Screening Indoor Threshold Levels of Carbon Monoxide (CO) Toxicity among Hospital Health Care Professionals in Sandstorm Ambient Air Pollution: Pulse CO-oximetry:Tehran-Iran;2011

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ARTICLE INFO

Article Type:
Original Article

Article History:
Received: 22 Nov 2012
Revised: 7 Dec 2012
Accepted: 20 Dec 2012

Keywords:
Air Pollution
Carbone Monoxide
Carboxyhemoglobin
Health Careprofessional
Pulse CO–Oximetry
Sandstorm
Toxicity

A B S T R A C T

Background:Carbone's monoxide is a poisoning gas and a pollutant of ambient air. Sandstorm is episodic dust-laden that reinforced CO toxicity levels in the environment. Hospital healthcare professionals are the first line healthy system organization and hospital workplace should be safe. The objective of this study was to determine the threshold levels of CO toxicity among hospital healthcare professionals in thesandstorm ambient air pollution through pulse CO-oximetry method.

Method: Participations recruited base on the designed protocol and following inclusion and exclusion criteria.

Results:A total of 117 subjects enrolled with means age ± SD; 38.97±9.03 years. It ranged between 20-60 years. Of those, 68 subjects was female and 49 male. Mean level of carboxyhemoglobin concentration (COHB %) was 2.52±3.40 SD,(P=0.03). 43% of sample study had CO toxicity upper than the normal set point. COHB% level noticeably increased in the female sex respect to male subgroups (χ =0.019).

Conclusion:The resultant's study was indicated particularity in female sex that a significant carboxyhemoglobin concentration found an above- normal set point level among target of population. As well as, threshold levels of CO toxicity in the workplace setting were noticeably high. Intervals of toxicity are nearby hazardous action level. The outcome of the study should be considered as an alarm for the public health program and presenting occult indoor CO poisoning.

►*Implication for health policy/practice/research/medical education:*
Pulse CO-oximetry

►*Please cite this paper as:*AginKh, Khodabandeh F, Moinazad-Tehrani M.Screening Indoor Threshold Levels of Carbon Monoxide (CO) Toxicity among Hospital Health Care Professionals in Sandstorm Ambient Air Pollution: Pulse CO-oximetry:Tehran-Iran;2011.*International Journal of Medical Toxicology and Forensic Medicine*.2013; 3(1):1-9.

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1. Introduction:

Carbonemonoxide (CO) is a tasteless,colorless, odorless and poisonous gas. Itderived from incomplete combustion

of any fossil fuels. The main source of a mass outdoor CO production is automobile and motor vehicleexhaust and estimated up to 70% (1).Its effects can be potentate in themegacitieswith heavy traffic. Public of the cities has been exposed accidentally against various toxic levels of COconcentrations and to follow different reactions to it. Detection of blood carboxyhemoglobin (COHB) concentrations above normal range isdiagnostic torecent contact against externalsources of CO level. Standardconcentration of COHBis recommended varied between 1-3% (2).It isproduced normally from endogenous hem metabolism. Safe margin of COHB is accepted by governmental air quality atbelow 3% (3).Clinical threshold level of CO toxicity appears in action level of 10% exposureand manifested most commonly asan acute or less likely in chronic features (4). Low-levels and continuous CO exposurecompetent to induce prolonged toxicity and contributes with adverse health effects (5). Ranges of clinical features havebegun from subtle manifestations asa light-headache, flu-like symptomsuntil cognitive problemand serious cardiovascular diseases (6).

Sandstormambient air pollution is an unusual episode of dust-laden. It has been recently taking place at Tehran; capital of Iran. Our hypothesis trend to support that sandstormepisode has an additive effect on the intensity of COconcentration at the workplace.It is effective at raising threshold level of CO toxicity and creating a new set point in the indoor environments during an episode at work time. Upward movement of threshold levels of CO toxicity leads to decrease the threshold interval between reserve safeties of healthy individual's respect to hazardous action level. Consequently, it is inducing poisonous population at risk and morbidity and mortality can be augmented among the target population.However,it can produce acute or occult subclinical feature of CO poisoning thatrelated to magnitude and stability of the phenomena.

Hospital healthcare professionals are the first linesocial of the healthy system organization and hospital workplace should be safe. Complications of toxicity with CO may be directly influenced on lifeactivity levels or being susceptible individuals to serious adverse health problems.PulseCO-oximetry is anon-invasive instrument that detects measures the concentration of COHB percentage (7). It has good susceptibility to detection of the occult CO toxicity at high-volume urban area (8).

The objective of this study was to determine the threshold levels ofCO toxicity among hospital healthcare professionals in the sandstorm ambient air pollution through pulse CO-oximetry method.

2. Materials and Methods:

The study was crossed-sectional. Itconducted at Logman Hakim general teaching hospital of ShahidBeheshti University of Medical Sciences (SBMUS), Tehran- Iran, Wednesday; 2011/13/4.

The hospital foundation constructed at six stairs and had 50 yearsold- age. It placed at the south of Tehran and situated geographicallyat the canyon of the city.Geographical Latitude distribution documented via Google's earth: West:35, 40, and 76,East:31, 23, and 07 and altitude: 1148 m. The traffic around the hospital was often heavy at the days of week and frameworks of streets werenot usually serviceable. As well as,the overall ventilation of building was not satisfactory and communication within different setting was not sufficient.The climate conditions recordedon the same day of the studyat 9-12 AM. The humidity and temperaturelevels ofthe local climate detected 30 percent and 25 centigrade, respectively.The workplace of setting included Intensive care units, operation rooms, general wards, and outpatient clinics. In addition, we divided building of hospital froman aspect of quality ventilation in two places: well-ventilation; operation room and ICU wards and poor-

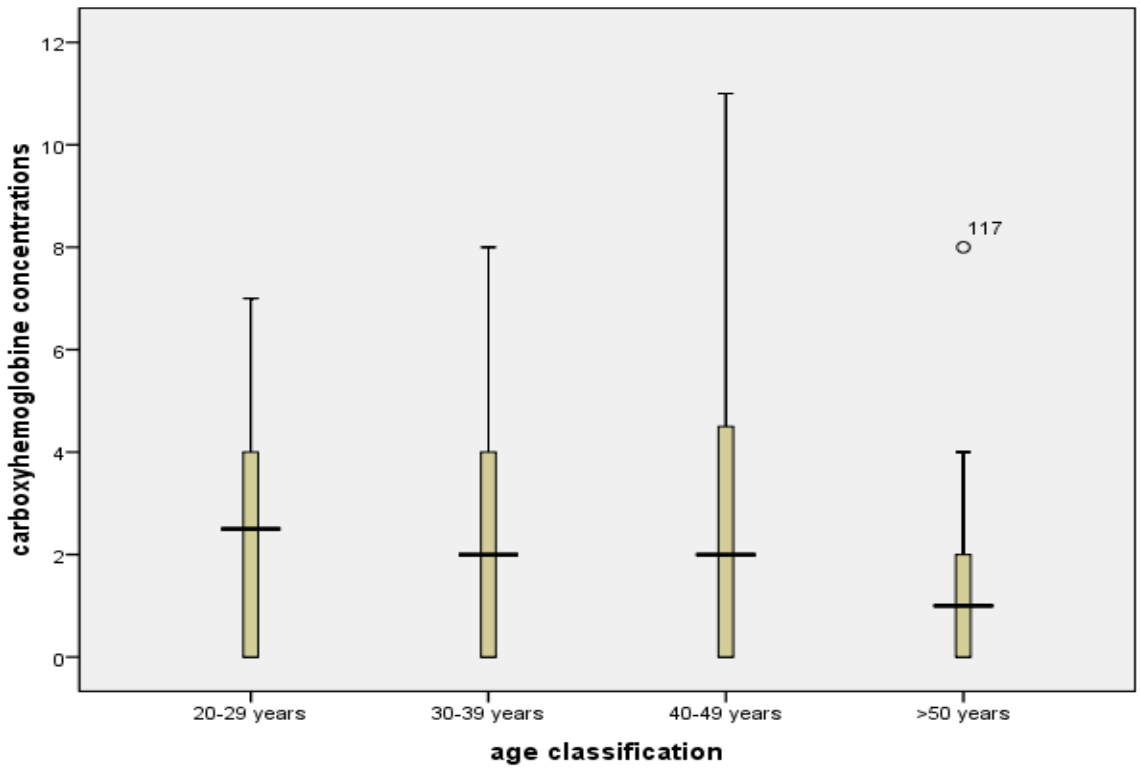

Fig. 1. Age distribution of carboxyhemoglobin concentrations among hospital healthcare professionals.

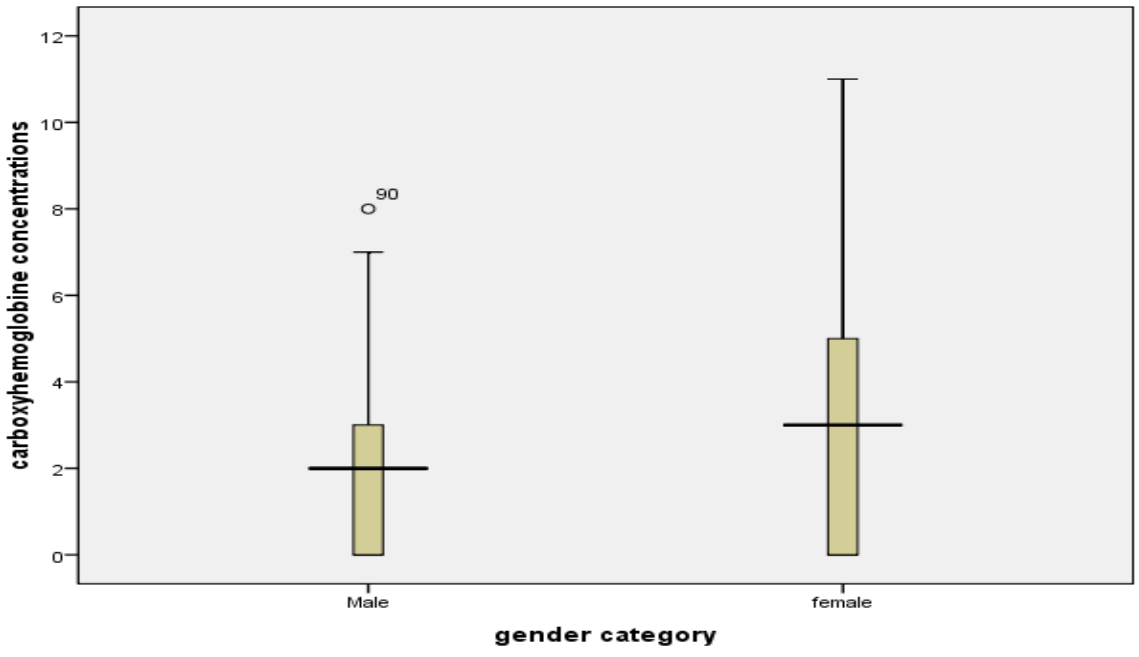

Fig. 2. Sex distribution of carboxyhemoglobin concentrations among hospital healthcare professionals.

ventilation; clinics and wards. Target population was healthcareprofessionals of hospital who has worked at workplace setting in astandard period every month.

Entrance criteria recruit the subjectsinclusive; healthcareprofessionalswithin the Logmanhospital, history of

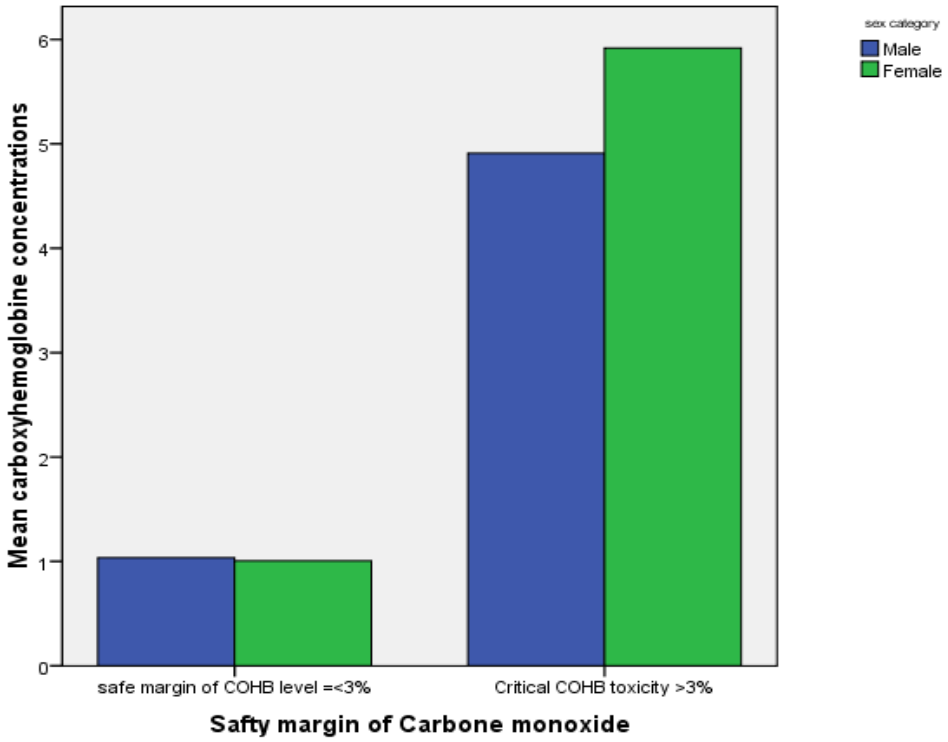

Fig. 3. Safety margin of CO levels among sex subgroups.

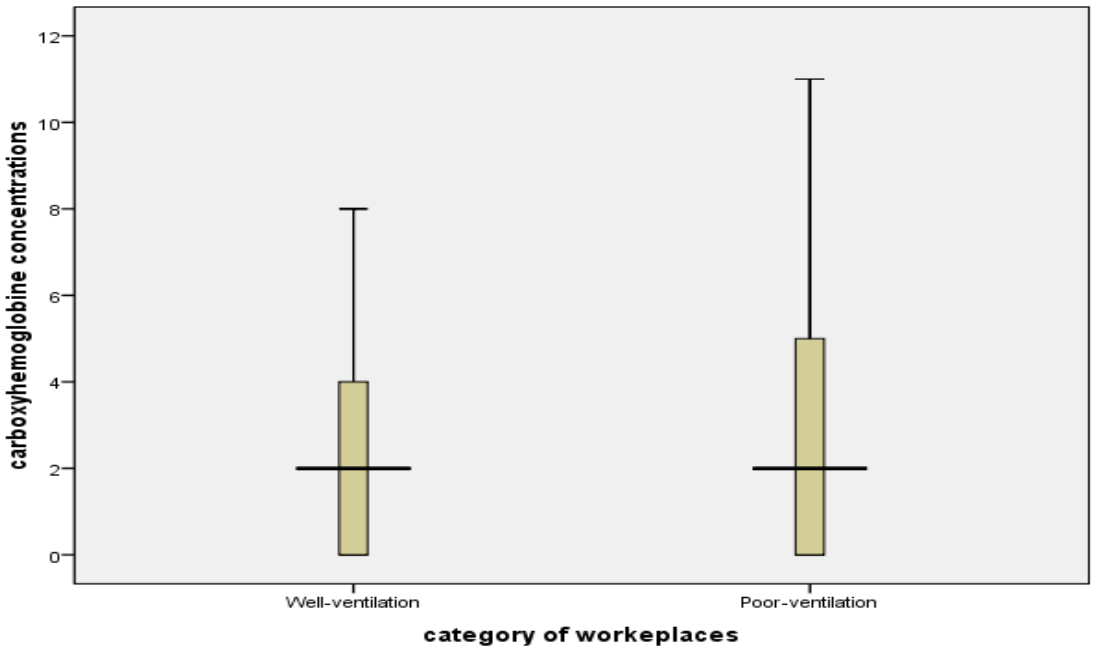

Fig. 4. Distribution of carboxyhemoglobinconcentrations within workplaces.

backgroundworking longer than three yearsat theirworkplaces and informed consensus. Any participation had one of the following highlights omitted from the

study as alack of participationsconsensus,smoking habit, taking placed with a physician at the workplaces.

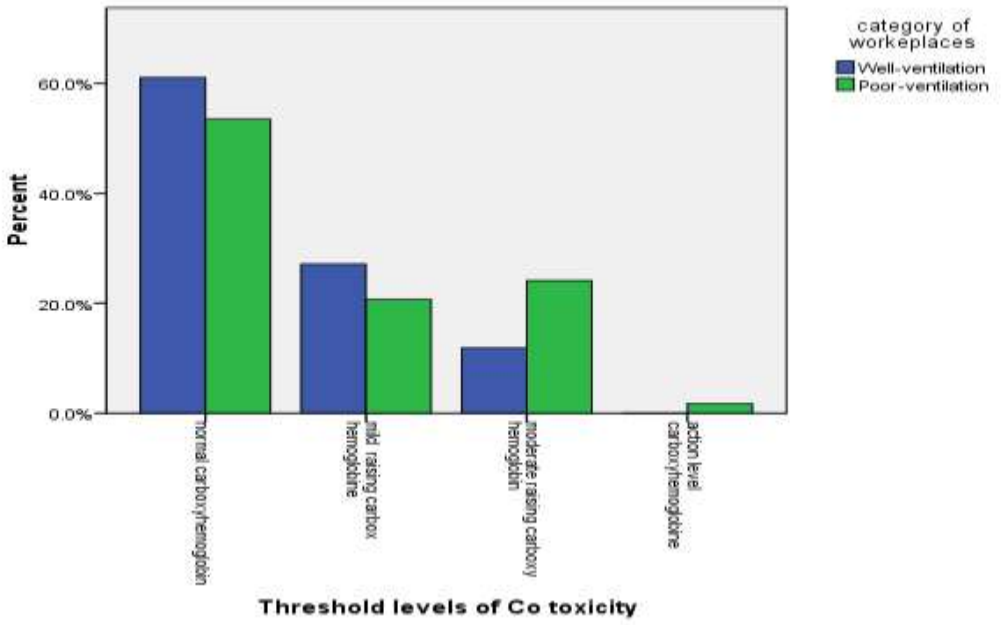

Fig. 5. Presents threshold levels of Co toxicity respect to quality of workplace ventilations.

opium smoking, and known respiratory diseases with clinical presentation. In addition, thesourcesof reading errorof Pulse oximetrywerelimited. They consisted of history of dyshemoglobinemia,anemia,skin pigmentation, nail polish,low perfusion state,delay of reading of less than 30 secondsand ambient light.All the subjects visited and examinedby a physician.

Cutaneous oximeter with Sensor adult's probe set on theindex finger. It can detectCOHB% levels and oxygen saturation. Recording data of Pulseoximeter maintained at 60 seconds until it achieved toPlateau level and stabilized.Set point of pulse-oximeter was 0.5%. Despite the wide range of variation, cutof point of concentration of COHBpercentage selected up to 2% of normal level.CO –pulse oximeter was Masimo (Trade name; Masimo- rainbow set: Radical -7 made in; USA).Safety margin of set pointwas atbelow 3%. It is suggested by the governmental quality aircontrol. Consensus information obtained from all the subjects. Measurement was Data recorded in the SPSS software version 18. Collected data recorded and summarized as a mean± SD and percentages. COHB concentrations assessed using one-sample T test. Associations between sexes with COHB levels carried out with Pearson's Chi-square. Independent-samples T test applied on the variable.Correlationof Kendall's tau-bperformed between defined variables. Significant level was set at in <0.05 (two tailed).

3. Results:

A total of 117 subjects completed criteria of study. Characteristics' target population recorded including; meanage±standard deviation; 38.97±9.30 SDyears, and ranged over 20-60 years.Of entire the subjects female were 68(58. %) and male 49(42%).Mean Pressure index (PI) was 3.20±2.21SD.Figure 1 shows age categories and distribution of COHB% concentration in hospital healthcare professionals. Mean whole blood COHBconcentrationsdetected 2.52±2.58SD percent (range; 0-11%).it was statistically significant to standard cut

of point at (P=0.03).Graph 2 reveals sex distribution of COHB% concentration in target population. 43 % ofsubjectshad a COHB%concentration greater thana normal set point,and thoseof them were70% female.

Graph 3 reveals safety margin of CO toxicity among sex subgroups. 33% of pubic of study situated at critical air quality zone (>3%) that of those71% was female.There were significant differences between gender with COHB%concentration(χ=0.037), and Phicorrelation was meaningful at(r=0.2; P=0.02).

Mean of oxygen saturation (SPO2%) detected 96.95±1.88 SD percent (ranged; 88-99%) that of those 3% showed hypoxia (SPO2<90%). Resulting indicated that only markedrelevantfound between COHB% withSPO2 (P=0.02, 95% CI=1.43 -0.15). Mean of COHB% greater than set pint was higher than normal range (97.4±1.33SD).Therewas statistically a weakcorrelationbetween COHB% levels with sex (r=0.2; P=0.03).

Graph 4 discloses COHB% concentrations within workplaces.24% of overall poisonous subjects distributed in a mild zone (3-4%), 18% in a moderate zone of toxicity (5-9%) and less than 1% in hazardous action level (=>10%). Frequencies of toxic population (39%) in well-ventilated places were lower than places associated with poor-ventilation46%. Within of category of workplaces, female sex distributed more in the well-ventilated (61%) respect to poor-ventilatedplaces (55%). As well as, frequency distribution of mild (27%) and moderate(12%) zones of toxicity levels within well-ventilated were lower than the same zones (mild;21%, moderate;24% and action level;2%) in poor-ventilated places. Graph 5 reveals distribution of subjects at risk in different quality of ventilated places.

Stop smoking is the policy in the hospital. Prevalence of total current smoking amongcrew memberswas 9% in the workplace setting. Smoker crewdistributed 40% in well-ventilationand 60% in poor-ventilation places.

4. Discussion:

Carbone's monoxide is one of the toxic inhalation gases,and its poisoningconsiders as a triage in medicine.Troposphere has 1% CO in well quality condition.CO originates from incomplete combustion of any carbonaceous fuels. It is odorless, colorless and mixture with air. Its detection in the indoor and outdoor environments reflects as an air pollutant biomarker. Adverse health effects of Co poisoning are establishedin the early decade (9).Resulting data indicated that significant CO toxicity found among healthcare professionals 43%. Following evidence may be agreement withthe recent outcome.

48% overall toxicity was seen in poor-ventilated place's respect to 39% in well -ventilated setting. The resulting indicated the distribution of threshold level's toxicity respect to workplace setting, behavior of subject in contact with toxic gas,ventilation quality and addictive effect of environmental conditions.

Widespread distribution of toxicity and presents the marked CO toxicity within the both well and poor-ventilated study settings are an agreement with following evidence. The hypothesis is that the pollutant source of CO poisoning in the workplace setting shouldbe undergone of global generationand originated from emission of outdoor environment or internal production.The most common known source of Indoor CO production is limited to the anesthetic lime absorbent, banked blood, coffee roasting, and oven in the medical center. Internal sources are not able to produce mass like poisoning at the tacking place of building.It seems rare.

Conversion rate of air has a direct effect on the environmental CO. It may be agreement with distinctive quality of the workplace's ventilation. Well-ventilated

setting was used from Air conditioner devices.

Clinical manifestation andseverity of poisoning subjects related to the bulk of CO contact, timing exposure, and steady-state condition and elimination period. However,formation and decline of COHB is thecomplex and has not been a linear model.Based upon the Coburn-Forster-Kane (CFK) equation (10) is a model of equilibrium of CO absorption. The rate of formation COHB related exponentially to the time of exposure. In other words, approximately less than 10% concentration of CO needs more times for equilibrium than higher concentrations of CO. furthermore, CO elimination from the body requires a long half-time (120-550 minutes)(11). Itbecomes longer in subject with high-grade CO poisoning. Suggested model represents that rapid COHB concentration take places in the first three hours and riches in the steady-state at 6-8 hours of exposure (12). Our measurement was taking placed six hours later than beginning worktime (7 AM). It seems thatdiscrimination between threshold levels of toxicitymay be related to theprimarilyin thesteady-state condition of exposure subjects, and secondarily; it may be achieved in biphasic states beyond the effect of ventilation. It occurs together withindividuals whoexposureagainst higher concentration of CO and associated with a longer elimination period.

Sandstorm laden dust episode has been occurring in recently years in Tehran. General agreement is that it is originated from our next neighborhood country, Iraq. Marked distribution is taking place in the cities of south and south-west of Iran. Tehran is involved less likely than other cities. Sandstorm acts as a dense layer on the city. Sandstorm episode can be potentate an effect on the CO concentration in the indoor workplace setting. It reinforced accumulation of toxic gas and increased threshold level of CO concentration in the environment (13).Markedly distributed CO poisoning within places with different quality of ventilation established significant mass like effect of external source of CO. Our finding indicated that poorly ventilated area support to induce ahigher set point of toxicity respect to Well-ventilated setting.

Human is exposed against CO sources represent two clinical features acute and chronic state. Differentiate between twoearly plans is difficult about low-level exposure. Following evidence may be translated the recent condition. Tehran is a metropolis. The cars produce 4,400 tone air pollutants every day and over 1, 6 million tons, a year (14). The last report of annual average of CO levels disclosed 5.76 PM between 2001-2002years (15). Tehran reveals Co concentrationabove a standard levelon most of the dayin 2009 years (16).Therefore, a chronic exposure took place as a background among public urban with an adaptation mechanism. Sandstorm episode creates a new set point between samples of workplace setting. It was subtle among population at-risk within well-ventilated places and significant in the poor-ventilatedsetting.Our finding may be animprovement withprolonged exposure state that appeared among mild threshold levelstoxicity.However, it reflected acute poisoning that superimposed on the chronic background.

Significant difference of toxicity levels was found between female with male subgroups (χ<0.03) and poisoning was noticeable higher in the female sex. Air pollutant has serious adverse effects on the impact of the healthsuch as increasing observed mortality rate (17), exacerbated cardiovascular and respiratory diseases (18) andalso reducing life expectancy (19). In addition, ithas the unfavorable effect on maternal health and induced preterm birth (20).Therefore, recent finding among healthcare professionalsshould be considered as two aspects; responsibility against mothers as a first-linefamily planningand however, they are the main arm of the health system organization.

Cigarette smoking is the common source of CO production withinthe indoor environment (21).Stop smoking is a policy

of the healthy system that should be followed by the personals. Emitting fumes can be affected on severity of a pollutant in the indoor environment via the numbers of current smoking and quality of the workplacesventilation. Total prevalent ofthe tobacco users detected in the workplace setting was8.5%. Frequency distribution indicated that they were oftenin the poor-ventilated areas. Smoking can be effective in the outcome of the study, whereas it occurred in the open circuit spaces and its effect wasnegligible.

Aging is another causal factor influenced on the result of the study. Elimination rate of the respiratory system decreased 1% per annum over the 40 years age-old. In addition, COHB concentrations increased beyond 40 years, and the rate of rising was not paralleled with CO exposure 21.Sequential sample of population distributed frequently in the range of 30-50 years (68%), and distinct proportion located in the 4th decade (33%).

Zone distribution of severity threshold toxicity indicated that frequency of CO toxicity was noticeableto mild zones (24%) and moderate (18%), respectively. Acceptable Co concentration levels should be below 10 PPM (Part Par Million) through the 8 hour work shift and over 30 PPM in 40- hour average workweek. Over it, exposure is hazardous (22).The intervals of threshold levels of CO toxicity respect to action level were different and limited to short distances.Therefore, any evidence can be changed the threshold of toxicity levels toward the action hazardous set point.

Noticeable volume of public entered at the critical level of toxicity (33%). Personal and workplace safeties are an issue of health concern. Highlighttopicsprevention should be suggested including; Quality control of air within workplaces, monitoring CO levels, defined duration of work period and determination of safety margin of toxicity.

In conclusion, threshold toxicity levels of CO are noticeable to healthcare professionals and nearly to action level. Female sex appropriates an adequate portion of CO poisoning. Ventilation of indoor workplaceenvironment has been effective in lowering threshold toxicity. The outcome of the study is suggested a chronic feature or at least superimposed acute poisoning among healthcare professionals.Sandstorm ambient air pollution augmented and produced new set point levels of COtoxicity.

Acknowledgment

The authors appreciate from cooperation of whole health professional staffs of Loghman Hakim general teaching hospital.However, I have special thanks from Toxicology department authorized using facility.

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