Report on some biological responses to high electric fields and indirect action of ultraviolct 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. up6-12mice were living ineach 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

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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 Azhir 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 bases of the cage; there was a field of about 1000volts 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 per cent 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 40days 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 occured with leucoytosis. 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 decreased 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; so 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 unusal 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 75 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 plateltes are reduoed, polychromacia and leucocytosis are noticed.

For sublethal doses, if the same amount of ozone 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 2r 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 anemia 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 dosses 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 oxydation 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 formulae 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, incindentally 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 microorganisma.

I believe that:

1- Through the effects of ozone on the organism, we can extend

our knowlege of the physico chemical reactions involved in the effects of radiation on biological systems.

2– Investigations on the ozone effects are advantageous for discriminating to some extent between the primary and direct effects of radiation on the organism from the secondary effects due the oxydising compounds or radicals, generated by the interaction of radiation with water.

3– Ozone may substitute advantageously x or γ ray radiotherapy, in cases as lung cancers where radiation can not reach the organ directly; 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 hasards due to the electric discharges and indirect action of ultraviolet 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 ozonisers with any living organism.

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PART TWO

HAEMATOLOGICAL EXPLANATION

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The animals chosen were white RF mice whose spontaneous rate of leukemis 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:

✡ Director Laboratories Pahlavi. Hosp.

	at the beginning	7 days after exposure (field)
Red cell	6.8-8.0 m	5.4 - 5.6 m
W. C.	5.6 8.0 thous.	11 - 12 thousand
Polymorph	40 70'/.	30 - 52'/.
eosinophil	4 10'/.	0 - 4'/.
lymphocyte	25 50'/.	34 - 70'/.
thrombocytes	300-400 thousand	120 - 260 thous.
polychromatic cells	0-05'/.	6 - 20'/.
	14 days after exposure	28 days (the field was cut off on 14th day)
R.C.	4-4.8 m	4 - 6 m
W.C.	8-12 thous.	6 - 14 thous.
polymorph	20-3.0'/.	32 45'/.
eosinophil	0	0
lymphocyte	68-75	49 - 61'/.
thrombocyte	80-100 thous.	100 - 180 thous.
polychromatic cells	10-25'/.	5 - 10'/.

EXPERIMENT BY ULTRAVIOLET

	2 days after exposure (32 H)	14 days after the light was put off
R.C.	4.9-7.2 m	4.8 - 6.4 m
W.C.	5- 8 thous.	7 - 12 thous.
platelets	100-150 »	160 - 240 »
polychromatic cells	6-16'/.	0 - 2./.

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

Whitby and Briton (1933) have shown that the number of polychromatic cells is parallel to the number of reticulocytes,

The studies on isoelectric point for polychromasia and reticulum by Rosegges (1936) and the relation between reticulocytes and marrow activity confirmed the identical nature of two cells. On the other hand it is shown that the reticulocyte reaction is regulated by tbe oxygen tension in the bon marrow but the toxic or inhibitory factor prevent the

marrow to carry out this process. We know also that they can induce the lymphoid leukemis 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 oxydising 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 saint que la radical hydroperoxyl (H 02) 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 differencier entre les effets primaires et secondaires de radiation et remplacer la radiotherapie par les rayons x et avec l'inhalation d'ozone dans les cancers du poumon etc.

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