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Space flight

Radiation threat to Mars astronauts

Simulated doses on a 1000-day mission exceed the safe limits set by space agencies

Alex Wilkins

A CREWED mission to Mars would expose astronauts to radiation levels higher than the safe limits set by space agencies, even with metal shielding, simulations have revealed.

There have been real-world and simulated studies of radiation doses in space, but these tend to be either time-limited or restricted in scope, such as only accounting for specific organs or focusing on men only.

"Many calculations took a very simplistic approach, but we have done it in a more comprehensive way," says Dimitra Atri at New York University Abu Dhabi in the United Arab Emirates. "I wanted to know exactly what these numbers are so that I could make up my own judgement whether such missions are safe or not."

Atri and his team bombarded virtual models of male and female bodies with solar bursts and certain types of cosmic radiation using software designed to let particle accelerators track how particles move through matter.

They then estimated radiation levels for more than 40 body parts and organs during a Mars mission with 600 days spent in space and 400 days on the Martian surface, with and without aluminium shielding in the spacecraft.

Many of the radiation levels for individual organs were found to be above 1 sievert, which is the safe cumulative dose for an astronaut's career set by the European and Russian space agencies. NASA's guidance says the total career radiation dose shouldn't exceed 0.6 sieverts.

Atri and his team then looked at the pathological effects of similar or lower radiation doses in the real world, such as in nuclear accidents, radiotherapy and medical studies. They found that even lower doses than their estimates could cause memory problems, thyroid cancer and cardiovascular problems (arXiv, doi.org/h7x9).

However, the results don't account for differences in how individuals might respond to the same dose of radiation. "These doses are in a grey zone, which is about 1 sievert," says Atri. "So it is certainly risky, and there will be a fraction of astronauts who are going to have a higher probability of getting cancer or maybe other diseases because of this, but maybe some will be fine."

Having this sort of data is important for any future space missions beyond Earth, says Libby Jackson at the UK Space Agency. She adds that her agency and others are working on ways to mitigate radiation, such as building shelters under the Martian surface and more advanced shielding on spacecraft.

The dangers of space radiation might be even worse than Atri's findings suggest, says Keith Siew at University College London. Cosmic radiation includes charged particles that are heavier than protons or helium, which aren't accounted for in the analysis. The effects of these heavy particles on the body, for which we have limited data, could be far more damaging than those of other radiation sources, says Siew. ▮

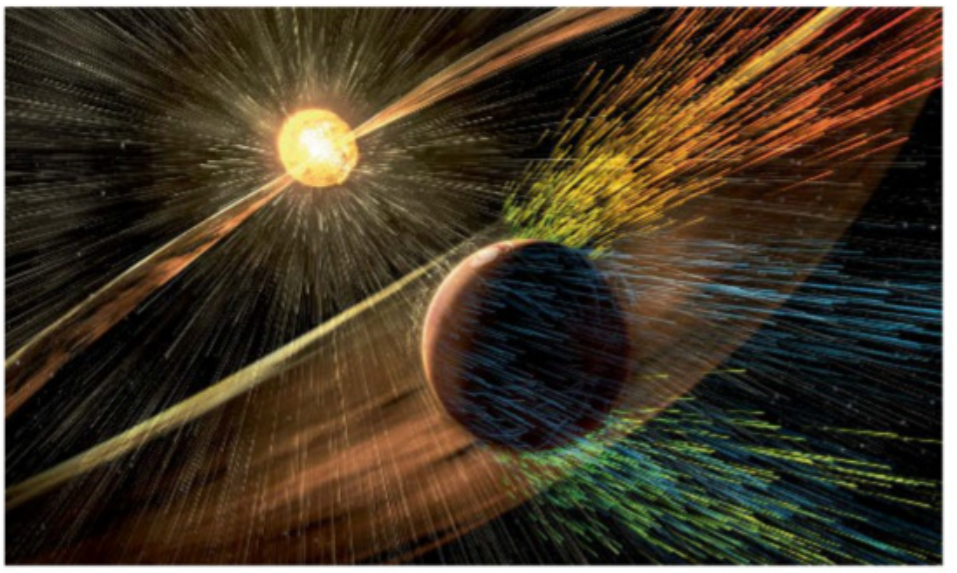

Illustration of Mars being bombarded by radiation from the sun

SCIENCE HISTORY IMAGES/ALAMY

Biotechnology

Cornea made from pig collagen may restore sight

CORNEAS made from pig collagen have restored sight for people who were previously legally blind or visually impaired.

More than 12 million people globally have corneal blindness, which can occur when the eyes' protective outer layer becomes cloudy or misshapen from damage or disease. Because corneal transplants normally require a human donor, only 1 out of every 70 people in need receive one.

Mehrdad Rafat at Linköping University in Sweden and his colleagues manufactured a flexible yet resilient dome that resembles a contact lens by extracting and purifying collagen from pig skin. Following successful trials in pigs, the team began testing the artificial corneas in human volunteers.

All 20 people in the trial had corneal blindness caused by a condition called keratoconus, in which the cornea thins and bulges outward from the centre of the eye. Fourteen were legally blind and six had severely impaired sight.

The procedure improved vision in all of the participants. Three of the formerly blind participants had 20/20 vision afterwards (*Nature Biotechnology*, doi.org/h7vj).

"We got much better results than we expected," says Rafat. Two years after the operations, nobody reported serious complications or adverse side effects.

Esen Akpek at Johns Hopkins University in Maryland says

"Three of the formerly blind participants had 20/20 vision following the procedure"

people with keratoconus can often be fitted with custom contact lenses, and that previous alternatives to donor corneas haven't taken off. "It will not cure anyone that cannot be cured with the currently available technology," says Akpek.

Rafat isn't sure what the final cost of the procedure will be, but says it should be more affordable than donor transplants, which can cost tens of thousands of dollars. Further clinical trials will be needed before the cornea could become more widely available. ▮

Corryn Wetzel