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Minimizing Oxidative Stress

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Abstract

A wearable device is described that reduces arthritic pain and promotes re-growth of hair by maintaining the body at a negative electrostatic potential during most of the day. The reactive oxygen species (ROS) responsible for alopecia differs from that which causes arthritic inflammation. These results and other reports in the literature suggest negative charge may inhibit oxidative attack by all ROS. The procedure described might therefore be useful for treating or preventing the development of many other conditions that involve attack of ROS on biological molecules and structures, including those generated iatrogenically; for example, in cancer treatment and surgery. It is suggested that prophylactic use of the device by healthy individuals may prevent the cumulative oxidative damage to organs and structures responsible for age-related conditions. It is also suggested that ambient static charge may affect the folding of proteins, nucleic acids and other macromolecules and, thereby, those conditions that are the result of mis-folding.

Background

Reactive oxygen species, including hydrogen peroxide, organic hydroperoxides, hypochlorite anion, singlet oxygen, ozone, superoxide anion, peroxynitrite anion, hydroxyl ion and alkoxy, propoxy, and hydroxyl radicals, are produced in the body by normal metabolic processes, and also in response to injected, infused, ingested and respired toxins, by the interaction of high-energy, penetrating radiation with molecules in the body and by both surgical and accidental trauma. One or another of these oxidants attacks every functional molecule and structure in the body. Lipids are especially vulnerable to oxidative attack, but proteins, and other functional molecules are also damaged. Among other things, they are a cause of mitochondrial mutations [1]. ROS are responsible for both the acute episodes of distress that characterize some conditions and the cumulative damage that results in partial or complete loss of function of organs and other body structures. The roles of oxidative stress in the conditions such as those listed below in Section IV A and B have been documented in hundreds of publications.

Endogenous antioxidants such as glutathione, superoxide dismutases, catalases and melanins normally reduce the concentrations of these reactive species and, thereby, minimize oxidative damage. However, the availability of these vital antioxidants can be reduced by disease and by exogenous agents that inhibit their production. These natural defenses can also be overwhelmed if ROS are produced too rapidly and in high concentrations, for example, by radiation treatment for cancer or accidental exposure to radioactive sources. In addition, some compounds of multivalent metals can increase oxidative stress.

There are two reports in the literature that suggest oxidative stress is reduced at negative electrical potentials. In 1972, Molnar reported [2] that the average life spans of mice maintained at a negative potential were significantly greater than those maintained at a positive potential and that negative charge gave relative protection against the effects of x-radiation. In 1974, Pammenter, et al. (3) reported that the viability of Zea mays seeds was extended if stored at a negative potential. I found no other examples, but I did find many phenomena consistent with the assumption that oxidative stress is inhibited at negative static potentials. I reported this review of the literature in a November 19, 2010 publication, *Effects of Ambient Electric (static) Charge On Biological Systems* [4], and I suggested that the degenerative effects of ROS might be inhibited in a safe way by putting the patient in a negatively charged Faraday cage.

A Novel Approach to Control of Oxidative Stress

A recent, severe flare-up of arthritic inflammation and pain created an opportunity to test my speculation that oxidative stress is inhibited at negative static potentials. Figure 1 is a diagram of the device I used to keep my body at a negative potential. It has two 23A (12V) dry cells in series with the free end of the battery assembly in contact with the stainless steel tube. I kept the device in contact with my body for most of the day by hanging it on a lanyard around my neck. The body is normally insulated from other voltage sources by rugs, clothing, shoes and furniture so the potential on all parts of my body was minus 24V when measured from the free positive end of the battery assembly. This was so except when I touched a grounded object such as a water tap.

The severe pain I was experiencing quickly disappeared, and I remained relatively pain-free as long as I continued to wear the device. The pain started to return slowly on three separate occasions when I was not wearing the device, but it subsided rapidly when I put it back in contact with my body. After several months, I noticed that some hair was growing in areas of my scalp that had been bald for decades. It has been established that hair loss is associated with the accumulation of hydrogen peroxide in hair follicles [5] while a different ROS, peroxynitrite, is involved in osteoarthritic inflammation [6]. These results and those in the literature cited above indicate negative charge inhibits the reaction of biological molecules with a variety of ROS and suggests that keeping the body at a negative potential may have therapeutic value in a large number of diseases involving oxidative stress, including those summarized below in Section IV.

Potential Applications

Oxidation has been identified as the operative stress in each of potential applications listed below except for those under IV C below: 'Exposure to High-Voltage Fields' and 'Flight and Space,' which are more speculative. The rationale for each of these potential applications was summarized in Reference 4.

A. Oxidative Stress Diseases

Listed below are some of the conditions that involve oxidative attack. Use of a wearable charging device may provide symptomatic relief and prevent the periodic acute phases of some of the conditions listed below. If use of the device begins when people are in good health, the cumulative oxidative damage that leads to deterioration and loss of function in old age, such as arthritis, osteoporosis, hair loss, macular degeneration and Type 2 diabetes may be delayed.

1. Autoimmune reactions

There are more than 80 types of autoimmune conditions. Some of the more common ones associated with oxidative stress are: Parkinson's disease, Multiple sclerosis, Crohn's disease, Diabetes, Rheumatoid arthritis, Systematic lupus erythematosis and Psoriasis. Some of the other conditions below may also be initiated by immune reactions.

2. Neurological Disorders

Alzheimer's and Huntington's diseases, Schizophrenia, Dementia and Epilepsy.

3. Cancer

Prostrate, Breast, Lung, Colorectal, Bladder, Uterine, Ovarian, Skin and Stomach cancers, Liver cancer and other wasting diseases and Lymphoma.

4. Liver Diseases

Toxic Hepatitis, Viral Hepatitis, Chronic Hepatitis and Cirrhosis.

5. Lung Diseases

Asthma, Emphysema, Pneumonia, Bronchitis (chronic and acute), Cystic fibroses, Pulmonary fibroses, Chronic obstructive pulmonary disease and Adult respiratory distress syndrome.

6. Cardiovascular Diseases

Heart failure, Heart attack, High blood pressure, Stroke, Impaired circulation, Cholesterol and Plaque formation and Sickle-cell anemia.

7. Digestive Diseases

Ulcerative colitis, Gastritis, Stomach cancer, Pancreatitis, and Peptic ulcer.

8. Kidney Failure

Kidney failure and Renal toxicity.

9. Infectious Diseases and Immunology

Viral infections, Toxic Hepatitis and Cirrhosis, Viral hepatitis (type A, B and C), Herpes, Common cold, Bacterial infection and Chronic fatigue syndrome.

10. Skin Disorder

Eczema, Polymyositis, Mycosis fungoides, Scleroderma, Pemigoid, Atopic dermatitis, Contact dermatitis, Sebborrheic dermatitis, Dermatitis herpetiformis, Acne conglobata and Acne vulgaris.

11. Eye, Ear, Nose, Throat and Teeth

Cataracts, Glaucoma, Macular degeneration, Hearing loss, Ear infection, Sinusitis, Periodontal (gum) disease and Nose, mouth and throat diseases.

12. Pregnancy, Lactation and Childbirth

Pre-eclampsia, eclampsia, hypertension, fetal alcohol syndrome and damage to the fetus by other toxins and administered drugs.

13. Male Problems

Prostrate enlargement, Prostrate cancer and male infertility.

B. Iatrogenic Oxidative Stress

The body generates often dangerous levels of ROS in response to common medical procedures severely limiting treatment options and effectiveness. Keeping the body at a negative potential during and, if necessary, after procedures, with either a Faraday cage or a wearable charging device may protect patients from oxidative stress and facilitate treatment. Following are some potential applications:

1. Cancer Treatment

To protect healthy tissue from oxidative attack by the ROS deliberately generated in high concentration in both radiation treatment and chemotherapy in order to destroy cancer cells. These oxidants can destroy healthy cells and vital structures far from the target cells producing side effects such as hair loss, deafness, nausea and neurological damage,

2. Radiology

To minimize the side effects of diagnostic medical and dental x-rays,

3. Drug Side-effects

To improve the therapeutic index of drugs by inhibiting oxidative side-effects. It

may then be possible to use already approved agents more effectively and to employ other agents that are currently unusable,

4. Surgery

To minimize generation of ROS in tissue damaged by surgical procedures,

To minimize the sometimes permanent post-operative cognitive disorders induced by anesthesia, which include loss of memory, reduced ability to reason, impaired judgment and personality changes,

To minimize the side effects of oxygen administered for life support. The most familiar examples are permanently damaged eyesight and hearing in premature babies. However, people of all ages, including full-term babies, can also be susceptible. It is likely that the immature organs of a fetus are susceptible to the same kinds of damage by oxygen administered to pregnant women,

To minimize the generation of ROS when blood flow is interrupted in medical procedures and also when blood vessels are reperfused,

To inhibit the oxidative deterioration of stored organs awaiting implantation and stored blood and to prevent the failure of skin grafts and the rejection of transplanted organs, and

5. Trauma

To minimize the oxidative stress induced by trauma, inflicted by accident or sustained on a battle field or playing field, which often impedes healing and leads to permanent damage, especially in the case of concussions and spinal injuries.

C. Other Applications

1. Non-medical Radiation Exposure

To reduce the cumulative effect of background radiation, which has been associated with aging and for protection against high-intensity sources created by accident or deployed as weapons,

2. Exposure to High-voltage Fields

To protect employees of electric utilities who have a higher-than-normal incidence of amyotrophic lateral sclerosis, presumably because they spend a lot of time close to high-voltage lines,

3. Flight and Space

To counteract the acceleration of oxidative processes at the highly positive static

potentials encountered at high altitudes and in space. Airline crews have a higher-than-average incidence of melanoma and amyotrophic lateral sclerosis. Positive charge may be partly responsible for “economy-class” syndrome, and

4. Winter Ills

To inhibit viral infections such as the common cold that may be promoted by seasonal differences in the vertical atmospheric potential gradient. In summer, the gradient is 60 to 100 volts per meter, while in winter it can be as high as 300 to 500 volts per meter. Therefore, a person spends more time in a more electrically positive static environment in the winter than in the summer. Keeping the body at a more negative potential with a wearable device may reduce susceptibility to viral diseases at all times but especially in winter.

Conclusions

A Faraday Cage may have advantages over the device described above in certain cases since it is a more reliable way of maintaining a desired static potential, and it would be possible to charge the body to a much higher voltage should this prove to be desirable. On the other hand, a wearable device may be able to provide symptomatic relief and protection against oxidative stress during most of the day without impeding normal activities. It could, for example, be worn prophylactically during most of a person’s daily activities. Other considerations are discussed below.

A. Electrical Hazards

The choice of 24 volts in the trial described above was arbitrary. The various ROS differ from each other, and it reasonable to expect that controlling each may require a different minimum applied voltage. Unless special efforts are made maintain electrical isolation, the practical voltage limit for a wearable device may be about 327 volts in dry air at Standard Temperature and Pressure. A person charged above this limits will experience a tingle or jolt upon touching a grounded conductor, which can be unpleasant but not normally dangerous, even when the body carries a fairly high voltage. Dielectric breakdown of dry air between spherical conductors occurs at approximately 30 kV/cm. or 3 kV/mm. It is easy to produce an electrical discharge more than one millimeter long by approaching a grounded conductor after walking across a carpet on a dry day, which demonstrates that a person can carry a charge of at least 3,000 volts and experience the discharge of this voltage without apparent harm. The reason, of course, is that very few electrons are required to raise the static voltage on a person's body to these high levels and the discharge current is very small. The same voltage limitations do not apply to treatment in a Faraday Cage. A person can accumulate a static charge of many thousand volts in such a device without sensing a current flow.

B. Side Effects

It must be determined by experiment whether inhibiting oxidation with applied charge also

inhibits any beneficial roles ROS may have in therapy and in ordinary biological processes. It may, for example, inhibit the reaction of nitric oxide with superoxide that produces antimicrobial reactive nitrogen species (RNS), which is part of the cell's response to bacterial pathogens [7]. If it does, it may be possible to increase the effectiveness of these RNS by applying positive charge with a device like that in Figure 1, reconfigured to deliver a positive charge. RNS are oxidants so the side effects of a more positive static charge would be increased oxidative stress on the whole body, but this would be limited to the treatment period.

There is evidence that it is the ROS produced by some chemotherapeutic agents that kill cancer cells. For example, kaempferol seems to induce apoptosis in glial cells by increasing production of ROS and reducing concentrations of the ROS-scavenging agents superoxide dismutase and thioredoxin [8]. It must be determined experimentally whether inhibiting oxidative stress during treatment does, in fact, reduce the effectiveness of radiation and chemotherapeutic agents. However, an imposed negative potential used after treatment might still be useful for preventing hair loss and other side effects. Positive static charge used during treatment might increase the effectiveness of both radiation and chemical agents.

Protein Folding

Misfolding of proteins and other macromolecules is considered the cause of many neurodegenerative diseases including cystic fibrosis and Alzheimer's, Parkinson's, Huntington's, Creutzfeldt-Jacob, and Gaucher's diseases. It is conceivable that folding to functionally effective configurations is prevented by oxidation of one or more sites on the protein itself or by oxidatively disabling chaperone molecules. However, it is also possible that folding is affected just by the static potential. Folding is guided by electrostatic attraction, and the relative shielding of different positive charges on the nuclei of a macromolecule may change at different static potentials so that the molecule folds to different configurations.

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Illustrations

Illustration 1

Figure 1: Stainless steel battery holder