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Internal Life Support System as the Next Step in Human Evolution

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Introduction

New times preparing us for new challenges which came sooner than expected. Prolonged exposure to space, even in relatively low orbit, has shown that the human body is not adapted to being in space in contemporary constructed space vehicles, as it causes numerous health problems such as: heart remodeling, arterial stiffness, risk of lung inflammation, disrupting the connection between perception and action in the nervous system, insomnia, decrease in muscle mass and strength, enlargement of the parenchymal organs and thickening of the walls in the digestive system, decreased number of immune cells, increased inflammation, bone mineral density loss etc. In virtually every structure of the body, from the micro to the macro scale, changes can be observed due to being in space. Health problems are correlated with the time spent in space [1]. It is believed that most health problems are caused by exposure to high-energy cosmic radiation, as well as the state of weightlessness. Cosmic radiation consists of galactic cosmic rays (GCR) and solar particle events (SPE). The GCR comprises high-energy protons, helium nuclei, and heavy nuclei. Space radiation induces the formation of reactive oxygen species ROS, which directly or indirectly damage virtually all body structures from DNA mutation, mitochondrial stress to collagen degradation [2]. The efficiency of the human body in eliminating free radicals although sufficient under terrestrial conditions occurring in organs and organelles such as live, mitochondria and peroxisomes [3] is highly insufficient under space conditions.

Attempts are being made to remedy this by feeding astronauts food rich in antioxidants [4], but this is insufficient. There are two ways to solve the problems of exposure to highly harmful external factors while in space vehicles, one of them is to build better, more Earth-like space vehicles primarily to stimulate Earth's gravity and protect against cosmic radiation, or to adapt human organisms to space conditions. Evolution is too slow in this case therefore self-improvement of human organisms is necessary. Self-improvement of human organisms may involve external life support systems, but another option, it seems, that offers much greater possibilities for development is Internal Life Support Systems. An Internal Life Support System ILSS in space should be a new internal organ in the human body. The name of the artificial organ that would support the body's internal functions, adapting them to the environment inside the vehicle in space Internal Life Support System abbreviated ILSS. The abbreviation ILSS is quite difficult to pronounce, and it can be easily confused with other commonly used abbreviations, so we propose the new name artgan derived from a cluster of words artificial organ to describe this device. The proposed artgan, an artificial supplementary human organ, differs from other artificial elements so far implanted in the human body in that while artificial organs are a kind of prosthesis, replacing hitherto damaged organs such as an artificial cochlear implant perform normal functions of the human body, the proposed artgan or artgans will help cross barriers hitherto inaccessible to human organisms.

In the contingencies of long-duration spaceflight, they will allow survival of the stress of reduced gravity, exposure to increased high-energy radiation, and other adverse factors acting on the human body. The proposed artgan will be responsible for ensuring the homeostasis of the human body in an environment that is completely different from Earth's, the changing conditions to which the human body has evolved over millions of years. It is not possible to wait millions of years for the human species to spontaneously evolve adaptations for being in space, so preparations must be made to adapt the human organism to these conditions. The adaptation of the human body for prolonged residence in space vehicles constructed so far should include the preparation of another internal organ, an artificial organ implanted directly into the human body, which will enable space exploration by providing adaptation to the adverse conditions of space. This artificial organ - artgan, like any other organ in the human body, should be characterized by basic properties common to all organs in the body such as the ability to self-regulate, to cooperate with other organs. This organ should be capable of efficiently ensuring the homeostasis of the human organism in such different from earthly conditions, and, above all, offsetting the negative effects caused by being in space. The main task of this organ, in addition to administering therapeutic substances to ensure the homeostasis of the human body in weightless conditions, should be the ability to remove free radicals resulting from cosmic radiation, to respond efficiently to changes in the homeostasis of the human body caused by the state of weightlessness and other adverse factors that can occur in cosmic conditions.

One of the main features of artgan ILSS adapting the human body for being in space should be to support the removal of reactive oxygen species ROS, which are one of the main cell-damaging agents, and the current ROS-adapted mechanisms in the body present on earth are not sufficient to effectively protect the human body. In the human body, free oxygen radicals ROS are removed in several different structures and defense mechanisms of the body, [5] from mitochondria in the liver to antioxidants present in blood plasma. The efficiency of these structures under conditions of prolonged residence in space is unfortunately not sufficient, as can be observed in the bodies of astronauts after prolonged residence in Earth orbit. Under terrestrial conditions, in some clinical problems, such as post cardiac patients to combat harmful free radicals formed after reperfusion of the vessel, vitamin C is administered intravenously as an antioxidant in high doses [6]. It should be borne in mind that the knowledge gained so far about the impact of prolonged stay in space concerns staying on the space station in relatively low orbits, only a few people have been in orbit around the moon and in a relatively short period, so it should be expected that human organisms staying at a much greater distance from the earth, unprotected by its magnetic field may be exposed to much more extreme cosmic radiation not to mention sudden exposure to other extreme events for the human's body like exposure to the solar wind without being protected by the earth's magnetic field.

ILSS artgan could enhance situational awareness. In an unfamiliar and extreme environment such as space, the organ would act as a biological radar, enhancing our ability to orient ourselves and react quickly to unforeseen threats. This internal warning system has the potential to open new frontiers of exploration, helping users react quickly to changing environmental conditions not detected by traditional senses. For the above reasons, the proposed artgan ILSS artificial organ implanted in the bodies of astronauts should have the ability to filter blood (especially to remove free radicals), monitor important laboratory parameters of blood particularly easily disturbed under space conditions, administer medicines/medicinal substances enabling the intended homeostasis of the body under space conditions, and possibly remove harmful substances that are not normally removed by the human body, e.g., products formed after the deactivation of free radicals. Worth considering is how to remove possible toxic substances formed by blood filtration. Two possible solutions to this problem can be adopted one of them is the removal of toxic agents directly into the urinary bladder. This solution, despite a certain "physiological simplicity," carries the risk of reabsorption from the body through the epithelium lining the urinary bladder as well as direct damage to the bladder epithelium by these substances. Another option is the direct emptying of a special container for waste substances through a specialized port.

Theoretically, free radicals should be bound to H2O2, which can then be enzymatically washed down to H2O and O2 but further problems will probably arise during trials with the finished device. One of the main components of the ILSS artgan should be a semi-permeable membrane with embedded enzymes adapted to decompose free radicals, sensors to ensure the ability to continuously monitor selected blood parameters, it should have the ability to continuously administer drugs, it should be equipped with a wireless charger, a subcutaneous port for refilling the administered substances, the ability to the wireless contact with an external computer etc. It should be noted that the capacity of the filtration ability does not need to be large, for the task of the ILSS will only be to support, not replace, all organs. At the same time, the artgan ILSS should have the capacity for continuous expansion and modification, since we don't know until the end what challenges human organism will have to face in space. For this reason, it is difficult to define exactly what substances can be administered that will improve the comfort of astronauts in space. They will probably be substances that regulate the functioning of the body and facilitate its adaptation to the lack of gravity, such as antiemetics, inhibiting bone resorption, muscle atrophy, regulating electrolyte levels, among others. There are at least dozens of ailments reported by those on the space station, and the ILSS artgan should be prepared for at least that many substances administered at the same time, which will remove these ailments.

Listing all the changes in the human body that occur during space missions is not the purpose of this proposal. Under Earth conditions, most of the ailments reported by astronauts are within the therapeu-

tic capabilities of the average practicing physician. Another consideration is where to implant the artgan ILSS. Anatomically, the most appropriate site for implantation of this artificial organ is subcutaneously, either in the right or left iliac fossa, a site perfectly chosen by transplant surgeons as a site for heterotopic kidney transplantation. The site is easily accessible by examination, with access to the relatively large vessels of the epigastric artery and vein and the urinary bladder. Implantation of an artificial organ at this site is associated with relatively low perioperative risk to the patient. It is easy to connect even for a relatively inexperienced surgeon, with the advantage that it can be reoperated by a member of a space mission in conditions far removed from human civilization. The epigastric vessels, the inferior epigastric artery and the inferior epigastric vein, appear to be the most suitable vessels to provide the proposed ILSS arthgan function. The vessel diameter of the epigastric artery of approximately 3 mm (with a flow rate of approximately 50- 200ml of blood per minute) should be sufficient to provide an effective adjunctive function of the ILSS arthgan. Disposal of the resulting body substances removed by the proposed arthgan ILSS should also be considered. In a standard kidney transplant procedure, the kidney is placed in the lower abdomen over the right or left iliac plate, the renal artery and vein are connected to the iliac artery and vein, and the ureter is sutured to the bladder.

While such a connection would have a number of advantages related to the larger diameter of the vessel and potentially more efficient operation and use of counterpulsation (as in the short-term treatment of heart failure), the advantage would be the possibility of increased tolerance to overload by increasing blood supply to vital organs, but the risk of difficult-to-control bleeding from such large vessels would increase significantly. There are still many unknowns that can only be solved by studying living organisms, such as the optimal size of the device, how to fix it more rigidly in the abdominal cavity, or how to allow a certain range of mobility. In addition, it might even be possible to connect the artgan ILSS to some peripheral nerve that would gently inform the patient of the risk of e.g. increased radiation and other dangers by means of electrical impulses, vibrations, etc. It is now known that during a long stay in space many unfavorable changes occur in the human organism, it is not really known whether they are a symptom, an effect or, what cannot be excluded, some imperfect way of adaptation of the organism to the conditions of Earth orbit. Because of the complexity of the issue, the proposed topic will require further study. Many technologies originally developed for space exploration have found their application in everyday life, there is a good chance that our proposed additional artificial organ called artgan ILSS could also be a universal organ/prosthesis with applications not only in space exploration but also in everyday life.

In many diseases we are dealing with subclinical forms of multi-organ failure, in the elderly, multi-organ support by the artgan could theoretically bring an improvement in quality of life. Other people who may benefit from an artificial organ to support the body's homeostasis are those exposed to extreme environmental factors, such as sailors on submarines, people involved in extreme sports, and a number of others. This work is the result of many years of joint discussions, research, analysis and reflection on the adaptation of the human organism to the adverse conditions of future space travel. The preparation of such an artificial organ with the current advances in medicine and scientific knowledge we have is completely within the reach of current technological capabilities.

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Competing Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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