Report on some biological responses to high electric fields and indirect action of ultraviolet rays.

Part one

by Kamal Djanab

It has been noted by some observers \[1,2\] that atmospheric disturbances may affect the human body through the action of the electric potential in the atmosphere.

It is observed that persons working in closed spaces where high electric fields exist, and investigators working with ultraviolet sources even though shielded show cases of a form of illness, whose symptoms are anemia, depression and insomnia, with apparent recovery when the exposed person stays away from his daily environment for weeks or months. This period for recovery depends on individuals, the intensity of the agent and the time of exposure. In order to find out the agent inducing the sickness and how the sickness starts I decided to undertake experiments with Albino mice placed in high electric fields. With the cooperation of Messrs. Reza Rouzbeh and Mohammed Sobuty, students of the Physics Department, experiments were started.

Experimental Design

Mice were placed in cylindrical cages with glass wall and wooden bases. The cages had a height of 10 cm. and diameters around 35 cm. The wall was made from rectangular glass plates of 25 mm. width and 2 mm apart, to allow the entrance of fresh air inside the cage. Up to 12 mice were living in each cage. Their food consisted mostly of raw wheat. Two metallic discs were placed outside and against the two bases of each cage. In cases where voltages higher than 20 KV were applied to a cage, pieces of insulators few mms thick were placed between the bases and metallic discs. Discs were made from galvanized iron plates. In order to reduce the discharge losses due to sharp points, steel rings one centimeter thick...
Professors of physiology and pathology of science were soldered around the discs.

A.C. voltages up to 30 KV effective value and double wave rectified voltages up to 15 KV were applied to cages.

In an earlier experiment we had observed a rapid decrease in survival time when the field intensity was increased. The average survival time in a field of 2500 volts per centimeter was less than two weeks. Victims had manifestation of internal hemorrhage. We decided to start with blood examination of exposed mice.

Dr. Ahmed Azhar of the Medical Faculty had the kindness to undertake this part of our investigations. The blood examination consisted of platelet and erythrocyte counts with percentage of polychromatic cells where they existed, leucocyte counts with percentage composition of different types. In the following, one experiment from each series is described.

1. Eight mice were placed in a cage, a full wave rectified voltage was applied on the basis of the cage: there was a field of about 1000 volts per centimeter inside the cage. Data concerning blood examinations show that before exposure, platelet counts ranged from 300 to 350 thousand per cmm. After 10 days, the range was from 240 to 300 thousand, with average reduction of 20 percent. After 40 days exposure, the range was from 100 to 180 thousand, with 60 percent average reduction. A slight recovery was observed when the field was cut off, but platelet reduction persisted and the average reduction was more than 40 percent after 6 weeks normal living.

Polychromasia was observed after 3 days of exposure, and the average was 3 per cent of erythrocytes after 40 days of exposure. Polychromasia was still increasing after the field was cut off. It reached 9 per cent at the end of three weeks normal living and decreased to 6 per cent and 3 weeks later. The variation of erythrocyte counts was irregular among the mice at the beginning, and an average reduction of 25 per cent was observed after 40 days exposure, then remained almost constant in following weeks, when the mice had normal living.

Leucocyte counts, although irregular during exposure, had shown no considerable changes during 40 days exposure, but on the average increased to twice the normal value after 3 weeks normal living and decreased to 130 per cent 3 weeks later. Mature eosinophils disappeared rapidly in some mice; lymphocytes reduction and an increase in neutrophil polymorphonuclears always occurred with Leucocytosis. Monocyte counts were irregular among the mice.

2. 4 mice were placed in a cage and an A.C. voltage of 25 KV effective value was applied across the bases. Two mice died during the first week of exposure. Polychromatic cells were 10 and 20 percent for the two that survived and reached 20 and 25 per cent after two weeks of exposure. At this time the field was cut off. One mouse died in the first week following the interruption of the field, and polychromatic cells of the last one decreased to 4 per cent after 2 weeks normal living. Other data show the same trend as in the first experiment with a more rapid recovery when the field was off.

The results of the two series of experiments with AC and rectified voltages could not be justified by the assumption of a direct action of electric field. So I postulated that observed facts may be due to the action of small amounts of ozone, produced by the silent electric discharges inside the cages; although neither corona was observed in darkness, nor anything unusual was smelt near the cages. I have not taken into account the possible effects due to the oxygen-nitrogen compounds which I believe are not of the same order as ozone effects. At low current density such as in our experiments: nitrogen oxides yield is very low compared to the amount of ozone involved. As the current density increases such as in spark or electric arc ozone yield is increased whereas nitrogen oxides production is increased.

3. To verify the assumption of ozone effects 7 mice were placed in a box with open top, which was placed at the bottom of a 200 liters barrel. A 9 watt ultraviolet mercury lamp was hung inside the barrel by the wall and shielded at distance of mice were protected from ultraviolet rays, but exposed to ozone gas generated by ultraviolet rays in the barrel. The barrel was nearly closed at the top. As the concentration of ozone was much higher than suspected in high voltage experiments, the ultraviolet source was taken away from the barrel after two hours and the mice were left inside the barrel. Then 15 hours later, the mice
sent for blood examination. Nothing unusual was observed in the blood examination.

After 2 days I started the same experiment with two groups of mice. The first group consisted of 7 mice that had been exposed already for 2 hours. The second group had seven mice that had not been exposed before. These two groups were exposed to the indirect action of ultraviolet rays for two consecutive days with eight hours each day.

The result of blood examination showed blood damage effects as follows:

In the first group platelet reduction up to 15 per cent and polychromatic cells up to 16 per cent were observed, whereas in the second group these quantities were 50 per cent for platelet reduction and 2 per cent for polychromatic cells per cent. After two weeks, under normal conditions of living, a more rapid recovery was observed in the second group. Data obtained from blood examinations show quite similar effects as in the previous experiments.

**Conclusion:** Atmospheric discharges, high voltage discharges and ultraviolet rays generate ozone in the air, which when breathed, has probably little immediate action on the blood elements, but affects the reticuloendothelial systems in bone marrow, spleen etc. Hence platelets are reduced, polychromasia and leucocytosis are noticed.

For sublethal doses, if the same amount of oxygen is absorbed over a longer period, immediate blood damage effects would be apparent in a later time and latent blood damage effects would exhibit themselves after a considerably longer period.

4. A source of 6 mc radium was held a 25 cm from the centre of a cage, so mice were exposed to an average daily dose of 2 r normal air equivalent of 7 radiations. Blood examinations showed no observable damage effects after 6 weeks exposure. Then 7 weeks after the end of exposure, blood examinations showed anaemia with an average erythrocyte reduction of 13 per cent, an average of 3 per cent for polychromatic cells and 30 per cent of platelet reduction.

**Conclusion:** Absorption of small doses of ozone causes premonitory changes in blood forming systems, similar to the radiation effects. The initial response to high doses of radiation is associated with nausea, vomiting and depression. The same effects are observed with high concentrations of ozone. When ozonised air is breathed, the first effect is irritation of respiratory system. Exposure to sublethal doses of radiation or absorption of sublethal doses of ozone, show latent effects in blood forming organs, which become apparent some time after the beginning of exposure. Biological response to radiation is known to be different in dry conditions or in contact with water. The efficiency of the bactericidal action of ultraviolet rays depends on hygrometric conditions of the air. Sunburns and erythema are more intense when the skin is wet. It is generally believed that nuclear radiations affect living organisms chiefly by their interaction with water [3]; the oxidation of organic compounds under the action of irradiation is often markedly increased by the presence of oxygen. This effect is assumed to be due to the participation of hydrogen peroxide and hydroperoxyl radical in the oxidation processes. This radical is known to be the most important agent for secondary radiation effects. This radical is supposed to be formed as a result of addition of H atoms to oxygen molecules or a ternary reaction of hydroxyl radicals in water exposed to radiation. Some formulæ generally written in chemistre for representing the chemical reactions in aqueous solutions of ozone, seems to be not adequate quantitatively for observed results, such as the reaction of ozone on acidified potassium iodide, I believe the reason is that hydroperoxyl radical evolved in the reaction of ozone on water has not been considered.

These facts with our experimental results, suggest that the ozone solutions involve the formation of hydroperoxyl radical, and hence similarities of radiation and ozone effects are observed.

Presumably these similarities extend to some extent over a number of important functions of the organism. Although we have not tested experimentally the effects of ozone on spermatogenesis and reproduction, incidentally we have observed a decline in reproduction among the groups exposed to ozone, compared to the non-exposed groups. Similarities have been observed in our experiments—not yet published—for radiation and ozone effects on microorganisms.

I believe that:

1. Through the effects of ozone on the organism, we can extend
our knowledge of the physicochemical reactions involved in the effects
of radiation on biological systems.

2. Investigations on the ozone effects are advantageous for dis-
criminating to some extent between the primary and direct effects of
radiation on the organism from the secondary effects due to the oxida-
ti
ing compounds or radicals, generated by the interaction of radiation with

ter.

3. Ozone may substitute advantageously x or γ ray radiotherapy,
in cases as lung cancers where radiation can not reach the organ direct-
ly; ozone may be absorbed directly through breathing of air containing
appropriate and safe doses of ozone.

4. Regulations should be formulated for protection against health
hazards due to the electric discharges and indirect action of ultravio-
et rays.

5. With mice we had the trouble of not being able to get blood
many times, they had been chosen as subject for experimentation for
the reason that, with available apparatus, we could not get such high
fields for bigger subjects. Now, I suggest that, these investigations may
quite well be followed up by using ultraviolet sources or ozonizers with
any living organism.

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PART TWO

HAEMATOLOGICAL EXPLANATION

By A. Azhiv M.D.

The animals chosen were white RF mice whose spontaneous rate
of leukemias is 1:1000 and haematologic examination of the peripheral
blood of all these mice was made at the beginning and at the different
intervals during the experiment as follows:

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EXPERIMENT BY ULTRAVIOLET

2 days after exposure (22 II) 14 days after the light was
put off

R.C. 4.9–7.2 m 6.4 m
W.C. 5–8 thous. 8.4 m
platelets 100–150 > 240 >
polychromatic

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In 1909 Hæved showed that polychromasia is not a degeneration
and in fact it is some relation between these cells and reticuloeyte.

Whitby and Briton (1933) have shown that the number of poly-
chromatic cells is parallel to the number of reticuloeytes.

The studies on isoelectric point for polychromasia and reticulatum
by Rosegges (1936) and the relation between reticuloeytes and marrow
activity confirmed the identical nature of two cells. On the other hand
it is shown that the reticuloeyte reaction is regulated by the oxygen ten-
sion in the bone marrow but the toxic or inhibitory factor prevent the
marrow to carry out this process. We know also that they can induce the lymphoid leukemias in many strains of mice by ionizing radiation and at lower dose level the myeloid form. Myeloid leukemia predominate in male but they can inhibit this incidence by castration and the susceptibility to induction depends to the age.

Brecher and Stohlman by labeling the red cells from irradiated dogs with Cr 51 and injecting intramuscularly into normal animal concluded that red cells damage was evident within 24 hours of irradiation but was more marked after days. The same result was obtained when normal red cells labeled with Cr 51 were transfused into irradiated dog. If the cells were collected 3 days after exposure and transfused into normal dogs they will gain a normal survival time.

They concluded that the damage to the red cells begins almost immediately after irradiation and this was related to the development of thrombocytopenia.

Summary: The similarities of effects produced by radiation, electric field, ultraviolet rays and ozone on the platelet and blood corpuscles suggest the presence of a common factor.

It is assumed that the effects of radiation is due the hydroperoxyl radical and we know it is the same for ozone and ultraviolet rays. These effects are useful for detecting to some extent the primary or direct and the secondary effects of radiation due to the oxidising radicals and we also may substitute x or γ rays radiotherapy by ozone in such cases as lung cancer.

Résumé: La ressemblance des effets produits par radiation, champs électrique, rayons ultraviolet et l'ozone sur les plaquettes et les globules sanguines donne l'idé d'avoir une facteur commune entre eux.

On sait que la radical hydroperoxyl (H O2) joue le rol principal dans les effects produits par la radiation et c'est la même radical qui se produit par les rayonnements ultraviolet.

En étudiant ces effets, on peut différencier entre les effets primaires et secondaires de radiation et remplacer la radiothérapie par les rayons x et avec l'inhalation d'ozone dans les cancers du poumon etc.