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ASSESSMENT OF HEPATIC, RENAL, HAEMATOLOGICAL FUNCTIONS AND LEAD BLOOD LEVEL AMONG EGYPTIAN FIRE FIGHTERS.

By

*Arafa A., **Afify M.

**National Egyptian Centre for Toxicological Research, Cairo University.*

*** Department of Biochemistry, National Research Centre, Egypt*

Abstract:

Background: Firefighters are potentially exposed to hazardous factors(physical, chemical and biological) during their work which endanger their life. **Objective:** The aim of this study is to evaluate the health hazards in Egyptian fire fighters by measuring the blood level of some of these chemicals (lead, carboxyheamoglobin) and by measuring some biochemical parameters. **Materials and methods:** This study was conducted on 25 fire fighter workers ,their ages ranged between 25-37 years (31± 3.5), working in El Maadi fire fighting station. Besides 25,non-smoker healthy subjects , matched for age that ranged from 22 to 35 (30.5 ± 3.8) number,sex, and socioeconomic status. All participants were subjected to the following laboratory investigations: blood lead level, hemoglobin and carboxyhaemoglobin (COHb) concentration, kidney and liver functions. **Results:** This study showed a statistically significant difference between the exposed group and the control group as regards COHb, levels of blood lead, ALT, creatinine and urea, while there was no statistically significant difference between exposed and control groups as regards B2 microglobulin urine level, AST, Gamma GT, albumin, total protein, haemoglobin concentration and bilirubin. **Conclusion:** This study points out to the need for more health protective measures to avoid adverse health effects that might endanger firefighters under their highly drastic working conditions. **Recommendations:** Continuous practical training for implementing workplace environmental control measures and proper use of personal protective equipment should be practiced by all firefighters. Firefighters must be under continuous medical follow -up to allow for early detection of any biochemical or hematological changes.

Key words: fire fighter- liver functions, renal functions, lead.

Introduction

Firefighters are exposed to hazardous materials including carbon monoxide, hydrogen cyanide, hydrogen chloride, benzene, sulphur dioxide, and lead. Fire smoke is produced by either combustion oxidation or pyrolysis (Cones et al., 1996). Smoke may also contain characteristic traces and heavy elements such as lead, boron, cadmium, selenium, arsenic, antimony and molybdenum (Bates , 1980).

Lead is a multi-targeted toxicant, affecting the gastrointestinal tract, haematopoietic, cardiovascular, central and peripheral nervous systems, kidneys, immune, and reproductive systems (Beton et al., 1996).

The most common toxic gases in fire smoke are carbon monoxide and carbon dioxide. Other gases may also be produced in toxicologically significant quantities, depending on the chemical structure of the burning material and the fire conditions (Kaplan et al., 1984). Carbon monoxide and hydrogen cyanide as toxic gases are principally implicated in the death of fire victims (Baud et al., 1991). Hydrogen cyanide poisoning is synergistic with that of carbon monoxide, and exposure may be more common in case of parent compounds such as polyurethane, acrylonitrile, and nylon (Hall and Rumack, 1986). Carbon monoxide is a chemical asphyxiant that is responsible for up to 80 percent of fire-related fatalities. Lethal concentrations of carbon monoxide are generally attained within l-3 hours of initiation of smouldering combustion. Inhaled carbon monoxide combines with the haemoglobin of red blood cells. The reaction of carbon monoxide with haemoglobin yields carboxyheamoglobin which is inactive in oxygen transport since both gases react with the same group in the hemoglobin molecule and haemoglobin has more affinity to carbon monoxide than oxygen. The decrease in oxygen transport capacity is proportional to the percentage of carboxyhaemoglobin (Klee, 1999)

Serum level of GGT (gamma glutamyl transferase) enzyme is commonly elevated in patients with acute hepatitis although the rise in GGT is usually less than that of the transaminases. Serum GGT may also be elevated in response to many toxins. Myocardial infarction, cardiac failure, diabetes and pancreatitis can also increase serum GGT (Ruppin DC., 1982). Apart from enzymes, total bilirubin level is elevated in various forms of liver disease such as cirrhosis, hepatitis and obstructions of the hepatobiliary system such as in gallstones or tumours and is also also observed in cases of intravascular hemolysis (Burtis,

1999) .Based on these facts,cases of chronic diseases were excluded from our study population.

Many of the above mentioned materials have been implicated in the production of cardiovascular, respiratory or neoplastic diseases, which may provide an explanation for the alleged increased risk for these illnesses among firefighters (Brandt-Rauf et al., 1989). Most fatalities from fires are not due to burns, but are a result of inhalation of toxic gases produced during combustion (Athanaselis ,2004)

Aim of the study

The aim of the present study is to evaluate the effect of fire smoke exposure on kidney and liver functions and haemopoietic system. Also to measure the serum levels of carboxyhaemoglobin,and lead among Egyptian fire fighters.

Subjects and method

This study was conducted on June 2010, in El Maadi fire fighting station. A written consent was obtained from all participants. Two groups participated in the study: The studied group comprised 25 male firefighters aged between 25-37 years (31± 3.5) working on the basis of 12 hours /day with one day off per week; the number of fires to which firefighters are exposed is not fixed . Workers were using vapor tight clothing and a positive pressure self contained breathing apparatus (SCBA) in severe fires. Male referents matched for age that ranged from 22 to 35 years (30.5 ± 3.8) years, smoking habit, and socioeconomic status were recruited from the relatives of the studied group serving as a control group. All our studied groups were non-smokers.

There is no reporting system that documents how many hours our firefighter are exposed /month in Egypt.

Detailed personnal, medical and occupational history to exclude those who were suffering from acute and/or chronic illnesses (as hypertension, diabetes, cardiac or chest diseases) were conducted for all subjects.

Sampling:

1- Blood samples

From each subject 10 cc of blood were taken using a dry plastic disposable syringe under complete aseptic conditions. Four cubic centimeters of blood were taken into a clean tube containing heparin for blood lead analysis. The rest, 6cc of blood ,were kept in a tube and allowed to clot then centrifuged at 300 r.p.m. for 10 minutes to separate the serum and then stored at -20 dc till the time of analysis.

2-Urine sample

A random urine sample was collected from each subject, volume between 1-10 ml, taken (not acidified) in a sterile container in order to measure B2 microglobulin in urine. Patients were instructed to empty their bladders then drink a large glass of water and then we collected the urine samples from them within one hour. The samples were kept in the refrigerator till transferred to the lab. Significant loss of B2 microglobulin activity occurs in acidic urine (PH< or = 6), so pH of urine was adjusted to be between 6 and 8, with 1mol/L sodium hydroxide.

All participants were subjected to the following laboratory investigations:

- blood lead analysis using atomic absorption spectrophotometer (Blanke, Decker, 1986)
- Hemogram: included hemoglobin concentration using Coulter counter.
- Determination of Carboxyhemoglobin percentage by direct spectrophotometer measurement in specific blood gas analyser.
- Determination of serum aspartate transaminase (AST) and serum alanine transaminase (ALT) by using the method recommended by the Committee on Enzyme of the Scandinavian Society for Clinical Chemistry and Clinical Physiology (1974).
- Determination of serum gamma glutamyl transferase (γGT) by using the method recommended by the Committee on Enzyme of the Scandinavian Society for Clinical Chemistry and Clinical Physiology (1976).
- Determination of serum bilirubin level by colorimetric method using available kit from Bio- Merieux Company, France (Perry et al, 1983).
- Determination of Kidney functions (urea and creatinine) done by using the auto-analyzer Synchron CX-5 delta (Beckman Inst. Inc., California, 2634, USA).
- Determination of proteinuria by turbidimetric method according to Silverman et al., 1986.
- Determination of urine microalbumin by immunoturbidimetric method using kit supplied by Pointe Scientific Inc., Michigan, 48146, USA (Bashyam ,1993).
- Analysis of B2 microglobulinin in urine was done using immuno chemiluminometric assay (ICMA). Normal range is (0-160) ug/l (Henne et al., 1997)

Statistical analysis

Statistical analysis was performed using computer statistical software package SPSS 9.02. Descriptive statistics was presented as mean ± standard deviation. Comparative analysis between different groups applied using students t test for parametric data and Wilcox on sum of rank for skewed data. P-value was considered significant if <0.05.

Results

Table (1) and Figure (1) show general characteristics and results of investigations of the studied group. The data show that there was no statistical difference in haemoglobin concentration(Hbconc) between the exposed group and the control group.

As regards carboxyhaemoglobin (COHb) there was a statistically highly significant difference (P<0.001) between exposed group (5.5±1.9) and control group (1.6±0.8).

The results obtained show a statistically significant higher levels of lead in fire fighters (10.9±1.6ug/dl) compared to that in the control group (8.3±2.4) (P<0.05) .

Table 2 shows kidney function parameters. The mean (±SD) of creatinine blood level among the exposed group was (1.3±0.5) that was significantly higher than that of the control group (0.8±0.2) (P<0.05).

There was a statistically significant higher urea level among the firefighter's group (19.4± 3.6) compared to that of the control group (17.3±1.6).

There was no statistical difference (P>0.05) between exposed (147.1±9.3) and control (143.9±6.9) groups as regards B2 microglobulin urine level.

Table 3: Demonstrates a statistically significantly higher level of ALT among exposed group (31.6±13.6) compared to the control (21.2±8.4),while there was no statistically significant difference as regard the AST, GGt, albumin,total protein or bilirubin levels.

The AST blood level among the exposed group was (20.1.±2.9) and among the control group was (18.8±4.5), while the Gamma GT blood level among exposed group was (16.4±3.5) and the control group was (14.9±4.5).

As regards albumin level among exposed group ,it was (3.8±0.7) while among the control group it was (4.1±0.5). The total protein level among exposed group was (7.5±0.8), for the control group it was (7.7±0.9) and the bilirubin level among exposed group was (0.3±0.1) and among the control group it was (0.4±0.2)

Table 1: General characteristics and results of investigations of the studied group.

Parameters	Exposed group	Control group	t test	P-value
Age(years)	31±3.56	30.5± 3.86	o.4	>0.05
Hb.conc.(gm/dl)	11.8±1.7	12.6±2.2	1.4	>0.05
COHb% (normal 0-2%)	5.5±1.9	1.6±0.8	9.4	**<0.001
Lead(Pb)(μg/dl)	10.9±1.6	8.3±2.4	4.5	**<0.001

P>0.05 non-significant P>0.05

**highly significant P<0.001

Table 2: Kidney function parameters in exposed and control groups

Parameters	Exposed group	Control group	t test	P-value
Creatinine (mg/dl)	1.3±0.5	0.8±0.2	4.6	**<0.001
Urea (mg/dl)	19.4±3.6	17.3±1.6	2.6	*<0.05
B2 microglobulin in urine (ug/l)	147.1±9.3	143.9±6.9	1.3	>0.05

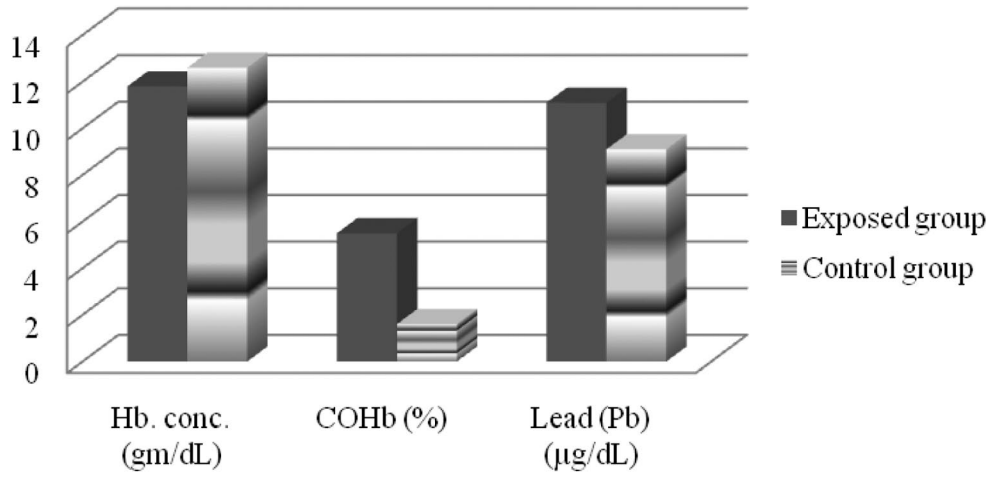
* significant P<0.05

**highly significant P<0.001

Table 3: Liver function parameters in exposed and control groups

Parameters	Exposed group	Control group	t test	P-value
ALT (U/L)	31.6±13.6	21.2±8.4	3.2	*<0.01
AST (U/L)	20.1.±2.9	18.8±4.5	1.2	>0.05
GGT (U/L)	16.4±3.5	14.9±4.5	1.3	>0.05
Bilirubin (mg/dl)	0.3±0.1	0.4±0.2	2.2	>0.05
Albumin (g/dl)	3.8±0.7	4.1 ±0.5	1.7	>0.05
Total Protein (g/dl)	7.5±0.8	7.7±0.9	0.8	>0.05

Figure (1):Blood levels of Hb, COHb, and Lead in the different studied groups



Discussion

Firefighters are exposed to toxicants that may have adverse effect on their health. In this study screening for health effects of fire fighting work with hazardous materials was done.

Our study included 25 male fire fighters and 25 normal subjects (men who have never been exposed to lead and carboxyhemoglobin)of their relatives as a control group .In order to study the possible subclinical health effects of hazardous materials of fire fighting; we studied liver and renal functions and hematological indices as markers of end organ effect.

Exposure to carbon monoxide was determined by the measurement of the per cent carboxyhemoglobin, (COHb %). The brain and the heart may be severely affected after CO exposure at carboxyhemoglobin, (COHb) levels exceeding 20% (AbdulRahman, 2009). In the present study, there was highly statistically significant increase in the level of carboxyhaemoglobin among fire fighters as compared to normal controls. This is in agreement with Brotherhood .et al study (1990) which showed that carboxyhemoglobin levels increased on average by 0.7% per hour in the fire fighters and by 0.3% per hour in the observers. Also ,Levey, in 1996,found a statistically significant difference between the mean baseline carboxyhemoglobin of non-smoking firemen and smoking firemen. A consistent increase in mean COHb levels after exposure to smoke was seen in both non- smoking and smoking men, but the mean increase in these two groups was statistically significant only at the 90 per cent level.

Kales, in 2003, conducted an investigation of unexpectedly high levels of carboxyhemoglobin in a group of firefighters. Twelve of 34, (35%) nonsmokers tested had levels greater than 4% COHb and 9 of 34, (26%) had levels of 10% or higher. All 24 nonsmoking firefighters retested after stopping exposure to fire smoke their COHb levels become less than 3%. Baseline carboxyhemoglobin readings of 64 firefighters ranged from 0% to 3% (mean 1% and median 1%).

This study showed that there is a statistically significant increase in the serum level of urea and creatinine in firefighters when compared to the control group .This increase can be explained by the rise in blood lead level in fire fighters group in comparison to control group. This doesn't agree with Kales et al study in 2001 which showed no difference between exposed fire

fighters group and control group as regards urea and creatinine blood levels .

Our results showed a highly statistically significant high blood lead level ($P<0.05$) in fire fighters (10.9±1.6) as compared to normal control subjects (8.3±2.4) .This is in agreement with Edelman et al study in (2003) which stated that lead levels were statistically higher in exposed fire fighters than in control group .In contrast to our results, AbdulRahman study reported that there is no difference in blood lead level between firefighters and control group (AbdulRahman, 2009).

As regards liver functions, our results showed a statistically significant difference between exposed and control group as regards ALT as many of the substances identified in fire smoke are suspected to affect liver cells .This finding is in agreement with AbdulRahman study in 2009 which showed a statistically significant increase in the blood level of ALT in fire fighters when compared to normal controls.This is in contrast to Kales et al. in 2001 who showed no significant variation in the blood level of ALT between firefighters exposed group and control group.

Our study showed no statistically difference between exposed and control group as regards AST, GGT, albumin, total protein and bilirubin.These findings were in agreement with Kales et al .(2001) who showed that, there was no significant variation between firefighters exposed group and control group as regards AST, GGT, albumin, total protein and bilirubin. Also AbdulRahman study in 2009 is in agreement with our study.

Manson et al .study in 2004 showed that aspartate transaminase (AST) was raised in acute liver damage, but was also present in red cells, cardiac and skeletal muscle and is therefore not specific to the liver. AST levels are raised also in shock and after exercise .

Conclusion

The results of this study point out to the need for more health protective measures to avoid hazardous health effects that might endanger firefighters under their highly drastic working conditions.

Recommendations

Periodic medical examination should be performed to ensure the presence of minimum acceptable level of physical performance for all firefighters.

“Occupational safety and Health Administration requires the employer to assure that employees who perform interior structural firefighting are physically

capable of performing those duties, and also require a certain level of physical fitness in order to wear a respirator".To determine if a firefighter meets the physical capability requirement,this is performed by either physical examination or successfully completing all required training and a job-related physical performance test as electrocardiogram and pulmonary function tests(Tritz,1991).

No one can deny that maintaining and assuring a fire fighter's physical ability is essential to the performance of a fire fighter's duties. That is why we recommend adding the following investigations to the standard performed tests for new recruits or periodically examined firefighters.

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