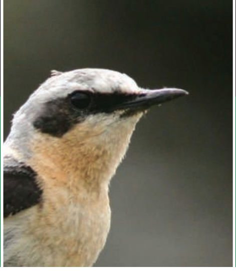

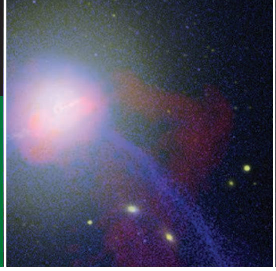

LETTERS

edited by Jennifer Sills

The Risky Road to Mars

IN THEIR REPORT "MEASUREMENTS OF energetic particle radiation in transit to Mars on the Mars Science Laboratory" (31 May, p. 1080), C. Zeitlin *et al*. try to assess the radiation risks to astronauts from exposure to galactic cosmic rays and solar flares during a manned expedition to Mars. They conclude that astronauts will receive about two-thirds of the lifetime exposure limit for humans during the round trip. I believe the dose could be even higher.

Zeitlin *et al*. did not consider the secondary effects of radiation-induced nuclear reactions in the human body. Nuclear reactions of protons and alpha particles with carbon, nitrogen, and oxygen nuclei lead to formation of lithium, beryllium, and boron nuclei. These reactions are most likely to happen for incident protons and alphas with energies between 5 and 100 MeV, particularly those between 10 and 50 MeV (*1*).

Astronaut on Mars (artist's conception)

The lithium, beryllium, and boron nuclei produced in such reactions are low in energy and much more heavily ionizing (i.e., more dangerous) than higher-energy protons or alphas. Thus, this type of radiation, below 100 MeV, is most likely to produce significant damage in human tissue. This radiation comes not only from the primary flare and galactic cosmic ray fluxes studied by Zeitlin *et al*., but also from the secondary flux of protons and alphas originating in the space capsule shielding, as well as from nuclear reactions. In the event of a significant solar flare event while an astronaut is outside the space capsule, the radiation effects would be further magnified, because the reaction probabilities are highest at energies corresponding to the solar flare spectrum.

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Response

IT IS TRUE THAT LOW-ENERGY LITHIUM, BERYLlium, and boron are produced in interactions between energetic protons and other ions with target carbon, nitrogen, and oxygen nuclei. As Viola describes, these nuclear fragments are low in energy and can have linear energy transfers of hundreds of keV/µm in water. However, such particles typically have very short ranges, traveling just tens or hundreds of micrometers in water before coming to rest. Thus, they produce very large, but highly localized, energy depositions in tissue. The biological effects of these types of energy depositions are not well known. According to the widely used International Commission on Radiological Protection Publication 60 (*1*), the quality factor—the factor by which a dose of radiation must be multiplied to estimate the associated biological damage—for this type of energy deposition reaches a peak at 100 keV/µm, then falls with increasing linear energy transfer due to the "overkill" effect, in which more energy is deposited locally than is required to kill cells (*2*). Many or most of the lithium, beryllium, and boron fragments in this category have linear energy transfers in the overkill region.

Our measurements during the Curiosity rover's transit to Mars are reported as point values of dose and dose equivalent—that is, they are the values that would be received at skin depth and not deeper in the body were an astronaut to be placed in the same radiation field. Extrapolation to points inside the body requires use of a radiation transport model, and properly constructed models (*3*, *4*) take account of all nuclear interaction products, including the low-energy light ions mentioned by Viola. Thus, transport model calculations based on our measurements can accurately include this contribution to the physical dose. How these and other contributions with high linear energy transfers should be weighted in terms of their biological effects is an open question, one that is the subject of much current research.

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CREDIT: DIETER SPEARS/INHAUS CREATIVE/ISTOCKPHOTOS

Controversial Salt Report Peppered with Uncertainty

A RECENT INSTITUTE OF MEDICINE (IOM) assessment (*1*) provoked controversy by concluding that there is a lack of evidence for health benefits of reducing sodium intake to the very low levels recommended by some authoritative groups ("Report reignites battle over low-salt diets," K. Kupferschmidt, News & Analysis, 24 May, p. 908). The IOM report was remarkable not only for its cautious analysis of the evidence—the authors said they could not define a "healthy" sodium intake range—but for its acknowledgment that salt's contribution to disease had been controversial for four decades. By contrast, in 2010, when the IOM issued "Strategies to reduce sodium intake in the United States," the committee chair stated, "For 40 years we have known about the relationship between sodium and the development of…life threatening diseases" (*2*). The new report shattered that sense of certitude. Unfortunately, instead of embracing the IOM analysis as an opportunity to pause to consider new evidence and retarget recommendations, authorities involved in the salt issue have largely dismissed, ignored, or explained away the report.

The American Heart Association (AHA) used the most aggressive message management strategy: It forcefully questioned the IOM committee's interpretation of the science (*3*). Advocacy groups and scientists associated with the campaign to reduce salt consumption adopted another tactic: They asserted that the IOM's nuanced analysis had been misrepresented in media reports that had emphasized disagreement over an issue of marginal importance—the evidentiary basis for recommending that at-risk groups totaling half the U.S. population reduce their sodium intake to 1500 mg per day, a level achieved by few consumers. They then claimed that such media reports distracted from the central message upon which everyone agreed: that excessive salt intake was perilous for health (*4*).

Those affiliated with the report itself also sought to temper the impression that the IOM had muddied the scientific waters on salt. In an unusual 3 June letter to U.S. Secretary of Health and Human Services Kathleen Sebelius, Harvey Fineberg, President of the IOM, lamented that some press outlets had "misstated" the report's conclusions and emphasized that the Centers for Disease Control and Prevention (CDC), IOM, AHA, and other authorities were "congruent" in supporting a population-wide reduction in sodium intake (*5*). Three days later, a commentary by three members of the IOM salt committee likewise stressed that the Dietary Guidelines for Americans (DGA), IOM, AHA, and the World Health Organization (WHO) were "congruent" in the belief that excess sodium intake should be reduced (*6*).

Other key players essentially ignored the IOM study. The New York City Health Department, which leads a coalition of health organizations in a partnership with industry to reduce sodium in restaurant and packaged foods, and the CDC—the agency that commissioned the report—both took this approach. Global health leaders also disregarded the IOM analysis: Two weeks after the report's release, representatives from some 200 nations at the 66th World Health Assembly adopted a resolution to combat noncommunicable diseases that included a plan to cut salt intake 30% by 2025 in an effort to achieve the WHO's sodium target of less than 2000 mg daily—a level at which the IOM said there was no evidence of health benefit (*7*).

At this moment, the mixed scientific picture of salt that now bears the imprimatur of the prestigious IOM may well be addressed by a period of self-imposed silence. But in the next year, when new U.S. Dietary Guidelines must be drafted, it is certain that opponents of strict salt regulation will use the IOM's findings to support their demands that policy recommendations be grounded in evidence of the highest caliber—a standard that those concerned with the hazards of salt assert would be almost impossible to meet.

This latest chapter in the salt saga underscores a fundamental challenge faced by policy-makers responsible for confronting morbidity and mortality at the population level: What should be done when the evidence appears to be uncertain or more complex than desirable from the perspective of public health messaging (*8*)? However challenging, we propose that a reflective policy approach, flexible enough to accommodate changing evidence, would serve the public well and reinforce the public trust in evidence-informed public health policy.

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CORRECTIONS AND CLARIFICATIONS

News Focus: "Discovery of a new titi monkey" by A. Regalado (2 August, p. 451). The name of the conservation group created by Javier García was incorrectly given as Herencia Nacional; the correct name is Herencia Natural (Natural Heritage). The HTML and PDF versions online have been corrected.

Perspectives: "Y weigh in again on modern humans" by R. L. Cann (2 August, p. 465). In the figure, Denisovians should have been spelled Denisovans. The HTML and PDF versions online have been corrected.

Editors' Choice: "Unintended consequences" (26 July, p. 319). The units for the cited concentrations of particulates should have been $\mu g/m^3$, not mg/m^3. The HTML and PDF versions online have been corrected.

News & Analysis: "Fragile wetland will test Turkey's resolve in protecting biodiversity" by J. Bohannon (26 July, p. 332). In the final paragraph, State Hydraulic Works, not the Ministry of Development, should be named as the granter of dam contracts. The HTML and PDF versions online have been corrected.

News Focus: "Indispensable outsider" by A. Finkbeiner (26 July, p. 334). In the timeline, "Brokers fast Fourier transform algorithm development" was placed in the year 1973. Garwin brokered the fast Fourier transform in 1963. The HTML version online has been corrected.

Reports: "Nuclear PTEN controls DNA repair and sensitivity to genotoxic stress" by C. Bassi *et al*. (26 July, p. 395). Ref. 15 should have been the following: C. Lee *et al*., *Cancer Res*. **64**, 6906 (2004). The HTML and PDF versions online have been corrected.

Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the past 3 months or matters of general interest. Letters are not acknowledged upon receipt. Whether published in full or in part, Letters are subject to editing for clarity and space. Letters submitted, published, or posted elsewhere, in print or online, will be disqualified. To submit a Letter, go to www.submit2science.org.