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Commentary

Keeping nanobacterial infections at bay during space travel

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Abstract

In January 2004, President George W. Bush unveiled plans to send astronauts to the Moon in 2015 and shortly thereafter to Mars. With the prospect of manned exploration of the planets drawing ever closer, the new discipline of Space Medicine is destined to come to the fore. Moreover, investigations of how human beings function under space conditions could provide important new insights into fundamental questions of human physiology and disease. We draw attention here to one such instance of a disease process that can be provoked by extended periods of exposure to low gravity.

Keywords: Nanobacteria; Astronauts; HIV; Bone mineral density; Primordial biosystems

Interfacial contact between microorganisms is a prerequisite for the transfer of plasmids. Gravity could promote microbial evolution within an aqueous environment by creating conditions in which microorganisms improve their chances of encountering each other and gaining easier access to nutrients. Ironically, lack of gravity could have virtually the same effect on microorganisms within hosts. Extended exposure to microgravity is known to impose extreme and multiple challenges to the immune system of humans, and it is in such compromised immunological settings that opportunistic infectious agents are encouraged to multiply and cause most damage. Indeed viruses carried by astronauts into space are known to become active and cause disease during space flight.

Astronauts exposed for extended periods to low gravity suffer a decrease in their bone mineral density [1]. Loss of bone mineral density occurs also on the Earth and can have several causes, one of which may be nanobacteria (NB). Being protected by shells consisting of apatite, NB may compete with bone for calcium and phosphate, while circulating in the blood [2]. In the laboratory, cultured NB responded to physiological stress in their environment by synthesizing slime [3]. Slime facilitates colony formation – a precondition securing the survival of microorganisms in a hostile environment. In individual NB, the nutrient-rich slime, thought to be abundant in calcium and phosphate (components fostering mineralization of the apatite shell), is likely to promote growth. Nanobacteria, due to their unique properties, including their protection by a mineral shell possibly containing DNA [4,5], are regarded as candidates for the origin of life [6]. Such primordial biosystems could have co-existed with mammals for many millions of years.

If low somatic concentrations of NB are already present in astronauts venturing into space, their experience of microgravity with its incumbent physiological impact could provide ideal conditions for replication of NB. Since both human bone and NB contain apatite, the growth of NB within the body can only be maintained at the expense of bone.

A similar scenario is probably realized in HIV-infected patients who frequently present with loss of bone mineral density, kidney stones as well as a pronounced tendency for peripheral neuropathy, a set of conditions of which peripheral neuropathy is also common to patients with diabetes and which has now arguably been linked to NB growth [7–9]. Their implication in diabetes is illustrated in a recent case that revealed large amounts of NB in the mitral valve of a 33-year-old diabetic patient [10].

In addition to the conditions discussed thus far, it is also becoming clear that NB probably play an important role in the initiation of heart disease in general [3,5,7,10–12] and

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coronary artery disease in particular [13]. It is significant in this context that HIV-infected patients are often burdened with heart disease. The presence of NB in HIV-infected patients has recently been *predicted* from preliminary observations indicating their probable involvement in peripheral neuropathy [7]. Thus inferring the presence of NB in HIV, and treating NB as opportunistic infectious agents that are encouraged to replicate by a weakened immune system, we arrive at the very plausible hypothesis that they may not only affect HIV-infected patients but also astronauts. It remains now to discuss what measures could be taken to alleviate the worst effects of NB proliferation in such cases.

In laboratory studies, it has been found that light with intensities comparable to the solar constant, e.g., delivered by arrays of light-emitting diodes (NASA LEDs), could inhibit the production of slime by NB [11]. Without the slime envelope, the gradual elimination of the NB which are circulating in the body appears feasible, the elimination being mainly via urine.

The above considerations lead us to suggest that a few simple precautions should be taken to prevent the undesirable consequences of NB replication in astronauts during long space voyages, e.g., to Mars. If it is not possible to eliminate dormant NB by some means prior to departure, the use of low-level laser light or LED arrays with intensities around the solar constant within the spacecraft may prove a useful option to alleviate the potentially hazardous effects of space travel. Our recommendation derives support from two recent developments: the identification of NB in the terrestrial atmosphere [14], confirming a previously formulated hypothesis regarding their atmospheric prevalence [15] and model simulations indicating a strong bioadhesive capacity of NB [12].

In conclusion, we reiterate that both astronauts and HIV-infected patients present a very weak immune system as well as reduced levels in bone mineral density. Hence the prevalence of NB in astronauts would seem to be implied from our knowledge of their possible role in reducing bone mineral densities in HIV. Therefore, studying the various modalities by which NB could be either eliminated from the body, or their harmful effects modified or ameliorated, in one group may also be of direct benefit to the other. A particularly promising strategy in the present context may be to design conditions in which NB are forced to incorporate suitable anti-infective agents [Sommer AP, Forcing nanoscopic infectious agents to incorporate antiinfectives by exposure to moderate laser light intensities – solutions inspired by nature. In: Proceedings of the Abstracts of the World Conference on Magic Bullets, Celebrating Paul Ehrlich's 150th Birthday, Nürnberg, 2004 (Abstract 514)], thereby reducing the ravages of secondary infections as in the case of HIV.

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