

SPECIMEN FORMAT FOR THESIS OF MONTH

Faculty : Science

Department : Biochemistry

Branch/ Area: : Biochemistry

Sub Subject Heading: : Occupational Health

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Title of the thesis : Air Quality Monitoring and Health Surveillance of
Photocopier Service Personnel in Xerographic Units

(i) In Roman Script -

(ii) In roman Script -

Nomenclature of Degree: : Ph.D

Month & Year of Enrolment: : March, 2011

Month & Year of Registration: : March, 2011

Month &Year of Submission: : March, 2016

Month &Year of Award : August, 2017

Name of Supervisor : Dr. G.P. Jeyanthi

Designation of Supervisor : Professor in Biochemistry

Centre/department/school in which research was conducted : Department of Biochemistry, Biotechnology & Bioinformatics

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Abstract within 300 words:

Service personnel in xerographic industry are routinely exposed to toner and their emissions from xerographic machines in a manner comparable to operators. However, the milieu of pollutants to which these personnel are exposed is varied due to the differences in the photocopier machines, associated factors and indoor environments. Therefore, evaluating the risks of exposure among service personnel is imperative. Chronic exposure to air pollutants has been documented to affect both the respiratory and cardiovascular systems. Till date no attempt has been made to evaluate the effects of photocopier exposure among the service personnel. It is this lacuna that necessitates the health surveillance program among them which are the most suitable biomarkers to assess to assess the health effects caused by the complex pollutants released from photocopiers. The findings revealed that chronic exposure to xerographic toners and their emissions might cause restrictive lung disease, high oxidative stress, inflammation and endothelial dysfunction among photocopier service personnel. High exposure to fine and coarse particulate matter emissions in the form of toner particles with release of different hazardous organic compounds emissions that include various volatile organic hydrocarbon compounds (aliphatic, aromatic, heterocyclic and polycyclic aromatic hydrocarbons compounds) and photocopier emissions leads to cardio pulmonary disease among the service personnel. Invasive biomarker Clara Cell Protein (CC16) was found to be the best indicator of lung function. ICAM-1 was found to be the best cardiovascular marker among the photocopier service personnel. Increased inflammatory endothelial marker Inter Cellular Adhesion Molecule (ICAM-1) and nonspecific inflammatory marker levels Interleukins 6 and 8 and CRP indicates associated co-morbidity of cardio problems coupled with lung dysfunction. An increased level of % DNA content in tail indicates the genotoxic effect of photocopier exposure. The non-invasive urinary putative biomarker discriminated by metabolomics were found to be 3 – aminoisobutanoic acid, L-Histidine, Hippurate and Oxoglutarate

i) Major objectives :

Hence, the present study was undertaken in two phases with the following two main objectives under each phase:

Phase I: Air quality analysis

- To elucidate the physical characteristics of both the selected xerographic units and machines.
- To analyse the ambient air quality of the selected xerographic centers.
- To determine physico-chemical characteristics of four selected brands of toner by Scanning Electron Microscopy Energy dispersive X ray Spectra (SEM EDX) elemental composition and head space Gas Chromatography Mass Spectrometry (GC-MS)

Phase II: Health surveillance of photocopier service personnel in xerographic units

- To assess lung function by spirometry
- To assess the status of biochemical, oxidative, inflammatory, selenium, cadmium and selenoproteins (invasive systemic biomarkers levels) in occupational settings amongst the study population.
- To assess genotoxicity exposure among study population
- To determine metabolomic differences in excretory urinary biomarkers by non invasive approach

ii) Hypothesis:

The hypotheses set up for the present study are as follows:

Null hypothesis (H_0): Occupational exposure to toners and emissions has no effect on the health of the photocopier service personnel in xerographic units

Alternate hypothesis (H_A): Occupational exposure to toners and emissions have effect on the health of the photocopier service personnel in xerographic units.

iii) Findings:

The outcome of the present study showed that there were the 3.8 fold higher levels of particulate emissions in comparison to national ambient air quality standards in xerographic units during machine operation and maintenance. Physical characterization of the toner particle size falls in the range of either coarse particles size ($PM_{10-2.5}$) or fine particles size ($PM_{2.5}$). Xerographic centres used local toners A, B and C rather than generic

toner D. Elemental composition of monochrome toner materials constitutes analysis by SEM EDAX showed core resin constitutes of > 50% organic carbon. Qualitative screening of toners by head space GC-MS showed release of different hazardous organic compounds emissions that include various volatile organic hydrocarbon compounds (aliphatic, aromatic, heterocyclic and polycyclic aromatic hydrocarbons compounds). Among the general health symptoms a higher prevalence of respiratory symptoms, headache, allergies and skin problems observed was influenced by occupational exposure. A noted decrease in selected lung function parameters (VC %, FEV1% and MVV % predicted) indicates restrictive ventilator pattern among photocopier service personnel. There were higher incidences of restrictive ventilatory pattern followed by obstructive and mixed ventilatory pattern defect among the service personnel. Causative factor of likelihood of lung dysfunction is merely due to occupational exposure. Among the blood cell indices: Haemoglobin, Red blood cell distribution width (RDW) levels were found to be increased due to oxidative stress induced haemolysis indicating hypoxic cardio-pulmonary inflammation and dysfunction where as in contrast Mean Corpuscular Volume (MCV), Mean Platelet Volume (MPV) and Platelet Large Cell Ratio (P-LCR) were found to be positively associated with pack years of cigarettes smoked rather than cumulative exposure. Hyperglobulinemia among service personnel indicates positive acute phase reaction caused by progressive decline in lung function with inflammation. Increased Thiobarbiturate acid reactive substances (TBARS) and the decreased levels of ferric reducing antioxidant capacity (FRAC) indicates the counteraction of the oxidative stress by antioxidants among the photocopier service personnel. Increased pneumoprotein, CC16 levels and its leakage into systemic circulation indicates pulmonary damage and decline in lung function. Increased inflammatory endothelial marker ICAM-1 and nonspecific inflammatory marker levels IL-6, IL-8 and CRP indicates associated co-morbidity of cardio problems coupled with lung dysfunction. Increased levels of % DNA content in tail indicated the genotoxic effect of photocopier exposure. Urine metabolomics study showed putative urinary discriminate metabolites as 3 – aminoisobutanoic acid ($\delta H1$ ppm, 2.943), L-Histidine ($\delta H1$ ppm, 3.979), Hippurate ($\delta H1$ ppm, 3.9465) and Oxoglutarate ($\delta H1$ ppm, 2.973) on comparison of peaks with Human Metabolome database using Metaboanlyst web server for Chemometric analysis with Partial Least Square Discriminant Analysis moderate model robustness of $r^2 = 0.7$ and $q^2 < 0.2$

Examiners

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