Effects Of Ambient Electric (static) Charge On Biological Systems

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Abstract

Evidence is presented supporting the hypothesis that static charge affects oxidative processes in biological systems. It is generally assumed that the static potential of our surroundings is zero in the absence of triboelectrically generated or applied charge; that is, there are neither more nor fewer electrons on an assembly of molecules than are contributed by the orbital electrons of the constituent atoms. However, this local “absolute” charge level can have very high positive or negative values depending on altitude, time of day and local potential sources. Unless they are well insulated from the environment, biological systems will equilibrate to this ambient potential. Positive charge appears to be associated with both increased oxidative damage by reactive oxygen species (ROS) and the related effects of inflammation. Among other things, ROS are responsible for oxidative damage to cells, vascular and barrier membranes and other structures.

Experimental evidence and a consideration of established principles suggest that these deleterious oxidative and inflammatory processes can be inhibited by eliminating positive static charge on the affected systems by applying negative potentials, preferably in a Faraday cage in order to eliminate harmful electrical, ionic and electrophoretic flow through the subject. The therapeutic applications of the proposed procedure for inhibiting oxidative stress include the emergency treatment of serious or life-threatening crises such as stroke, head and spinal trauma, cardiac events, acute pulmonary distress and radiation exposure; longer-term treatment of conditions caused by chronic inflammation; and co-application with other treatment modalities, such as radiation and the use of specific agents in order to minimize liver damage and other oxidative side effects.

Static charge may significantly affect response to drugs, and the ability to control oxidative side effects with applied charge should allow the introduction of new therapeutic agents. It may be possible to prevent oxidative damage to stored blood, tissue and organs by eliminating positive charge. The procedures for maintaining animals, people, blood, tissue and organs at neutral or negative potentials are safe and easily done. The optimum voltages will have to be determined experimentally, but they will probably be low. It is also possible that static potential will affect the folding and refolding of proteins.

Introduction

Oxidative Stress and Inflammation

There is overwhelming evidence that ROS are responsible for damage to cells, vascular and barrier membranes and other structures. It is also clear that this oxidative damage can compromise the integrity and function of these biological structures. Lipids and lipoproteins are especially susceptible, but virtually every kind of biological molecule, including nucleic acids, proteins and carbohydrates can be attacked by ROS. Among other things, oxidation can initiate cell apoptosis, increase the permeability of the blood-brain barrier and change critical electrical properties of the vascular endothelium.

Many systems in living organisms consist of colloids and gels separated and contained by membranes. Agglomeration of these colloidal suspensions and gels and adhesion of these to membranes and vascular surfaces is inhibited or prevented in the same way that it is in simple colloidal suspensions; that is, by charge stabilization. In the case of living organisms and most colloids encountered in nature and commerce, it is negative charge stabilization. In biological systems this is achieved by oriented polar molecules, which give the particles, cells and membranes electron-rich surfaces, which by mutual repulsion, inhibit coalescence and adhesion. However, with the use of microprobe sensors, it was shown many years ago [1] that the an inflamed vascular interface can lose its normal electrical properties and actually become electron-poor, which leads to deposition of colloidal particles, adhesion and lysis of cells and blockage of blood vessels. This has been confirmed in more recent work [2] showing oxidation is responsible for loss of endothelial cell polarity. Iron released by red-cell lysis may add positive feedback to the process by catalyzing further oxidation. ROS should form more readily in oxygenated blood than in oxygen-deleted blood, so oxidative damage to the vascular interface may be one of the reasons that plaque forms more readily in arteries than in veins.

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Reactive Oxygen Species

Reactive oxygen species detected in biological systems include free radicals such as hydroxyl, superoxide anion and ozone as well as oxidants such as hydrogen peroxide, singlet oxygen, hypochlorite anion and peroxynitrite anion. All are strong oxidizing agents. Many are involved in normal cell functions, but some are overproduced under certain conditions. For example, folding of nascent polypeptides to native, functional configurations depends, among other things, on oxidative formation of disulfide bonds, but some ROS remain in the immediate environment after the protein folding process is completed [3]. The following partial list of ROS reported in the literature illustrates their widespread generation in normal metabolism as well as in the response of organisms to trauma, disease and radiation.

(1) It is believed that superoxide is generated during the normal production of ATP in mitochondria. The superoxide anion is also generated in chloroplasts, microsomes, peroxisomes and cell nuclei.

(2) Radicals are synthesized by enzymes such as NADPH oxidase and myeloperoxidase in neutrophils and macrophages in response to bacterial and viral antigens, and they are considered by some to be the primary defense of the body against bacteria.

(3) Other ROS-generating enzymes include xanthine oxidase, which is activated on reperfusion after ischemia or surgically interrupted blood flow, as well as prostaglandin synthase, lipoxigenase, aldehyde oxidase and amino acid oxidase.

(4) ROS are formed in the reaction of oxygen with various molecules when catalyzed by iron-sulfur proteins such as ferredoxins and cytochromes and other, similar molecules containing either iron or other multivalent transition-group metals. These same metals can, in various coordinated states, catalyze the reaction of oxygen with many biological molecules. Examples are copper in Wilson's disease, iron in hemochromatosis and manganese in manganism

(5) ROS are generated at the sites of wounds, contusions and hematomas.

(6) ROS are generated directly through the interaction of ionizing radiation such as x-rays, gamma rays, neutrons and even ultraviolet light with almost every biological molecule. The interaction of energetic radiation with water molecules produces hydroxyl ion, the most reactive radical known.

(7) Other reactive species such as hydrogen peroxide, hypochlorite ion and peroxynitrite ion are formed mostly through the reaction of the primary active species, such as superoxide and hydroxyl ions, with molecules in the immediate biological environment.

(8) Ozone is generated as part of the body's response to inflammation by processes that have not been fully elucidated.

Natural Protective Mechanisms

Normally, enzymatic defenses such as superoxide dismutase, catalases, glutathione reductase-peroxidase and, at some sites, melanins prevent runaway, self-perpetuating oxidative attack on biological systems. However, there are a number of conditions in which either the protection afforded by melanins and enzymes is overwhelmed by excessive production of ROS; for example, when ROS are generated by high doses of ionizing radiation, or when the protective enzyme systems and melanins are degraded or dysfunctional [4]. For example, the ROS-buffering activity of neuromelanins can be significantly impaired by elevated systemic levels of urate, homocystine, copper or excess iron, which can result in psychotic behavior, movement disorders and deafness.

Reported Effects of Negative Static Potentials

There are two reports in the literature describing effects of applied negative potentials on biological systems. In 1972, Molnar reported [5] that the average and maximum life spans of mice maintained at a negative potential were, respectively, 25 and 32 percent greater than those maintained at a positive potential. In addition, the white blood count of mice maintained at a negative potential was almost twice that of control mice raised at ground potential and more than twice as much as those maintained at a positive potential. Molnar also reported that negative charge gave relative protection against the effects of x-radiation. In 1974, Pammenter, et al. [6] reported that storage at a negative charge maintained the viability of Zea mays seeds. Molnar and Pammenter, et al. referred to the processes as cathodic protection.

Oxidation involves the loss of orbital electrons from an atom or molecule, and we can speculate the extra-orbital electrons present at negative static potential levels provide an additional energy barrier to removal of orbital electrons. Conversely, oxidation may be favored energetically at positive potential levels. Possible examples of the latter effect are discussed below.

The Ambient Static Potential

We are accustomed to thinking of the absolute static potential of our bodies and surroundings as being zero. However, it can vary greatly from zero, which may have significant effects on biological systems through the mechanisms discussed in this article. There is, first of all, a vertical positive field of about 100 Volts (V) per meter from ground potential. A well-insulated probe at an altitude of one meter will equilibrate at a potential of 100V positive; at five meters the potential will be +500

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and so on to a maximum potential of +400,000 V at an altitude of about 4,000 meters, above which a high ion content makes the air a good conductor and potential differences cannot be established.

Atmospheric and earth potentials also change in other ways. For example, a current of positive charge, which peaks at 7:00 pm London time and is at a minimum at 4:00 am London time, flows down to the earth worldwide. This current diminishes the negative charge of the earth, but the charge is restored locally at random sites on an irregular schedule by lightning, then worldwide by terrestrial conduction from the lightning strike sites. The local potential is a resultant of all these current flows. Thus, the ambient potential of an organism can be changing constantly. We do not ordinarily sense these changing potentials because resulting current flows are very small. A more complete description of atmospheric potential can be found in The Feynmann Lectures on Physics [7].

Probable Effects of Ambient Potential on Health

Positive static potentials may have direct health consequences. For example, aircraft will equilibrate to the same voltage as the air through which they fly, which is generally at a high positive potential. This may be the reason that pilots have a higher-than-average incidence of amyotrophic lateral sclerosis (ALS). Linemen and other electrical utility workers can be exposed to very high positive potentials in a variety of ways and they, also, have a higher incidence of ALS. The positive charge in aircraft may also be responsible for some of the medical problems and discomfort experienced by passengers. Protons are the dominant charged species in cosmic radiation so space travelers may also be exposed to oxidative stress.

The static voltage at a ground site is usually relatively more positive just before lightning strikes, which may explain the sharp increase in asthma attacks (referred to as “thunderstorm asthma”) reported at those times.

A controversial correlation has also been made between foehn winds and health. Foehn winds are hot dry winds that blow down the leeward slopes of mountains. They occur worldwide and have regional names such as Chinook winds in the Rockies, Nor’westers in New Zealand, Fogony in the Pyrenees and Favonio in Italy. However, foehn winds, the name used in the Alps, has become a generic name for the phenomenon. There is a popular belief, in all localities where they occur, that foehn winds cause a variety of symptoms and conditions, such as headaches, nausea, allergies, nervousness and depression. It was discovered in the recent past that foehn winds carry positive ions down to ground level, which may be the cause of these effects on health.

The phenomena discussed above may be more or less direct responses to the ambient static potential. In addition, the somewhat uneven 24-hour pulsing of the absolute potential at the surface of the earth may indirectly affect biological systems through the circadian metabolic rhythm. The onset times of some conditions tend to cluster at specific times in the 24-hour cycle. For example, asthmatic attacks occur more frequently in the early morning hours. Osteoarthritic inflammation and pain usually peak at night and are less severe in the morning, while rheumatoid arthritic pain tends to be more severe in the morning.

Chronotherapy

Many publications have appeared over the past twenty years claiming that the efficacies of some drugs and the levels of side effects depend on the time of administration. For example, it has been reported [8] that the cytotoxicity of more than thirty anticancer drugs varies by more than 50% as a function of dosage time, presumably because the therapeutic ratio of these agents is most favorable when cytotoxic side effects are at a minimum. It has been suggested that the efficacy of and tolerance to anticancer drugs depend on dosage times because of the difference in timing of cancer cell division and normal cell division. For example, the proliferation of some types of lymphoma cells peak between 9 and 10 pm, while cells in the gut lining divide faster around 7 am, and those in bone marrow, near noon. It is assumed that the effect of chemotherapeutic agents on all cells is greatest when they are dividing and that side effects can therefore be minimized if the anticancer agents are administered when the proliferation of normal cells is at a minimum. The possibility that the metabolic cycle is influenced by the ambient static potential has apparently not been considered.

The Circadian Rhythm

Both the onset of some conditions and the responses to drugs have been correlated with the circadian rhythm. However, the circadian rhythm itself has remained mysterious. There is an extensive literature suggesting that the rhythm is linked to the light-dark cycle. Perhaps the light-dark cycle does play a limited role in setting the phase of the circadian rhythm in humans, but there are too many exceptions and inconsistencies to consider it either the cause or the main controlling factor. Many animals and even some single-cell species maintain a circadian rhythm in the absence of light cycles. Among these are totally blind mole rats and blind fish that live in totally dark caves. Alaskan ground squirrels and porcupines maintain their circadian rhythms through months of constant light or constant darkness. The reported drift of the

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circadian cycle of some light-deprived organisms to periods slightly longer than 24 hours suggests that light may play a role. However, the proposed control mechanism of light operating through the suprachiasmatic nuclei does not explain the circadian rhythms detected in single cells such as that of the prokaryotic cyanobacteria Synechoccus elongates and the fungus Neurospora or in plants such as Mimosa pudica and the tamarind tree.

It is possible that the daily pulsing of the ambient potential is at least partly responsible for the circadian rhythms observed in cells and other systems. The static potential was not controlled or even considered in reported studies of the circadian rhythm so even the effects of light are not clear. If therapeutically favorable metabolic conditions in the circadian cycle can be duplicated by applied charge, it might be possible to improve the treatment of many conditions.

Conclusion(s)

Chemical and physical considerations of the oxidative and inflammatory processes as well as experimental evidence suggest that these processes may be inhibited at zero or negative static potentials. It should be worthwhile to examine the utility of applied static charge in the treatment of disease. Applied negative static charge should have a great advantage over natural protective systems, whose effectiveness is limited by capacity and diffusion rates, and natural protective systems can become dysfunctional for a variety of reasons. In contrast, the protective effects of an applied potential should be available almost immediately everywhere in the organism.

This article is focused solely on controlling the deleterious effects of oxidation. Genetic predispositions, pathogens, specific toxins, allergens and environmental stresses are important initiating factors in most conditions, but in almost all cases, oxidative stress is considered to be responsible for acute crises, long-term degenerative processes and their associated pain and discomfort. The possibility discussed above that the daily ambient potential pulse may be the cause of the circadian rhythm should be investigated in this connection. It is not possible at this point to untangle the direct effects of static charge on ROS from indirect effects due to rhythm-induced metabolic changes. There are dozens of model studies of the circadian rhythm in the literature that could be repeated at controlled static potentials. However, there are conditions, such as many listed below, that should respond directly to changes in the ambient potential even if no correlation with the circadian rhythm exists.

Inflammation of organs, especially the heart and lung, and other structures can be chronic or occasional or periodically increase to crisis levels. Controlling inflammation in this way may help the afflicted to weather crises and allow normal replacement and repair mechanisms to proceed. It may also be useful in conjunction with therapeutic agents such as antibiotics and antivirals. There are many examples in the literature of potential therapeutic agents whose use is problematic or impossible because of serious inflammatory side effects and liver damage. It may be possible to improve the therapeutic ratio of both currently used and problematic agents by post-dose control of static potential.

Testing the hypothesis

The effects of static potential are different from those in which there is current flow, which can be harmful. It has been demonstrated that current flow, even at nine volts, generates ROS. In these experiments and in the design of therapeutic applications, it will be necessary to minimize electrical, ionic and electrophoretic flow, which means that the subject should not be in a gradient field. There should be no current flow through the organism or specimen. These requirements will be best met in a Faraday cage, which can take a variety of forms such as metallized plastic mesh body bags or electrically isolated rooms or chambers suited to the application.

It will be necessary to determine experimentally whether optimum results can be achieved by merely reducing the static potential on the subject to zero or whether some level of negative potential will be therapeutically superior. Since the first ionization constant of most atoms is less than ten volts, we can speculate that very high negative potentials will not be required. In any case, it is likely that the optimum applied protective voltages will be in the range that we are already normally exposed to. However, established animal models can be used in initial tests to explore the effects of different levels of both positive and negative charge on the acute phases of many conditions. There are thousands of experiments with animal models reported in the literature that could be repeated at controlled static potentials. Among other things, it should be possible to determine whether changes in the ambient potential are responsible for precipitating the seemingly random crises that characterize diseases such as sickle-cell anemia and cystic fibrosis. These experiments should identify

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potential side effects and provide parameters for testing in humans. Some of the hypothesized effects of static charge, such as those on stored blood and tissue and on sickle-prone cells, can be explored in vitro.

Applied potential may be therapeutically useful in the treatment of diseases and conditions characterized by chronic, low-level oxidative stress as well as those with acute, life-threatening episodes. However, the pronounced symptoms in the latter would make the effects of applied charge more easily observable. The specific system, interface or process likely to be affected in acute phases of the following test candidates are identified whenever possible. In some cases, there will not be dramatic changes of symptoms, but the effects of applied charge can be assessed by examining biological markers. Some suitable subjects for investigation are discussed below.

Cancer

Adriamycin (doxorubicin or DOX) is effective against a broad range of cancers. However, the body reacts to Adriamycin and some other agents such as Bleomycin and cytokines by producing ROS, and these agents can cause persistent and, sometimes, permanent problems, including heart damage, hearing loss, infertility, short-term memory loss and sometimes permanent cognitive difficulties referred to as “chemofog” or “chemobrain.” If the anticancer activity of these agents depends critically on the production of ROS, then the application of negative charge may reduce their effectiveness. However, there is evidence that antioxidants taken orally do not diminish the efficacy of these agents. Therefore, it is probably worthwhile to evaluate the application of anticancer agents and irradiation with the subject at a negative potential. Alternatively, it may be useful to follow chemotherapy or radiation with applied charge in order to minimize collateral damage. Co-application of negative static charge may allow the use of many new procedures and agents that cannot now be employed because of inflammatory side effects.

Toxins and Allergens in General

Adriamycin and Bleomycin, which are mentioned above are only two of a very large number of agents that react with biological molecules to form ROS. For example, carbon tetrachloride reacts with P-450 protein in the liver, which leads to generation of lipid peroxides and an autocatalytic cascade of oxidation reactions that cause extensive liver damage. These side effects may be inhibited at negative static potentials. Therefore, the suggested procedure may serve as an emergency treatment for people accidentally exposed to such toxins. The possibility that applied charge could be used to prevent liver damage by such agents should be easily tested in animal models

In acute responses to allergens, the body reacts by overproducing ROS. The application of negative static potential may be useful, especially in potentially life-threatening cases.

Radiation Exposure from Accidents and Hostile Action

In the period immediately after the end of WWII, the U.S. Atomic Energy Commission and its predecessor agency funded a great deal of research in order to find therapeutically acceptable radical scavengers to counteract the effects of radiation exposure, accidental or otherwise, but no very effective and safe agent was uncovered through this work. However, the need still exists, especially because of the threat of “dirty bomb” use by terrorists. It may be possible to use chargeable metallized body bags for the emergency treatment of radiation victims.

Trauma

Tissue responds to contusions, concussions and accidental or surgical wounds with the production of ROS, which further damage the tissue and produce extensive inflammation and swelling. In the brain and spinal column, increase in intradural pressure and the other effects of inflammation can prevent nerve fiber reconnection and healing and result in temporary and sometimes permanent loss of function. It may be possible to limit inflammation and the consequent damage by applying negative charge as quickly as possible after the trauma occurs. First responders could do this with metallized plastic mesh body bags.

Ischemia and Reperfusion

The brain can be deprived of blood, among other reasons, by heart attacks, stroke, the acute phase of sickle cell anemia or during open-heart and organ-transplant surgical procedures. In these cases and in non-surgical ischemias, it may be important to control static potential as quickly as possible in order to limit oxidative damage.

ROS are generated when blood flow is interrupted, and it is important to reestablish blood flow as quickly as possible in order to limit the oxidative damage to cerebral function. However, during ischemia, xanthine oxidase concentrations increase and there is a loss of superoxide dismutase and glutathione peroxidase. These changes result in significantly more oxidative damage when the vascular system is reperfused, further damaging brain tissue and sometimes interrupting reperfusion. It has been estimated that in cardiac arrest, the most common cause of cerebral ischemia, about 90% of resuscitated patients have some long-term or permanent neurological dysfunction. A similar condition called “transplant brain” affects a large percentage of transplant patients. Oxidative

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damage also occurs at other body sites on reperfusion. It may be possible to avoid these problems by reperfusing at negative static potentials or, preferably, by also performing all surgical procedures at a negative potential. This should be quite safe, economical and easy to do.

Arthritis

Oxidative stress plays a role in both rheumatoid arthritis and osteoarthritis. ROS degrade hyaluronic acid, modify collagen, alter immunoglobulins, activate and deactivate specific enzymes and cause apoptosis of synovial T-cells. These degenerative processes and the attendant pain might be controlled by the proposed procedure.

Fibrosis

Cystic fibrosis, a disease characterized by fibroblast proliferation, can affect almost every exocrine system. The most life-threatening effects are pulmonary obstruction and increased susceptibility to pulmonary bacterial infections. There is evidence that fibroblast proliferation is initiated by ROS, and therefore, applied static charge may prevent life-threatening crises and offer symptomatic relief.

Sickle-Cell Anemia

In sickle-cell anemia, variable fractions of the patient's red blood cells are molecularly abnormal, and these cells become misshapen; that is, sickle-shaped, under certain conditions. It was long assumed that the anemia and pain associated with the condition occurs simply because the misshapen red cells cannot pass easily through capillaries because of size and shape. However, other factors seem to be important. The extremely painful, life-threatening phase of the disease in the lungs and elsewhere is characterized by abnormal adhesion of sickle cells to the vascular endothelium, and the passage of white blood cells and platelets is impeded for the same reason [9].

The adhesion of blood cells and platelets suggests that the normal oriented structure of their surface molecules and that of the vascular endothelium have been disturbed or degraded, very likely by oxidation. Applied static charge should be tested to determine whether positive static is responsible for sickle-cell crises and whether applied negative may therefore be useful in sickle cell crises. It has been demonstrated that susceptible red cell can be sickled at electrodes, but the effect of static charge has apparently not been explored. Some of this work could be done in vitro in microscope-size Faraday cages. If sickle-cell crises are, in fact, precipitated by positive charge, it may be possible to treat patients in crisis with applied negative charge.

Oiabetes

There is evidence that ROS are causative agents in both Type I and Type II diabetes. For example, in Type I, plasma xanthine oxidase levels are elevated, which leads to increased plasma lipoperoxide and oxidized-blood glutathione levels [10]. Elevated ROS levels are believed to be responsible for pancreatic beta-cell destruction and for the long-term damage to other organs. Drugs such as alloxan and streptotocin cause diabetes in animals, apparently through the production of ROS. Therefore, applied negative static potential may be useful in the treatment of diabetics.

It has been demonstrated that the pancreases of Type I diabetic mice can begin to produce insulin again if attack by white cells can be prevented. These oxidative reactions should be prevented at negative potentials, which may help establish pancreas and stem cell implants (see Blood, Cells, Tissue and Organs below).

Blood, Cells, Tissue and Organs

Stored blood is currently considered to have a 42-day shelf life at 4oC. However, many recent studies indicate that blood deteriorates significantly long before 42 days. A recent retrospective study [11] showed that both in-hospital and out-of-hospital mortality of patients who received red blood cells after cardiac surgery were associated with duration of storage.

Oxidation of many specific blood components is mentioned repeatedly in the literature, and antioxidants are widely used to prolong the shelf life of blood and preserve compositions, especially those of specific disease markers in samples drawn for clinical analysis. The use of antioxidants in blood and concentrates intended for transfusion is more restricted because of side effects. Complement activation during storage of blood under normal blood bank conditions has been reported. It is likely that these are reasons for the decline in blood quality in storage, and it is possible that these effects would be inhibited if the blood were stored at a negative potential.

Similar changes occur in a wide variety of blood-container materials (glass, metals and plastic), so it is not likely that materials leached from container surfaces are responsible for the degradation on storage. It is possible that the changes that occur in stored blood are the result of exposure to ambient positive charge. Molnar reported the white blood cell count of mice maintained at a negative potential was almost twice that of control mice raised at ground potential and more than twice that of mice maintained at a positive potential. One could interpret this difference as an effect of ambient charge on white cell production. However, the assumption that negative charge inhibits loss of cells through oxidation is more

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consistent with all the reports in the literature. Imposed negative charge on stored blood may help maintain its usefulness. Storing blood in this manner should be easy to do even when the blood is stored in non-conductive containers. If the blood (or blood fraction) is electrically connected to the negative terminal of a battery, the blood will be at the same potential as the terminal. There is no need to connect the positive terminal to ground.

The viability or shelf life of cells, tissue and organs harvested for research, implantation and transplantation might, for similar reasons, be improved by maintaining them at a negative potential, which could be done with batteries as suggested above. Attempts to restore functional motor neurons through implantation of fetal stem cells have been largely unsuccessful, suggesting that growing stem cells may be susceptible to the same kind of damage that affected the native motor neurons. In addition, stem cells, like all rapidly growing cells, would be more susceptible to oxidative damage because of greater ROS production. The production of embryonic cells in cultures is improved by the addition of antioxidants [12], which suggests that the proposed procedure may protect growing stem cells both in vitro and in vivo. Tissue, such as bone marrow, that is frozen and then thawed for therapeutic use is often rendered useless by oxidative damage in both the freezing and thawing processes. The post-thaw vitality of cells is somewhat improved by the presence of an antioxidant. It would be interesting to evaluate cells, tissue and organs that had been harvested, frozen, stored, thawed and implanted at negative static potentials. The IVF success rate might, similarly, be improved.

Psychiatric Disorders and Neurodegenerative Diseases

A broad range of central nervous system syndromes, including psychoses, depression, dyskinesia and senile deafness, have been correlated with the presence of ROS or with substances and conditions that are known to promote the formation of ROS. These include alcaptonuria, homocystinuria, hyperthyroidism, iodism, bromism, Wilson's disease, manganese poisoning, hemochromatosis and acute intermittent porphyria.

ROS have been implicated in many neurodegenerative conditions, including Alzheimer's disease, Parkinson's disease, amyotrophic lateral sclerosis, Huntington's choria, cerebral palsy and autism. Protein misfolding is either the cause of some of these conditions or it is a by-product of other processes. The ambient potential should affect oxidative disulfide bond formation in the folding process. It is possible that other chain-association factors, such as hydrogen bonding and van derWaals forces, will also be affected, so ambient potential may have a profound effect on protein folding and refolding.

Bacterial and Viral Infections

A common feature of all the elements of the immune system, including phagocytes, cytokines, lymphocytes, immuno-globulins and T-cells, seems to be the production of ROS when challenged by a pathogen. It is widely, but not universally, believed that these ROS are the effective agents against bacteria and protozoa. If they are, in fact, the biocidal agents, then reducing the production or availability of these active species by any means should allow bacteria and protozoa to thrive. However, increasing antioxidant and radical scavenger levels do not seem to compromise natural defenses against these pathogens, which suggests that inhibiting oxidation by other means will not compromise either natural defenses or drug efficacy. There is a minority opinion that enzymes are the true biocidal agents, but it is not clear whether ROS are needed to activate the enzymes. Nevertheless, it would be interesting to explore the usefulness of applied charge, especially with antibiotics, such as beta lactams, whose biocidal activity does not seem to depend on oxidation. The preservative effect of negative ambient charge on blood cells discussed above should help maintain therapeutically effective levels of these cells, especially in the presence of ROS generated by inflammation.

ROS levels are also elevated by viral infections, but ROS seem to have no antiviral activity, at least in the case of influenza, viral pneumonia and neurotropic viral infections. However, in both bacterial and viral infections, ROS are responsible for acute, life-threatening conditions, such as severe acute respiratory syndrome (SARS) [13]. These acute effects might be inhibited by negative charge.

Flight and Space TravelPassengers in flight equilibrate to the potential of the aircraft, which is, functionally, a Faraday cage, and the aircraft, in turn, equilibrates to the potential of the air through which it travels, which is at a generally high positive potential. It may be possible to protect to protect passengers and crew against the probable long-term effects described above, and also against deep vein thrombosis, the so-called "economy-class syndrome," by maintaining the aircraft at an zero or negative potential. This could be done simply and economically by ejecting positive ions from the plane continuously in flight. The current flow required will be quite low, and suitable ion guns and electrostatic spray devices are available from several manufacturers. It is believed that positive ions, mainly protons, are the predominant charge carriers in cosmic rays, so space travelers will be exposed to

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oxidative stress over long periods. The procedure suggested above is not practical because of weight restrictions. However, it may be possible to create zones of negative charge within the spacecraft for the occupants.

Conflict of Interest Statement

The author was not employed by a commercial organization or associated with any teaching or research institution during the period in which this study was conducted, and he has no personal relationships with medical researchers in relevant fields. This study was unsponsored and unfunded.

References

1 Sawyer, P.N., J. Electrochemical Soc., Review and News, Vol. 125, No. 10(1978) pp 419c-436c
2.Radisky, D. and Bissel, M.J., Nature 436 (2005) p123
3.Tu, B. P. and Weissman, J.S., JCB, Vol. 164 (3), 341-346
4.Proctor, P., Physiol. Chem.& Physics 4 (1972) pp349-360
5.Molnar, K. Mech. Age. Dev. 1 (1972/73) pp319-326
6.Pammenter, N.W., Science Vol. 186 (1974) pp1123-1124
7.Feynmann, Leighton, Sands, The Feynmann Lectures on Physics, 2nd Ed. Addison Wesley, Sec. 9
8.Levi, F., Journal of Pharmacy and Pharmacology, Vol. 51, No. 8, 1 August 1999, pp.891-898(8)
9.Klings, E.S. and Farber, H.W., Respiratory Research 2 (2001) pp280-285
10.Desco, M., Asensi, M., Marquez, R., Martinez-Valls, J., Vento, M., Pallardo, F.V., Sastre, J., Vina,J., Diabetes 51 (2002) pp1118-1124
11.Schleuning, M., Schmid-Haslbeck, M., Utz, H., Jochum, M., Mempel, W., Willmanns, W., Blood, Vol79, No.11(June1), 1992: pp3071-3075
12.Akaike, T., Reviews in Medical Virology, John Wiley and Sons,
Vol. 11 (March/April, 2001) pp87-101
13.Thompson, J.A. and Ludwig, T.E. U.S. Patent Application Publication

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