CLINICAL COMMUNICATION TO THE EDITOR

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Moon Walkers and Urban Pollution

To the Editor:

Despite 50 years of experience in space, only about 530 individuals have ventured into this dangerous environment, and only 12 have been subjected to the hazards of the moon. With the recent loss of Neil Armstrong, who, on Apollo 11 was the world's first moon walker, vital information has now become available.

Due to the National Aeronautic and Space Administration's (NASA's) restriction of independent access to medical data, there could be no independent analysis of the 8 moon walkers who remain alive. Now, for the first time, a comparison can be made between the shortest lunar mission and one of the longest missions—Apollo 15, involving James Irwin—with, in turn, greater dust exposure for much longer durations in the habitats until return back to Earth, and significant differences in predisposing factors for endothelial dysfunction.

The combination of dust inhalation and invariable reductions of a vessel dilator, atrial natriuretic peptide, could have been responsible for Irwin's severe stress test hypertension of blood pressure (BP) >275/125 mm Hg on the day after return.[1,2] But also, Irwin showed a single resting blood pressure of 145/110 mm Hg a month before his mission. A contributing factor, conducive to magnesium (Mg) loss with heat exposure, is that Irwin did not properly set the cooling temperature of his space suit (personal communication, Mary Irwin), while experiencing noon temperatures of 121.1°C (250°F). In addition, Apollo 15 astronauts in training were exposed to "intense summer heat" conducive to an Mg loss from sweating and renal Mg loss—compounding invariable Mg deficits with space flight. In addition, there was no access to water due to a malfunction of Irwin's in-suit water device.[1,2] Neil Armstrong, on the other hand, showed a significantly elevated stress test—diastolic BP during a bicycle stress test, providing greater BP accuracy by arm support than on a treadmill—the day after splashdown (up to 160/135 mm Hg); this is consistent with ischemic left ventricular dysfunction with a specificity of 100% in a study of 102 subjects.[3] This necessitates comparison with a resting BP of 110/85 mm Hg a month before lift-off, with no resting BP after return available—before the stress test; a difference of diastolic BP in comparison with the resting level, far above the cut-off abnormal level >15 mm Hg.

When I discovered 6 years ago that Irwin returned from his Apollo 15 mission with a stress test BP of >275/125 in just 3 minutes on the day after return from his 12-day mission, and that both David Scott and Irwin experienced several cardiovascular complications from inhaling dust brought into the habitats on their space suits—with impairment in cardiac function, manifested by abnormal stress tests in both[4]—I was puzzled because these complications had not been reported with the other 5 Apollo missions. I had attempted to explain this with the assumption that the variation in the quantity/quality of dust was responsible; that this was triggered by the variations of the 6 lunar locations. NASA apparently was puzzled as well, and considered Apollo 15 an "anomaly." Now, with the discovery, via information provided by NASA through the Freedom of Information Act (FOIA), that Neil Armstrong had also experienced, following his 8-day mission at age 38, evidence consistent with impairment in left ventricular function, I realize that I had been mistaken.

Now we have evidence, which I also obtained through the FOIA, that a 4th astronaut, Alan Shepard, the oldest at age 47 years, also showed an abnormal stress test, with a drop in his BP from a maximum stress test level of 210/85 mm Hg at the 16th minute, down to 185/70 mm Hg (**Table**).

I was not able to obtain comparison data from NASA regarding the 4th deceased moon walker, Pete Conrad, following his Apollo 12 mission, because none could be located even after a follow-up letter. Because the aging process of the cardiovascular system in microgravity is 10 times faster than on Earth;[5] with the exposure to urban pollution reaching life-threatening levels in Beijing, for example, we should take advantage of this discovery by conducting research on the International Space Station with rats, exposing them to urban dust for perhaps 4 hours per day. After exposure of humans to urban pollution, the diastolic BP has been shown to rise significantly in just 2 hours.[6]

It has been established that, on Earth, the ideal Ca:Mg intake ratio should be 2:1.[7] However, in microgravity, due to significant differences in bone metabolism, invariable

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Requests for reprints should be addressed to William J. Rowe, MD, Medical University of Ohio at Toledo, 1485 Bremerton La., Keswick, VA 22947.

E-mail address: rowerun@aol.com

Table A comparison of lunar cardiovascular complications of Armstrong and Irwin.

	Total Duration	Lunar Surface	EVA	Complications
Armstrong	8 days, 3 hours	21.5 hours	1 (2.5 hours)	H (diastolic)
Irwin	12 days, 7 hours (O)	67 hours	3 (5-7 hours each)	A, B, C, D, H, S

A = angina, classical, during reentry; B = bigeminy; C = cyanosis during stress test; D = dyspnea, severe during reentry; EVA = extravehicular activity; H = hypertension; O = orbited moon 48 hours before return; S = syncope during bigeminy.

malabsorption, depletion of storage sites for Mg in bones (60%), and skeletal muscles and soft tissue with, in turn, an invariable significant serum Mg deficit, there would be a difference in the ideal Ca:Mg intake ratio.

A study would require first establishing a favorable Ca:Mg intake ratio in exercised rats in microgravity[5] by evaluating their white blood cell telomere lengths and telomerase levels in microgravity, with age-matched rats for comparison on Earth; then repeating the study in exercised rats while subjecting them to urban dust pollution. This may require a 6-month period because that duration might be required to determine life-span changes.[5]

In those rats that do not survive for that duration, telomere lengths and telomerase levels could be determined in the vascular cells of their organs.

William J. Rowe, MD
Fellow, British Interplanetary Society
Department of Medicine
Medical University of Ohio at Toledo
Keswick, Va

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