mean amounts per sample were compared with each other to determine significant differences if any. It aimed to compute the projected blood levels of the heavy metals through dermal and inhalational absorption and compare with the set safe blood limits.

1.3. Scope and limitations

The study analyzed three brands of gloves and masks each sold in Manila, Philippines. The prepared samples were analyzed using Atomic Absorption Spectrophotometry. The blood levels of individuals using the products were obtained by mathematical calculation considering the absorption rates of the heavy metals upon inhalation and dermal exposure. No actual blood samples were collected and analyzed.

2. Methodology

2.1. Research design

This study followed a descriptive, exploratory design. The randomly selected masks and gloves were analyzed for its lead, cadmium and chromium contents.

2.2. Locale of the study

The research was performed in Manila, Philippines from October 2013 to January 2014. The samples were prepared at the General Toxicology Laboratory at the University of the Philippines, Manila. The instrumental analysis was done at the Institute of Chemistry, Dela Salle University Manila.

2.3. Collection of samples

The samples were randomly procured from a drugstore and medical supplies stores in Manila, Philippines. These were placed separately in brown bags and stores in a cool, dry area prior to its preparation.

2.4. Preparation of samples

To 5 g of the each sample, 10 mL nitric acid was added. These were left overnight for pre-digestion. The samples were then heated using a water bath maintained at 80-100 °C for 5 hours, cooled, filtered and filled with distilled water to volume in a 50 mL volumetric flask. The samples were transferred and stored in polyethylene bottles prior to Atomic Absorption Spectrophotometry [8]

2.5. Instrumental analysis

The lead content of the samples was analyzed using AAS-6300, Shimadzu, France) controlled by a personal computer using WizAArd software. Measurements were carried out at 217.0 nm with 0.7 nm low slit and 5 mA electric current. Prior to analysis, the spectrophotometer was calibrated with standard lead solutions using distilled water as blank. The standard solutions and distilled water were provided by the Chemistry Instrumentation Laboratory of the De La Salle University, Taft Avenue, Manila. Heavy metal concentration levels were expressed in mg/kg unit.

2.6. Data Analysis

The concentrations of heavy metals lead, cadmium and chromium in masks and gloves were statistically analyzed using one way ANOVA. From the data projected levels of the heavy metals in blood were computed by mathematical procedure taking into consideration the absorption by inhalation and dermal route.

3. Results and Discussion

The glove and mask (both mid and edge parts) brands collected and analyzed all contained heavy metals lead, cadmium and chromium (Tables 1, 3, 5). Upon mathematical manipulations, considering the absorption rate via the skin and the lungs, the gloves generally showed projected blood concentrations (in parentheses) within safe limits with the exception for glove brands 2 and 3 for lead (Table 2). The Permissible Exposure Limits of cadmium, lead and chromium are 5mcg/m³, 50 mcg/m³, 5 mcg/m³ at 8-hour time weighted average (TWA) [9]. The amount went beyond the acceptable limit for this heavy metal in blood. The safe

blood levels of chromium, lead and cadmium are 3 mcg/dL (absence of known exposure) [10], 5ug/dL [11] and 5ug/L [12]

Table I: Heavy metal contents of three glove brands

Ppm	Glove Brand 1	Glove Brand 2	Glove Brand 3
Mean Cadmium +/-SD	0.6911+/- 0.0006	0.6727+/-0.0003	0.6941 +/- 0.0011
Mean Chromium +/-SD	0.4476+/-0.0003	0.2089+/-0.0001	0.3581+/-0.0005
Mean Lead +/-SD	0.5326+/-0.0006	10.1584+/-0.001	10.4477+/- 0.0003

Table II: Projected blood levels of heavy metals upon dermal absorption

	Glove Brand 1	Glove Brand 2	Glove Brand 3
Mean Cadmium mcg/L	691.1 (3.455)	672.7 (3.3635)	694.1 (3.4705)
Mean Chromium mcg/dL	44.76 (0.4476)	20.89 (0.2089)	35.81(0.3581)
Mean Lead mcg/dL	53.26 (0.5326)	1015.84 (10.1584)	1044.77(10.4477)

The projected mounts of cadmium,chromium and lead in blood coming from the mid and edge parts of the three mask brands analyzed showed values way beyond the safe limits set for these heavy metals. The amounts are generally quite high for lead and cadmium because of its high absorption rate upon inhalation with lead at 100% and cadmium 10-50% in addition to high concentrations in the materials studied.

Table III: Heavy metal contents of three mask brands (mid part)

ppm	Mask (mid) Brand 1	Mask (mid) Brand 2	Mask (mid) Brand 3
Mean Cadmium +/-SD	0.6415+/-0.0003	0.6579+/-0.0003	0.6694+/-0.0003
Mean Chromium +/-SD	0.1094+/-0.0002	0.2089+/-0.0004	0.1044+/-0.0003
Mean Lead +/-SD	0.1644+/-0.0005	0.2498+/-0.0003	0.1710+/-0.0004

Table IV: Projected blood levels of heavy metals upon inhalation

	Mask (mid) Brand 1	Mask (mid) Brand 2	Mask (mid) Brand 3
Mean Cadmium mcg/L	641.5(64.15 to 320.75)	657.9 (65.79 to 337.95)	669.4(66.94 to 334.7)
Mean Chromium mcg/dL	10.94 (10.94)	20.89(20.89)	10.44(10.44)
Mean Lead mcg/dL	16.44(16.44)	24.98(24.98)	17.10 (17.10)

Table V: Heavy metal contents of three mask brands (edge part)

ppm	Mask (edge) Brand 1	Mask (edge) Brand 2	Mask (edge) Brand 3
Mean Cadmium +/-SD	0.6464+/-0.0001	0.6632+/-0.0001	0.6388+/-0.0011
Mean Chromium +/-SD	0.2735+/-0.0002	0.5222+/-0.0005	0.0895+/-0.0007
Mean Lead +/-SD	9.6784+/-0.0004	0.2696+/-0.0002	0.4931+/-0.0004

Table VI: Projected blood levels of heavy metals upon inhalation

	Mask (edge) Brand 1	Mask (edge) Brand 2	Mask (edge) Brand 3
Mean Cadmium mcg/L	646.4 (64.64 to 323.2)	663.2(66.32 to 331.6)	638.8(63.88 to 319.4)
Mean Chromium mcg/dL	27.35(27.35)	52.22(52.22)	8.95(8.95)
Mean Lead mcg/dL	967.84(967.84)	26.96(26.96)	49.31(49.31)

Using one way ANOVA, the p values for the tests related to heavy metals present for gloves, masks (mid) and masks (edge) at units of parts per million, showed 0.0777,0.000 and 0.4381.The three mask (mid part) brands showed mean values of the heavy metals which are significantly different statistically from each other. This implies that heavy metal amounts vary among different brands of masks (mid parts). The heavy metals in the gloves and masks (edge parts) though present are not significantly variable from each other.

Allied medical health professionals like Pharmacists, Nurses, Medical Technologists, Physical Therapists among others use gloves and masks in different areas in designated workplaces. This practice, aides in the

prevention of spread of infection from patients to staff and vice versa. With the presence of heavy metals in gloves and masks, absorption through the skin and the respiratory system will most likely occur. Cadmium may cause severe arthralgia and osteomalacia in middle aged postmenopausal women with low calcium and vitamin D intake, or itai-itai disease. It attacks the kidneys on chronic poisoning, lungs and gastrointestinal tract on acute inhalation and ingestion, respectively [13], [14] The toxic potential of chromium depends on its oxidation state. Cr VI is more toxic than Cr III [15] It causes adverse gastrointestinal effects in humans and animals [16]. It causes unwanted affects to the respiratory, hepatic, endocrine, immunological, and neurologic system. Accumulation of chromium can lead to cancer. It can adversely affect the gastrointestinal tract upon ingestion [15]. Lead has been associated with neurological abnormalities. High levels of lead in blood often correspond with impaired potential intelligence among children in a linear, dose-dependent fashion. This is contrary to its far more subtle effects on other neurologic functions [17]

4. Conclusions and Recommendations

Therefore from the results of this study, it is concluded that all of the randomly collected and analyzed gloves and masks (both mid and edge parts) contain heavy metals lead, cadmium and chromium. The masks showed unsafe projected blood levels of lead, cadmium and chromium compared to standard limits set. Only glove brands 2 and 3 for lead showed unsafe projected blood levels. All glove brands showed safe levels for cadmium and chromium and glove brand 1 for lead. It is recommended that all glove and mask brands be analyzed for heavy metal contents to be able to identify the brand/s least hazardous to the allied medical health professionals. Other heavy metals must be tested as well. Manufacturers of these products must be able to improve the production design to minimize contaminations that may endanger the health of health care givers.

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