SKIN

COMPELLING COMMENT

Space Medicine - The Next Frontier for Dermatology

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Since human space exploration began with the Vostok 1 in 1961, astronauts, cosmonauts, and taikonauts have been subjected to the effects of microgravity. Microgravity alters the normal physiology of cells and tissues observed on Earth and there are also spaceflight-related exposures that contribute to disease states. The study of these effects at the organ system level reveals several adverse effects in space voyagers, including cardiovascular dysfunction, vision impairment, genitourinary complications, and immune system impairments.[1-3]An understudied organ system, however, is the skin and the document and theoretical pathologies that might arise during spaceflight. This has ramifications for the dermatology community that have been briefly introduced in the past,[4] but have not gone into illustrating the dearth of dermatologists involved in space medicine. This article highlights some of the dermatologic complications have arisen in spaceflight and theoretical pathologies while announcing a call to action for the dermatology community to become involved in research and clinical efforts within this niche, yet rapidly growing field.

Dermatologic complaints that have been documented by the National Aeronautics and Space Administration (NASA) thus far have been relatively benign such as an episode of mild contact dermatitis after exposure to a biosensor electrolyte paste experienced by the Commander of Apollo 12.[4] Other astronauts have experienced symptoms such as dry, itchy skin, heightened sensitivity, and an increased risk for skin infections.[2] Furthermore, Kailas and Hoenig have discussed the abrasive and cytotoxic effects of lunar dust on skin cells.[5] While these conditions contribute to morbidity, they have not resulted in outright mission failure. However, consideration of more sinister theoretical ailments secondary to decreased immune system function in space should be given and the role dermatologists might play in this sphere.

Astronauts undergoing long-duration spaceflight have experienced increased latent viral reactivation measured by increased shedding of Epstein-Barr virus, varicella-zoster virus, and cytomegalovirus.[6] While the cutaneous manifestations of Epstein-Barr virus and cytomegalovirus are either benign or present in the immunocompromised and newborns, documented reactivation of varicella-zoster virus in astronauts poses concern for the possibility of zoster outbreak in spaceflight. While the astronauts who demonstrated increased viral shedding of varicella-zoster virus were asymptomatic, the combination of a suppressed immune system and the isolated, unfamiliar, and stressful space environment (further suppressing astronauts' immune systems through increased cortisol

production), may predispose to a symptomatic zoster episode.

Similarly, a decrease in cell-mediated immunity has implications for common dermatologic disorders such as psoriasis. Psoriasis is an autoimmune condition that implicates components of cellular immunity such as the major histocompatibility complex and T lymphocytes. Far from a theoretical dermatologic condition of spaceflight, psoriasis has been a documented medical complaint of astronauts during the Space Shuttle missions (1988-1995).[7] At present, dermatologic conditions, including psoriasis, are not disqualifying factors in astronaut selection. Nevertheless, careful consideration and management of this condition and similar autoimmune diseases of the skin is warranted. Abrasive/traumatic skin contact with spacesuits during training and during extravehicular activities may lead to worsening of symptoms via Köebnerization. Furthermore, as previously described, the combination of factors during spaceflight may predispose to psoriatic flares and, possibly, joint involvement during long-duration voyage far from standard medical facilities.

On another note, the effects of radiation exposure during spaceflight have implications for skin malignancies, further highlighting the role of dermatologists in space medicine. The NASA Longitudinal Study of Astronaut Health report in 2004 studied the men and women who have been selected as NASA since the formation of the space program in 1959. This study documented 33 cases of basal cell and squamous cell carcinomas, representing a three-fold increased risk compared to a control cohort. Furthermore, two diagnoses of malignant melanoma were reported, both of which resulted in fatalities.[8] While the study discusses the outdoor exposure astronauts experience during training and recreation as a contributing or confounding factor, we are nevertheless unable to discount the overall risks of being an astronaut from consideration. Despite spacecraft and suit designs that attempt to limit radiation, astronauts still experience considerable occupational radiation; it has been suggested that astronauts experience approximately 50-2,000 millisieverts (mSv) of ionizing radiation exposure during a six-month International Space Station mission.[9,10] A study by Azizova et al notes that the risk of nonmelanoma skin cancers is significantly increased in workers occupationally exposed to ionizing radiation at cumulative doses above 2.0 Sv (RR = 2.52; 95% CI: 1.60, 3.97) compared to reference group (0–0.05 Sv).[11]

Superficial infection is an additional important consideration in spaceflight and an area of expertise in dermatology. The International Space Station has been noted to be colonized with numerous bacteria, including Staphylococcus, Micrococcus, Bacillus, Streptococcus, and even some fungal species.[12] Similarly, the Russian Mir has been documented to be colonized with species such as Escherichia coli, Serratia marcescens, Legionella, spirochetes, and more.[13] The confined quarters and inability to thoroughly clean the spacecraft during missions contribute to infection risk. In fact, commonly reported is the colonization and transfer of Staphylococcus aureus species between astronauts.[14] During missions, it would be important to identify preventative decolonization measures and acute management of superficial infections. Furthermore, novel pathogenic species encountered during missions to other planets in the future may benefit from the shared expertise of dermatologists and infectious diseases specialists.

Flares of known dermatologic conditions have been documented to impact astronauts during training and even resulted in changes

in assigned mission roles. For instance, worsening of atopic dermatitis has been documented due in part to the dry conditions aboard the International Space Station.[15] Additionally, a diagnosis of idiopathic urticaria, identified prior to training or during training, would categorize an astronaut candidate as potentially unfit to fly while a history of angioedema and anaphylaxis are definite contraindications. During spaceflight, urticaria may result from decompression sickness which may occur during extravehicular activities.[16] Appropriate management, without impacting cognition, is mission-critical and would benefit from dermatologists' input. Although the previously highlighted dermatologic conditions are not an all-inclusive list, they do highlight the important role the dermatology community can play in space medicine- a role that is markedly lacking. In fact, the author of this present paper has conducted an analysis of the aerospace medicine faculty of the consortium of 12 institutions that comprise the National Space Biomedical Research Institute, NASA flight surgeon biographies, and aerospace medicine residency trainee profiles. Various specialties ranging from internal medicine, emergency medicine, neurology, urology, cardiology, orthopedic surgery, and more are represented. Notably missing from the list are dermatologists.

As humankind voyages to planets beyond and as commercial space travel have captured our fascination in recent times, the risk of dermatologic conditions manifesting in spaceflight conceivably increases. Herein serves as a call for action to the dermatology community to actively engage in the discipline of space medicine, which would greatly benefit from our specialty's expertise. The complexity of cutaneous disease in space overflows into concepts such as altered pharmacodynamic/pharmacokinetics of drugs in space, the absence of gravity influencing vehicles for topical medication delivery, cost considerations of identifying the most versatile medications/treatment modalities to transport to the space station, screening astronaut and civilian populations prior to inclusion for spaceflight, and participating in astronaut healthcare through performing skin checks and managing dermatologic diseases during training and via telemedicine with astronauts in space. These areas and more would benefit from dermatologists' contributions. Truly, by participating in space medicine, the dermatology community will be embarking on a new frontier - one that is both mystifying and far from home, but not devoid of dermatological ailments.

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