Preface

In 2009, with the International Space Station (ISS) declared fully operational, NASA and its partners ushered in a new era of spaceflight: permanent human presence in low Earth orbit (LEO). As the culmination of decades of manned spaceflight activities, the ISS focuses attention on what has been learned to date and on what must still be learned before humans can embark on future exploration endeavors. What we may discover during the forthcoming exploration of the solar system may shape the future of humanity, but before exploration class missions (ECMS) can leave LEO, we must be sure the astronauts will survive, which is why space medicine is the key to the future of humans in space.

Space medicine has undergone a gradual evolution, from developing and implementing selection and retention standards to minimizing the probability of disease in astronauts in space, to providing clinical support for short-duration missions and, most recently, to supporting a permanent human presence in space onboard the ISS. The ISS not only serves as an orbiting laboratory and technology development platform; it also provides clinicians with a unique opportunity to conduct research to optimize crew safety and performance – factors critical in reducing the biomedical risk of extended space missions.

Missions to Mars and beyond will test space medicine to the extreme. First, there is the question of how to protect astronauts from radiation that can pepper an astronaut's body like machine-gun fire. While mission planners are confident they can protect astronauts by using polyethylene shielding, there is a second kind of radiation for which there is no protection: cosmic rays possess too much energy for shielding to be effective. They pass through tissue, leaving cells mutated or dead, which means understanding their biological effects will be a priority. To protect themselves, astronauts may have to take anticancer drugs or, as suggested in this book, be infused with nanobots capable of repairing the damage inflicted by the radiation.

In addition to being fried by radiation, spacefarers embarking upon ECMs also face weakened muscles and significant bone loss. The obvious countermeasure to keep the muscles and bones fit is exercise, and the message to long-duration astronauts is clear: do the exercise and you will be okay – don't and you'll be carried off the spacecraft. However, even with rigorous daily exercise, astronauts still lose bone mass and scientists don't know when or if the body stops losing bone. If bone loss can't be prevented, there is the real risk that astronauts landing on some distant planet or moon will fracture bones. To counteract the bone loss, it has been suggested that astronauts take drugs normally given to osteoporosis patients, while another idea is to use artificial gravity to provide astronauts with doses of gravity to counteract the effects of weightlessness. These interventions and others, many of which are discussed in this book, will be vital in preparing for Mars missions and beyond. Chapter by chapter, this book examines the future of space medicine as it relates to human space exploration and describes what is necessary to keep a crew alive in space, how it is done today and how it will be accomplished in the future.

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