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Comments on “Space: The Final Frontier—Research Relevant to Mars”

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Dear Editor

This letter refers to the Health Physics article by JD Boice entitled “Space: The Final Frontier—Research Relevant to Mars”, in which the consequences of leaving the Earth and its protective atmosphere and magnetosphere are addressed (Boice 2017). Considering the potential differences between men and women in their lifetime risk of developing cancer and the risk of Alzheimer’s disease and dementia, Boice states that the Million Person Study (MPS) which is 10 times larger than the study of the Japanese atomic bomb survivors, will provide scientific knowledge to fill some of the current scientific gaps. Boice believes that the large size of the MPS can decrease the uncertainty in the risk estimates, narrowing the 95% confidence interval which will help astronauts safely stay for longer periods in space. Boice also highlights that to account for the uncertainties, the permissible career exposure limit set by NASA for each astronaut is a 3% risk of exposure-induced death (REID) from cancer at a 95% confidence level.

Boice states in the abstract “A critically important gap in knowledge surrounds the health consequences of exposure to radiation received gradually over time”. Such a statement does not take into consideration substantial amount of data from cohorts that have been exposed to radiation over extended periods of time accidentally or incidentally during the past several decades, including data from residents of radio-contaminated apartments in Taiwan (Hwang et al. 2006), radiation workers in the nuclear shipyard worker study in the USA (Sponsler and Cameron 2005), British radiologists who entered service during 1955–1979 (Berrington et al. 2001), and the evacuated residents of villages near Mayak nuclear weapons facility (Kostyuchenko and Krestinina 1994). In all these cohorts, following exposure to radiation over several years for mean doses ranging from ~50 mSv to ~500 mSv, cancer risk has been observed to decrease. In addition, clinical trials of repeated applications of total body low-

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Conflict of Interest

None declared.

dose irradiation over a period of five weeks independently (Pollycove 2007) or in an adjuvant manner (Sakamoto 2004) for a total dose of 1.5 Gy have demonstrated a cancer therapeutic effect of the radiation exposures whereas similar doses have been observed to increase cancer risk for acute exposures (Ozasa et al. 2012).

Though there are many publications that claim to support the LNT model or low-dose radiation carcinogenicity, they have been found to have major flaws in their data, analysis, and/or interpretation (Doss 2015). The data widely acknowledged to be the most important data for estimating radiation health effects, the atomic bomb survivor cancer mortality data (Ozasa et al. 2012), are not consistent with the LNT model because of the significant curvature in the dose-response shape (Doss 2013).

In spite of such strong evidence against the LNT model, and the poor quality of evidence supporting it, the standard practice has been to use the LNT model to fit epidemiological data. Such a procedure can mask the presence of threshold or hormetic dose-response.

The use of the linear no-threshold model for calculating the cancer risk of astronauts from radiation exposure in space is not justified and is counter-productive as it causes unwarranted cancer concerns regarding space radiation. A model based on available valid data - which support radiation hormesis - should be used to estimate such risks and would likely show that the cancer risks are not significant from the chronic exposure to space radiation.

Although not specifically addressed by Boice, solar particle events (SPEs) represent an additional radiation hazard during the Mars mission. Doses due to the SPEs (including the most significant solar flares, such as the 1859 Carrington event) can be kept below hazardous levels with appropriate shielding (Cucinotta et al. 2007).

In summary, the issue that MPS addresses, of the carcinogenic effect of radiation doses over extended periods of time, has already been addressed in other studies and many of them have shown reduction of cancers from even high radiation doses which are known to be carcinogenic when received acutely. Hence, the use of the LNT model to estimate cancer risks from space radiation is not justifiable. Based on cited data, chronic radiation that the astronauts would face during a trip to Mars is not likely to be of carcinogenic concern.

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