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Anesthesia and Surgery in Space: Comment

To the Editor:

We read the recent article penned by Komorowski *et al.*[1] with great interest, and we congratulate the authors on a well-composed and thought-provoking article addressing space exploration and the challenges of medical care, especially anesthesia, in this austere environment.

Although undersea and hyperbaric medicine is often associated with treating conditions secondary to increases in ambient pressure, such as those arising from scuba diving, it also aids in understanding and treating the pathophysiology of exposures to hypobaric conditions, like those experienced by pilots or astronauts.

In fact, entering any current space suit from a living environment, such as the International Space Station or a lunar lander, requires a decompression to a lower ambient pressure.[2] Human trials involving decompression from sea level (1 atmosphere absolute [ATA]) to ambient pressure of the U.S. space suit (0.3 ATA) has resulted in decompression sickness in up to 20% of exposures and venous gas emboli in up to 62%.[3] Furthermore, knee pain due to decompression sickness was experienced by Gemini X astronaut Michael Collins in 1966.[4]

Although such events in space have thus far been rare, increased numbers of human exposures and time in space will raise the probability of such an event. Thus, we believe training in undersea and hyperbaric medicine is crucial and preparatory for the future medical challenges inherent with interplanetary spaceflight. Currently, there are 10 Accreditation Council for Graduate Medical Education–approved training programs in undersea and hyperbaric medicine.[5]

Competing Interests

Dr. Moon reports payment for contribution to the Merck Manual (Merck and Co., Inc., Kenilworth, New Jersey). Dr. Covington declares no competing interests.

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Anesthesia and Surgery in Space: Reply

In Reply:

As pointed out by Drs. Covington and Moon,[1] in response to our recent article,[2] mitigating the risk of decompression sickness is of utmost importance for future missions to the Moon or Mars. This risk is proportional to the ratio *R* between the partial pressure of nitrogen in the tissues and the pressure of the spacesuit.[3] For future space exploration missions, an acceptable risk of decompression sickness is reached for an *R* less than 1.3 to 1.4.[4] Whereas the atmosphere inside the International Space Station is normoxic and normobaric (14.7 psi and 21% oxygen), the American spacesuit circulates pure oxygen pressurized at 4.3 psi (about 0.3 atm).[3] As a consequence, astronauts prebreathe oxygen for 4 h to wash out nitrogen from body tissues (to reduce the partial pressure in the tissues) before depressurization, with the option to enhance denitrogenation with physical exercise.[3,4] For a Mars mission that will potentially have almost daily extra-vehicular activities, 4 h of prebreathe time for each spacewalk will be operationally impractical.

Several solutions exist: lowering the ambient pressure of the habitat (at the cost of increasing the fraction of inspired oxygen and flammability) or raising the suit pressure (at the cost of increasing suit rigidity and the metabolic cost of movement).[4] Pretreatment with hyperbaric oxygen before decompression may also be effective in reducing the incidence of decompression sickness, although the evidence remains limited to animal models.[5] It is estimated that an atmosphere in the habitat of 8.0 psi and 32% oxygen would eliminate the need to prebreathe.[4] Another solution might come from innovative hybrid suit design, combining "mechanical counter-pressure" and gas pressure.[4] Finally, "smart suits" could progressively lower their internal pressure during the extra-vehicular activity to improve flexibility while keeping the *R* ratio within acceptable bounds.[4]

The challenge of spacesuit design, and more globally of manned spaceflight, elegantly illustrates the interactions between physiology and engineering in designing life support systems, very much like the applied physiology and physics that underpins submarine and diving activities, pressurized airplanes, high-altitude mountaineering, but also the delivery of anesthesiology and critical care on Earth.

Competing Interests

The author has received speaker honoraria from GE Healthcare (Limonest, France) and consulting fees from Philips Healthcare (Eindhoven, The Netherlands).

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Epidural Anesthesia and Postoperative Delirium: Comment

To the Editor:

The recent article titled "Delirium in Older Patients after Combined Epidural–General Anesthesia or General Anesthesia for Major Surgery: A Randomized Trial"[1] explored whether combined epidural–general anesthesia reduces the incidence of postoperative delirium in elderly patients recovering from major noncardiac surgery. The authors suggested that delirium was significantly less common in the combined epidural–general anesthesia group than in the general anesthesia group. However, we have some commentary and questions for the authors on their conclusions.

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