Study the Effect of Gases Rising From Electric Generators on Sera Protein, Iron, Transferrin and other Biochemical Parameters in Iraqi Workers Employed on the Operation of Diesel Generators

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INTRODUCTION

Diesel generators which are used in the living quarters when electricity is cut off, is a significant source of emissions of polluted air. In electricity generation, an electric generator is a device that converts mechanical energy to electrical energy. A generator forces electric current to flow through an external circuit. (Navid G. 2013)

There are many gases and compounds emitted from diesel generators, which cause air pollution and negatively affect the health of those who work in the run generators. The estimating results show the emissions are carbon monoxide CO, nitrogen oxides NOx, carbon dioxide CO2, volatile organic compounds VOC, sulfur oxides SOx and particulate matter PM. (Hardy K. and Thom S. 1994), these gases are toxic and have negative effects on the bodies of people permanently exposed to these gases.

The precise mechanisms by which the effects of carbon monoxide are induced upon bodily systems, are complex and not yet fully understood. (Weaver L. 2009) Known mechanisms include carbon monoxide binding to hemoglobin, myoglobin and mitochondrial cytochrome oxidase, and carbon monoxide causing brain lipid peroxidation (Bateman D. 2003; Drewry A. 2003)

The traditional belief is that carbon monoxide toxicity arises from the formation of carboxyhemoglobin, which decreases the oxygen-carrying capacity of the blood and inhibits the transport, delivery, and utilization of oxygen by the body. (Alonso et al. 2003; Blumenthal I 2001). The NOx reacts with ammonia, moisture, and other compounds to form nitric acid vapor and related particles. Small particles can penetrate deeply into sensitive lung tissue and damage it, causing premature death in extreme cases. Inhalation of such particles may cause or worsen respiratory diseases, such as emphysema or bronchitis, or may also aggravate existing heart disease. (Alonso et al. 2001).

Proteins are large biological molecules, or macromolecules, consisting of one or more chains of amino acid residues. Proteins perform a vast array of functions within living organisms, including catalyzing metabolic reactions, replicating DNA, responding to stimuli, and transporting molecules from one location to another. Proteins differ from one another primarily in their sequence of amino acids, which is dictated by the nucleotide sequence of their genes, and which usually results in folding of the protein into a specific three-dimensional
structure that determines its activity. (Blumenthal I, 2001) Albumins are a family of globular proteins, the most common of which is serum albumin. The albumin family consists of all proteins that are water-soluble, are moderately soluble in concentrated salt solutions, and experience heat denaturation (Fan H, 2009).

Iron is one of the most essential trace elements in the body (Fukuhara M et al. 1996). Iron is essential for fundamental cell function, and also a potential catalyst for chemical reactions involving free radical formation and subsequent oxidative stress and cell damage (Greingor J et al. 2001). Because of its ability to cycle between the ferrous (Fe$^{2+}$) and ferric (Fe$^{3+}$) oxidation state, iron can serve as a carrier for oxygen and electrons and as a metal cofactor for enzymes (Farrow J et al. 1990). Most of the iron in humans is located within the porphyrin ring of heme, which is incorporated into proteins such as hemoglobin, myoglobin, catalase, peroxidase, and cytochrome. (Farrow J et al. 1990; Lewis G 2002).

Transferrin’s are a family of iron-binding proteins found in the physiological fluids of many vertebrates. (Farrow J et al. 1990). The transferrin molecule, with a molecular mass of about 80 KDa, is folded into two similarly sized homologous N- and C- lobes that are stabilized by many interaction disulﬁdes (Mendell M. 2007). The transferrin molecule has two binding sites for iron and therefore, may exist as di ferric transferrin, as one of the mono ferric transferrin, or as apotransferrin (Wolkoff P et al. 2006). Transferrin is the major plasma protein involved in transport of iron (Dales, R et al., 2008). Binding of iron by transferrin, results in striking conformational changes in the two lobes (Lewis G 2002). The delivery of transferrin-bound iron to cells is dependent upon the expression of transferrin-binding molecules, which are known as transferrin receptors (Lewis G 2002). Thus, serum transferrin has considerable reserve capacity to bind iron, called unsaturated iron binding capacity (UIBC) (Fukuhara M et al. 1996). The aim of the present study is to estimate the influence of gases rising from diesel generators on Iraqi workers employed on the operation of diesel generators particularly increased poisoning symptoms such as muscle weakness irritability, headaches, fatigue, difficulty concentrating, constipation, anemia, unusual paleness, kidney function disorder, and loss of appetite on some biochemical parameters.

**MATERIAL AND METHODS**

Blood samples were collected from 33 Iraqi workers employed on the operation of diesel generators (36.88±4.35 years) comparing with 24 male healthy (35.21±5.32) years. The medical history was taken. The blood was allowed to clot for 10-15 min. at room temperature, centrifuged for (10) min. at (3000rpm). Serum total protein and albumin were determined by spectrophotometric methods supplied by Randox kit. Serum TIBC and iron level were measured by spectrophotometric methods supplied by Biomaghreb kit. To calculate the unsaturated iron binding capacity (UIBC), the serum iron concentration was subtracted from the TIBC.

\[
\text{UIBC} = \text{TIBC} - \text{Serum iron concentration}
\]

Transferrin can be estimated indirectly from the TIBC value by the following equation (Mehdie A. et al. 2013).

\[
\text{Transferrin (µg/dl)} = 0.7 \times \text{TIBC (µg/dl)}
\]

The percentage of saturation of transferrin with iron is determined by the following equation:

\[
\text{% Saturation of transferrin with iron} = \frac{\text{Serum iron}}{\text{TIBC}} \times 100
\]

**Protein Electrophoresis Polyacrylamide Gel Electrophoresis:**

Polyacrylamide gel 7.5% was prepared by mixing 7.5 ml of distilled water, 33 ml of Stock buffer (Tris-glycine 0.15 M) pH 8.9, 22.2 ml of Acrylamide solution. The mixture was de-gassed for 15 minutes, then 3.2 ml of Ammonium per sulfate solution and 0.1 ml of N,N,N,N-tetramethylenediamine (TEMED) were added to the mixture solution. The mixture was gently mixed and loaded in the gel plates. The gel was allowed to polymerize for about 40 minutes. The electrophoresis was carried out at 50 mA and 15 v/cm for 30 min., then of 10 µl of the samples were applied into the wells in the gel. The electrophoresis is was continued at 40 mA and 15 v/cm for 3 hours or until the Bromophenol Blue dye reached the gel margin.

All statistical analysis in the study was performed using SPSS version 19.0 for Windows (Statistical Package for Social Science, Inc., Chicago, IL, USA). Descriptive analysis was showed the mean and standard deviation of variables. The significance of differences between mean values was evaluated by Student t-test. The probability \(p<0.05\) was considered statistically significant, while \(p>0.05\) was referred to statistically insignificant.

**Results:**

The results were observed from thirty three large private electrical generators workers [group A], 24 normal men [group B] were serve as control group shown in table 1 and figure 1.
The biochemical parameters in thirty three large private electrical generators workers [group A], 24 normal men [group B].

Result in table 1 and figure 1 and figure 2 showed that a non significant decrease (p>0.05) in the mean concentration of total serum protein and albumin of Iraqi workers employed large private electrical generators workers [group A] in comparison with mean total serum protein concentration of control group. Low [total protein] only occurs as a result of conditions causing low values of the major components, i.e. albumin and the immunoglobulins (particularly IgG). A low [total protein] but normal [albumin] may be the first indication that a patient has humoral immunodeficiency(Tietz NW 1995).

Similar to most of the plasma proteins, albumin synthesizes in the liver where it is produced at a rate of approximately 0.7 mg/h for every gram of liver. This protein has an average half-life of 19 days. Albumin functions primarily as a carrier protein for steroids, fatty acids, and thyroid hormones in the blood and plays a major role in stabilizing extracellular fluid volume by contributing to oncotic pressure (known also as colloid osmotic pressure) of plasma (Zunszain P et al 2003).

The table 1 and figure 1 showed that there is highly significant decrease in the mean concentration of serum globulins of working group in comparison with mean serum globulins concentration of control group(p<0.05). The globulin fraction includes hundreds of serum proteins including carrier proteins, enzymes, complement, and immunoglobulins. Most of these are synthesized in the liver, although the immunoglobulins are synthesized by plasma cells, Malnutrition and congenital immune deficiency can cause a decrease in total globulins due to decreased synthesis(McPherson R 1984). As our knowledge no previous study referred to these result in Iraqi workers employed on the operation of diesel generators. The decreased level of the serum albumin and increased of serum globulin level in Iraqi workers employed on the operation of diesel generators in these study that showed in table 1 and figure 1 lead to reduce in albumin / globulin ratio.

Iron level showed a significant increase in working group when compared to control group(p <0.01). Unusual iron status can be easily clarified by the indication of inflammation and the transfusions carried out. A probable reason for this phenomenon could be improved intestinal iron absorption caused by generators gases - induced mucosal damage. Carbon monoxide has a higher distribution coefficient paralleled to oxygen and enzyme in the human body that creates carbon monoxide is heme oxygenase which is located in all cells and breaks down heme (Dunn A et al 2011). When CO is not ventilated it binds to hemoglobin, which is the principal oxygen-carrying compound in blood; this produces a compound known as carboxyhemoglobin. The traditional belief is that carbon monoxide toxicity arises from the formation of carboxyhemoglobin, which decreases the oxygen-carrying capacity of the blood and inhibits the transport, delivery, and utilization of oxygen by the body. As our knowledge no previous study referred to these result in Iraqi workers employed on the operation of diesel generators.

Result in table 1 and 1 showed that there is highly significant increase in the mean of TIBC, UIBC, transferrin (µg/dl) and highly significant decrease in the mean of % Saturation of transferrin with iron in Iraqi workers employed on the operation of diesel generators in comparison with control group(p<0.01).

Total iron-binding capacity (TIBC) is a medical laboratory test that measures the blood's capacity to bind iron with transferrin (It is performed by drawing blood and measuring the maximum amount of iron that it can carry, which indirectly measures transferrin, since transferrin is the most dynamic carrier. Total iron-binding capacity is a measure of the maximum concentration of iron in serum bound to protein. Transferrin saturation is nothing but present of saturation value with iron (Yamanishi H et al 2003). Another mechanism involves effects on the mitochondrial respiratory enzyme chain that is responsible for effective tissue utilization of oxygen. Carbon monoxide binds to cytochrome oxidase with less affinity than oxygen, so it is possible that it requires significant intracellular hypoxia before binding (Kalantar Z. & Koppel J 2003) As our knowledge no previous study referred to these result in Iraqi workers employed on the operation of diesel generators.

Table 2 and 3 showed a non-significant effect of smoking on large private electrical generators workers and control groups. These result may be due to a little number of man in both groups.

Table 1: The biochemical parameters in thirty three large private electrical generators workers [group A], 24 normal men [group B].

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>S. Protein[µg/dl]</td>
<td>6.99±0.72</td>
<td>7.32±0.58</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>S. Albumin[µg/dl]</td>
<td>3.82±0.41</td>
<td>3.90±0.15</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>S. Globulin [µg/dl]</td>
<td>2.75±0.68</td>
<td>2.41±0.27</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Alb/Glb Ratio</td>
<td>1.41±0.52</td>
<td>1.64±0.22</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Iron (µg/dl)</td>
<td>197.8±22.27</td>
<td>135.9±24.42</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TIBC (µg/dl)</td>
<td>629.9±51.32</td>
<td>346.6±38.72</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>UIBC(µg/dl)</td>
<td>44.9±35.41</td>
<td>249.8±29.52</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Transferrin (µg/dl)</td>
<td>447.2±34.94</td>
<td>289.9±46.97</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>% Saturation of transferrin with iron</td>
<td>31.43±2.744</td>
<td>39.45±7.22</td>
<td>&lt;0.01</td>
</tr>
</tbody>
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Fig. 1: Mean distribution of biochemical parameters in thirty three large private electrical generators workers [group A], 24 normal men [group B].
According to this study, the following facts could be concluded:

Exposure to electrical generators gases may also decline lifespan and have health special effects in the long term for these workers. Death rates from a variety of causes could be found to be higher in Iraqi workers employed on the operation of diesel generators with elevated serum iron, TIBC, UIBC, Transferrin and decreased % Saturation of transferrin with iron levels; these include stroke, and heart disease, and common death rates from all causes. According our result the accumulative contact over a continued period possibly will have a more important effect on some features of health than current exposure. Some health effects, such as different
cancer diseases are a significant risks when these workers exposure to electrical generators gases is prolonged (over about one year).

REFERENCES


