A Cross-Sectional Survey of Acquired Subclinical Methemoglobinemia among Hospital Healthcare Professionals in Sandstorm Episode of Ambient Air Pollution: Tehran-Iran, Pulse Co-Oximetry

Agin Kh[1]*, MoinAzad-Tehrani M[1], Khodabandeh F[1]

[1] Heart and Lung Division, Logman Hakeem General Teaching Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

A R T I C L E I N F O

Article Type:
Original Article

Article History:
Received: 8 Feb 2013
Revised: 28 Feb 2013
Accepted: 5 March 2013

Keywords:
Methemoglobinemia
Healthcare Professional
Pulse Co-oximetry

A B S T R A C T

Background: Subclinical methemoglobinemia (MetHb) is an occult disease. Clinical diagnosis is difficult. Acquired MetHb is a most common presentation in practice, and its detection help to improve health status of involved individuals. Healthcare professionals enumerate as one of the at risk groups against adverse health effects.

Method: All the participations were hospital healthcare professionals and to follow designed criteria to the study.

Results: A total of 117 healthcare professionals fulfilled the criteria of study. Mean age was 39±9 SD years, ranged 20-60 years. Female sex included 52%. Frequency of MetHb was detected in 6% of population. Of them, 71% were male. All the subjects were diagnosed with MetHb located at the poor-ventilated workplaces. There were significant differences between MetHb and carboxyhemoglobin levels (P<0.001).

Conclusion: Subclinical MetHb was meaningful in the target of population. It may be originated due to ambient air pollution. There was high-frequency levels of involvement in men had. Evaluation the causal factors are an impact that will require the future studies.

►*Implication for health policy/practice/research/medical education:*
Methemoglobinemia among Hospital Healthcare Professionals in Sandstorm Episode of Ambient Air Pollution

► *Please cite this paper as:* Agin Kh, MoinAzad Tehrani M, Khodabandeh F. *A Cross-Sectional Survey of Acquired Subclinical Methemoglobinemia among Hospital Healthcare Professionals in Sandstorm Episode of Ambient Air Pollution: Tehran-Iran, Pulse Co-Oximetry. International Journal of Medical Toxicology and Forensic Medicine*. 2013; 3(2): 42-47.

Corresponding author: Agin Kh, MD. Associated Professor of Medicine, Specialist in Internal Medicine, Pulmonologist & Pulmonary Critical Care, Logman Hakeem General Teaching hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Tel: +98-2155413424
E-mail: khosrow.agin@yahoo.com & agin@sbmu.ac.ir

1. Introduction:

Methemoglobinemia (MetHb) is unusual hemoglobin. It is produced by direct interaction between oxidizing agents and iron atoms. Those compounds convert ferrous to ferric state, and reduce oxygen–carrying capacity of hemoglobin. It causes decreases delivery of oxygen to the tissues

and clinically presented as hypoxemia and tissue hypoxia. MetHb generates a little amount in the healthy subjects. It produces from the action of commensally bacteria within the mouth and gastrointestinal tract (2). Standard range of MetHb is less than 1-2% (1), and its half-life is 1-3 hours. The time of elimination can be increased if the exposure time is prolonged (3).

The MetHb is presents as acquired and inherited features. Acquired MetHb is the common presentation in practice. MetHb indirectly is originated from contamination of subjects with exogenous nitrate and nitrite compounds. They are the principle achievable sources for public at-risk (4). The primary sources of acquired MetHb include nitrogen compounds in water (5) as well water in the rural area (6), food-borne (7) and vegetable-borne nitrate (8), medications (9) and industrial productions (10). However, MetHb can be induced by air pollution (11, 12). Recent concept does not consider actually as another common source. There are only a few reports about MetHb and air pollution due to automobile exhaust fumes (13-15).

Pulse co-oximetry is the reliable method in detection of MetHb concentrations (16). Using Pulse co-oximetry is a facility in practice to support early diagnosis of MetHb as a life-threatening problem. Eight-wavelength pulse oximeter is accepted instrument (Masimo-Rad 7) in detection of MetHb%. The range of detection is between 0-12% and over it. There is no information about screening healthcare professionals for acquired MetHb.

The purpose of study was to assess the methemoglobinemia status among healthcare professionals at the hospital setting in air pollution condition of the city.

2. Materials and Methods:

The study was cross-sectional. It conducted in Logman Hakim general teaching hospital of Shahid Beheshti University of Medical Sciences, Tehran-Iran, 2011.

The hospital is in the south of Tehran. Its altitude characterization is 35, 40, and 76 west-31, 23, and 07 East and altitude; 1148 m. The hospital has old building apparently 40 years. General ventilation of building is not satisfied. It is in the old texture of city, and circulation of cars is heavy around the hospital.

The study was designed in the hospital setting at sandstorm ambient air pollution among healthcare professionals. Participations were enrolled as healthy individuals. Inclusion norm consisted of informed consensus, normal hemoglobin without anemia, and no history of glucose-6-phosphate dehydrogenase deficiency G6 PD (17). Exclusion criteria consisted of using known medications that interfered in hemoglobin and inducing methemoglo-binemia such as; benzocaine, lidocaine, nitroglycerin, phenacetin, quinines, sulfonamides and vitamin C. In addition, consumption of foods was the receptacle of nitrates as a cauliflower, carrots, spinach, hot dogs, sausages and conserves preceding three days before the study. Water used in the hospital to provide from network within the city, and all subjects used food of hospital.

The coetaneous probe of pulse oximeter was inserted in the index finger of subjects. Stabilization period was 60 seconds designed for correct recording of pulse oximeter data. All the limitations influenced on the reading data by a pulse oximeter deleted as a; skin pigmentation, nail polish, low perfusion and ambient light. Co–pulse oximeter usage in the study was Masimo for detection and measurement level of MetHB (Trade name; Masimo- rainbow set: Radical -7 made in USA). It is multiwavelength (eight lights) and sensitive to methemoglobin measurements. Cut of point of methemoglobinemia was set up to 2% of normal value.

The data were recorded in the SPSS program analyzer (version 18). Frequency distribution of variables, compare mean value of one-sample T test, independent sample t-test and ANOVA were

performed. Significant set point was at P<0.05% in tow tailed.

3. Results:

A total of 117 adult's healthy individuals followed the criteria of study. The mean age recorded 38.97±9.30 SD years, ranged 20-60 years. Female sex was 52% and male 42%. Figure 1 shows age distribution between male and female sex.

Mean of MetHb±SD was 0.54±1.08 SD percent. 6% of study population had MetHb. Of those 71% was male and 29% female. Figure 2 reveals methemoglobinemia distribution between male and female sex. Those were statistically significant difference P<0.001 (95%CIs= 1.65- 1.25).

Figure 3 discloses distribution of methemoglobinemia among target population respect to workplaces. There were significant differences between MetHb and workplaces (P<0.001). All finding cases of MetHb were detected at places with poor ventilation. Figure 4 presents methemoglobin levels distribution in the age groups. Frequency of age distribution of MetHb was presented noticeably in the age classes of 3th 7% and 4th 8%.

ANOVA was performed between factor of MetHb and depended list of carboxyhemoglobin (COHB), oxygen saturation, age and gender. Significant differences were found between MetHb and COHB levels (F=6.42, P<0.001).

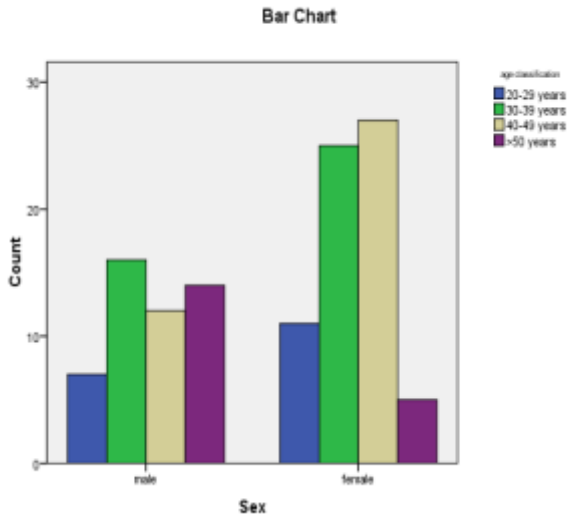

Fig. 1. It shows age distribution between male and female sex.

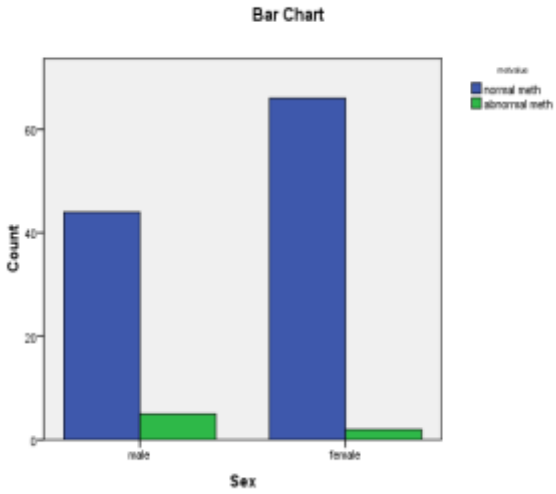

Fig. 2. It reveals methemoglobinemia distribution between male and female sex.

4. Discussion:

Nitrogen is needed for living organisms. It finds in the reactive fixed form most as nitrogen compounds. Cycle of reaction nitrogen performs in the environment. The main sources of reactive nitrogen consist of nitrogen fertilizer, burning of biomass, fossil-fuel combustion. Nitrate is one of them (NO3). Nitrogen oxides have ecologic effect and health hazards. It can be worsen viral infections, induced cough, bronchial hyper–responsiveness and airway inflammation. In addition, Ecological effect of oxide's nitrogen includes green-house gas; destroy ozone layer, nitric acid rain and contamination of groundwater, soil (18).

Clinical manifestation of ME correlates to the amount of reduced hemoglobin saturation. The poisoning appears most common as acute features. Chronic condition is seen in inherited model or prolonged exposure against oxidizing agents. Subclinical MetHb should be considered in setting of poisoning. Early concept is important because of the threshold reserve of oxygen saturation has been decreased between patients at -risk.

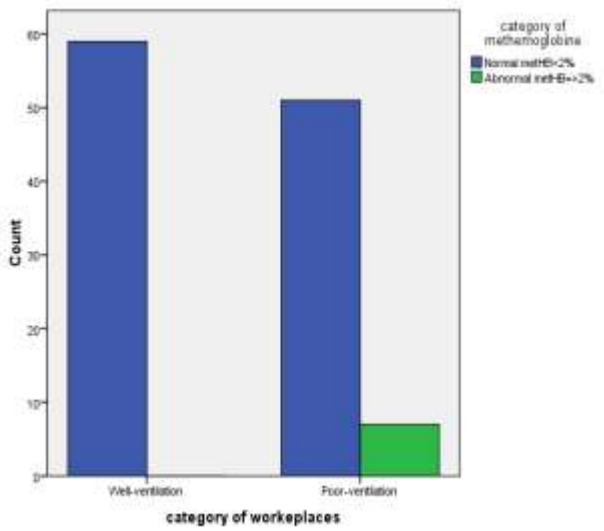

Fig. 3. It discloses distribution of methhemoglobinemia among target population respect to workplaces.

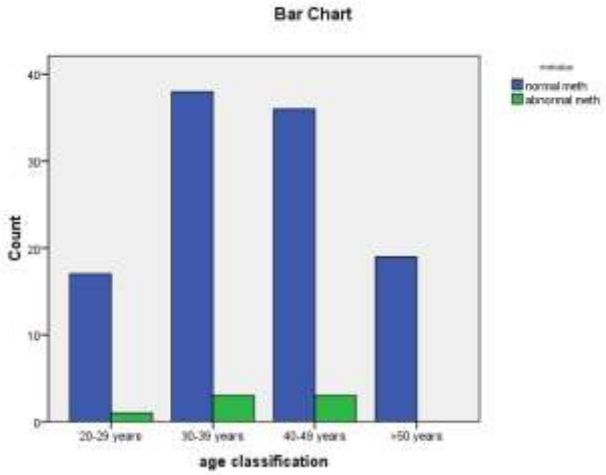

Fig. 4. It presents methemoglobin levels distribution in the age groups.

MetHb is an issue that has not been diagnosed, and frequently to be missed in the practice. Less than 10% MetHb often is subclinical, and well tolerated with the victim. MetHb levels at 15%-20% saturation accompanied with cyanosis (19), and However, MetHb between 20%-30% established as a; dizziness, headache, lethargy and dyspnea. In addition, with levels of Up to 45% and over are associated with central nervous system depression and convulsion. Lethal dose of MetHb is reported at 70% and higher (20).

Our study revealed significant subclinical MetHb in the healthcare professionals at hospital setting. The following evidence may be reflected the interpretation of the resultants. The possible source of agents perhaps can be able to induce MetHb among target population being air pollution, water and foods.

Air pollution also can be induced MetHb among public of the cities 11 (21). Nitrogen compounds are the biomarker of the air pollutants. They can be reversibility bounding with hemoglobin. They are strong oxidative agents, and produced from emitted exhaust systems of motor vehicles and industrial fumes. The most common nitrogen compounds are nitric oxide (NO) and nitrogen dioxide (NO2). Normal range is 0.1 ppm in environments. Nitrogen in bound with fossil fuels is combusted at high temperatures. They are released as a free radical and produced NO. It is slowly reacted with the environment oxygen, and produces nitrogen dioxide NO2. Estimated up to six million tons of nitrogen oxides produces with automobile per annum (22). They are toxic for human and can be induced inflammatory respiratory disease and methemoglobinemia. Aside, Nitrogen oxides can hydrate, and changed to nitrous acid. It is a mutagenic agent (23). Additional effects of MetHb included increased oxidative agents, produced oxidative stress on the cell membrane and, tissue damage to the target organ (24).

It seems to inform that the outcome reflected the acute state of healthcare professional's poisoning. The study was cross-sectional and supported the recent concept. Long- lasting air pollution in the Tehran and old-age of study setting respect to unsatisfied ventilation were produced susceptible conditions for chronic exposure to the subjects at-risk. MetHb can be lasting in the patients through two aspects. Recent study reported effect of continuous exposure against compounds associated with oxidizing properties that

induce permanent MetHb in the individuals at risk, 25 (25). In addition, the rate of turnover of MetHb in the body is 0.15 per hour. Omitting the causal factors from the environmental population at- risk should be declined the threshold levels of MetHb. Therefore, it was disappearing from the blood. The other arm of chronic MetHb is congenital defects in metabolism and structure of hemoglobin red cell. It is rare in the study and associated with low probability.

Nitrates and nitrites are the most common oxidizing compounds that are found within the environment. Nitrite's sources of production are the nitrogenous waste from animal and human. It is easily distributed in groundwater that the mainstay sources of supply drinking water in the public (26). It remained for decades in the environment (27). However, its chemical properties are highly soluble and changed to nitrates. Drinking water has been contaminated in the rural area with nitrates (28). There are some controversial reports about drinking water contaminations in Tehran. The recent concept cannot be the source of interpretation of our data.

Food additives (29), intake of vegetables and fruits that has been fertilized with nitrate contents the other contamination sources in the rural area for inducing MetHb. Vegetable consumption provides 80% of dietary source of nitrates (30). It may be to interfere in the production of our data. However, distribution of the MetHb in the subjects of the study revealed that the absolute of the poisoning occurred in the poor ventilated workplaces. It rolled out the contamination sources of foods and water consumption in the study setting.

Sex difference was not understood in the MetHb. In addition study disclosed presentation of noticeable subclinical MetHb in the male sex.

In conclusion, subclinical methemoglobinemia was detected among healthcare professionals in hospital setting. Air pollution was known as the causal factor in producing MetHb. Male sex involvement was prominent in frequency.

Acknowledgment:

We thank a lot from staffs of Logman Hakim hospital.

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