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Letter to the Editor

Letter to the Editor: Potential of Regenerative Medicine for Solutions in Space Health

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Dear Editor,

The sharing of innovative perspectives on the challenges faced in space exploration, combined with effective solutions related to regenerative medicine, creates a favorable environment for revolution. Long-duration extraterrestrial travel is in the planning stages of major government agencies and companies worldwide for a significant resurgence in the coming decades. These journeys, as well as simulations in Earth analogs, pose significant challenges to astronauts' health, with adverse effects on both physical and mental health[1]. In this context, emerging technologies arise and are refined to meet the specific demands of humans in suborbital and orbital flights, as well as in lunar or Martian environments, among others, promoting not only cellular regeneration but also a more robust biological adaptation to the hostile conditions encountered in the space setting[2].

"Degenerative changes affect numerous organ systems, including the musculoskeletal, hematopoietic, endocrine, nervous, ocular and immune systems[2]. In addition, the space environment accelerates biological aging and increases cancer risk due to: promotion of oxidative stress, DNA damage, mitochondrial dysregulation, epigenetic changes, alterations in telomeric DNA and changes in the microbiome[3]. A recent example was that of two NASA astronauts who returned to Earth after nine months on the International Space Station (ISS), during a mission originally planned to last only eight days. Both presented observable and likely hidden debilitations, probably resulting from prolonged exposure to microgravity and cosmic radiation, without excluding the psychophysiological effects of extreme confinement and isolation[4].

In this scenario, regenerative medicine offers significant potential to meet space health needs[5]. Technologies from this field and related areas, isolated and especially combined, can enhance the biological adaptability of astronauts, optimizing cellular responses to extreme environmental stressors[2,6], such as CRISPR.

CRISPR in vivo screening targeted at adult stem cells and non-germline progenitor cells presents itself as a promising tool for identifying and correcting specific genetic mutations resulting from exposure to the space environment[7]. Initially limited to organoids or tumors transplanted into mice[8], this method can minimize the impacts of exposure to high-risk environments, such as those experienced by astronauts[9]. Although this biotechnology raises ethical and biosafety concerns, its application can be carried out safely and responsibly[10,11].

The initial cost of these technologies is high; however, the long-term benefits are substantial. The implementation of therapies such as the ones mentioned would not only contribute to the health of astronauts but also open doors for advances in regenerative medicine, with applications in the treatment of degenerative diseases and accelerated biological aging, including on Earth, consequently contributing to the advancement of the scientific field[9]. Collaboration between space agencies, universities and companies can provide the necessary funding to make these solutions viable, especially considering that investments in prevention are more economical in the long run and save lives.

Regenerative medicine, with an emphasis on the application of in vivo CRISPR technology for stem cell therapies, is recommended as a key solution for the challenges of space medicine and concentrated efforts in this direction are differentiators. It can significantly improve the health conditions of astronauts while providing essential clinical data for highly precise personalized medicine, adapted to the specific needs of space explorers and Earthlings. Sincerely,

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