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*EDITORIAL*

# Neil Armstrong's Lunar Diastolic Hypertension

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Neil Armstrong showed a significantly elevated stress test - diastolic Blood Pressure (BP) during a Bicycle (B) stress test on return from his historic lunar mission; use of a B, provided a considerable advantage over a treadmill for BP accuracy with the test, the day after splashdown. There was a remarkable elevation of the diastolic BP (160/135 mmHg), consistent with ischemic left ventricular dysfunction since, in comparison with a resting diastolic BP of 110/85 a month before lift-off with no resting BP available before the stress test, there was a 50 mm difference; far above the cut-off abnormal level of > 15 mmHg --- with 100% specificity. This abnormal response of the diastolic BP probably reflects a deterioration of myocardial function [1-4]. At age 39, Armstrong may have had in addition coronary artery disease, but not coming to light until his first myocardial infarction at age 61. With catecholamine levels, twice Earth supine levels, invariable Space reductions of serum Magnesium (Mg) ----- despite poor sensitivity in serum --- with vicious cycles between the two, invariable dehydration with lack of thirst, elevations of angiotensin and in turn catecholamines, endothelial leaking of plasma (mostly water), it should not be surprising that Armstrong's lunar dyspnea and tachycardia are consistent with catecholamine (takotsubo) cardiomyopathy [5,6].

I have emphasized that this deterioration of cardiac function, occurred BEFORE Armstrong's entering into the lunar habitat and exposure to highly toxic lunar dust inhalation brought into the lunar module on the space suit and inhaled until completion of the 3 day journey to Earth. Lunar dust was found to be highly toxic because of its high iron content which could be taken up by a magnet. It is a unique portion of the regolith on the moon, consisting predominately of impact produced glass with nano-sized metallic iron particles. The invariable reductions of Mg with space flight, contributes to inability for transferrin to bind tightly with iron, keeping it out of harm's way [6,7].

This, in turn, precipitates the release of potentially deadly hydroxyl radicals, conducive to oxidative stress, with endothelial injuries. There is substantial epidemiological evidence, implicating air pollution, particularly particulate matter as a major risk factor with serious health consequences. The primary concern is the particles that are equal or less than 10 um in diameter. Because of their small size, these particles are inhaled deeply into the lungs, with a portion deposited in the alveoli, into the pulmonary circulation and then, presumably systemically [8].

Epidemiological studies show that there is an association between airborne particulate matter and cardiovascular morbidity and mortality. There is evidence of acute cardiovascular effects in instrumented large animals, exposed to concentrated ambient particles. Furthermore, new research tools are available, particularly heart rate turbulence, non-invasive measure of baroreceptor function and T wave alternans, indicating susceptibility to life-threatening arrhythmias [9].

The Apollo 15 mission, triggered numerous arrhythmia complications, shown by telemetry, exemplified by Irwin's brief syncope with bigeminy while transferring from the lunar to the command module; the syncope lasted for about 30 seconds. Also, Irwin's stress test-cyanosis of nail beds after return, supports my "Apollo 15 Space Syndrome" [5].

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With urban pollution, what is the role of iron? [6] Childhood blood pressure is an important predictor of hypertension and cardiovascular disease in adulthood. Exposure to particulate matter constituents, in particular iron, may increase blood pressure in children based on the PIAMA study [10].

Much of the urban pollution, regarding iron, seems to be coming from iron released from brake linings, for example. Among non-exhaust sources, brake wear can be a significant particulate matter contributor. Many studies have shown high particle concentrations in the fine fractions. A considerable mass of wear particles were found in diameters smaller than 0.1 um. Most researchers have reported IRON, copper, zinc, lead to be the most abundant metals in the brake lining [11].

Based on my own experience with 4 trips to China beginning with my first to Beijing in 1988 in contrast to my last to Beijing in 2011, I have witnessed a dramatic change regarding both the number of automobiles and the pollution. Whereas, in 1988, I saw at the most 10 cars (all government) per day in Beijing, now thousands of new cars are sold there, daily. In 2011 in Beijing, I couldn't see the street for 3 days from my 9$^{th}$ floor hotel room. With my last trip, my 4$^{th}$ to China, (Haikou) in 2013, I became ill, confined to bed for 3 days with extreme somnolence and persistent non-productive cough. Since Armstrong's cardiovascular lunar complications occurred after only a single lunar excursion, it begs the question as to what might the cardiovascular complications stemming from several lunar excursions and of longer durations. The experience of Irwin, with three lunar excursions on Apollo 15 provides further troubling complications. Irwin returned from his longer lunar mission with extraordinary hypertension (275/125) after only 3 minutes on a bicycle stress test the day after return. On the day of return, his cyanosis of the nail beds supports the "Apollo 15 Space syndrome"; I postulated that the severe fingertip pain during space walks, provided a warning of ischemia in the absence of angina [5]. The blue fingertips during a stress test on return could be trapped venous blood secondary to oxidative stress-induced endothelial injuries.

With longer missions in the presence of malabsorption and no subcutaneous replenish able device to administer Mg and pharmaceuticals, the complications will certainly become intensified with an increasing risk of a fatality. Correcting Mg deficiencies may prolong life [12-14].

A recent study [15] has shown that the combination of mechanical stress and the absence of molecular oxygen and water, which are important characteristics on the moon, may lead to increased production of reactive oxygen species. As I emphasized above, in the presence of iron, particularly conducive to deadly hydroxyl radicals and with the insufficient protection of transferrin in the presence of a severe Mg deficit, this combination is indeed deadly; this is particularly disturbing with a Mg deficiency in at least 60% of Americans and throughout the world [14].

Potentially fatal lunar complications may occur unless some method is developed to entirely prevent the hazards of lunar dust by removing the space suit in an airlock before entrance into the habitat. As for the urban population hazards, the information derived from Man's lunar experience plays an important role in our understanding the life-threatening hazards of urban pollution and the role of iron.

## Conclusions

Neil Armstrong's single space walk, triggering heart failure, followed by inhalation of deadly lunar dust, exemplifies the problems encountered on Earth with progressively increasing urban pollution and exposure to automobile brake iron laden dust. The latter ties in with Armstrong's bicycle stress test on Earth return with diastolic hypertension, indicating impairment in cardiac function. Furthermore, the investigation of children exposed to inhalation of iron particulate matter, portends hypertension in adulthood. Irwin's 3 lunar excursions were more hazardous than Armstrong's single excursion with on return, his extraordinary stress test hypertension and stress test-cyanosis of nail beds. This provides a clear wake-up call regarding the hazards of urban iron-laden particulate matter and the increase of urban pollution, witnessed by the author's 4 trips to China with progressive pollution over a 25-year-period.

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