Mars mission Risk 29: Scientists research ways to reduce radiation-induced brain damage

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Among the gravest risks of a manned flight to Mars ranks the possibility that massive amounts of solar and cosmic radiation will decimate the brains of astronauts, leaving them in a vegetative state, if they survive at all.

Dubbed "Risk 29" by NASA's Mars scientists, the cosmic radiation risk remains a show-stopper because shielding a spacecraft from all radiation could make it too heavy to reach Mars, which, at its closest, is 38 million miles from earth.

Now, medical scientists have been tasked to determine the human brain's maximum safe cosmic radiation dose and to decipher precisely how radiation causes cognitive impairment, part of a quest for biological countermeasures to reduce radiation-related cognitive impairment.

The NASA-funded $14-million research project could not only help eliminate the risks to astronauts, it could unravel the biomechanics of brain damage, potentially benefiting patients with degenerative neurological conditions like Alzheimer's disease.

"This research may not only help make it safer to go to Mars, it could lead us to a deeper understanding of how the brain functions," said one of the principal investigators, Richard A. Britten, Ph.D., associate professor of radiation oncology and biophysics at Eastern Virginia

Medical School (EVMS) in Norfolk, Va. "That eventually could help patients dealing with conditions that cause dementia."

The idea of a manned mission to Mars has captured the imagination for decades, and gained force after the Astronaut Neil Armstrong took his first step on the moon in 1969. But flying to Mars, even without humans aboard, is a monumentally risky engineering feat. Since 1998, the United States has completed seven Mars missions. Four failed when the Mars landers were lost on arrival.

As part of a new push to put a man on Mars, NASA has sketched out a roadmap laying out 45 risks to astronauts in a space mission that is likely to last two years. Those risks include accelerated bone loss, motion sickness, the inability to treat minor illnesses, an inadequate quantity of food and the possibility of "interpersonal tensions" between crew members.

Risk 29 addresses the fact that Mars astronauts will be bombarded by high-energy cosmic radiation – shielded on Earth by the atmosphere and the Van Allen Radiation Belts – that few medical scientists have studied.

"These are very obscure kinds of radiation that on Earth we would only see in the event of a nuclear disaster," said Britten.

To made matters more complex, one possible trajectory involves flying around Venus and using its gravitational pull to sling the spacecraft toward Mars. That means flying closer to the sun and spending months on the opposite side.

"The sun is basically a big nuclear reactor," said Britten.

The scientists hope to determine how much shielding the spacecrafts and astronauts will need, and also develop other countermeasures that to help

reduce radiation-induced brain damage.

To help determine the brain's maximum acceptable dose of solar and cosmic radiation, Britten's team must replicate the type of radiation astronauts will be exposed to in deep space. They then must calculate how much damage is caused by particles with various energy levels.

"There are only a handful of laboratories in the world where these kinds of high-energy particles can be produced," Britten said. His team will be work closely with scientists at Brookhaven National Laboratory in New York.

As part of his $1.2-million segment of the study, the EVMS team will measure physical and behavioral changes in rats exposed to various levels of the type of radiation that Mars astronauts will encounter in space. They will also conduct proteomic analysis of portions of the irradiated brains to obtain more precise details about the biochemical changes.

To date, many scientists have suggested that reduced cognitive impairment results solely from the death of the brain's neurons. Britten believes other, more complex mechanisms are at work, processes that could be manipulated by NASA's medical staff.

"Once we understand what's not working, then maybe we can fix it," said Britten.

Because radiation damage is similar to the free-radical injury resulting from aging and other neurological diseases, the research could lead to better treatments for conditions like Alzheimer's disease that cause progressive dementia.

Source: Eastern Virginia Medical School