ASTRONAUT'S HEART

Recent media coverage of the 50th anniversary of the Moon Landing (July 22, 1969) prompts me to recall something about which I had some knowledge - very indirectly! It involved the heart history of astronaut Ed White who on June 3, 1965 was the first American to walk in outer space. A year and a half later (January 27, 1967) he was one of three astronauts who died of asphyxiation when a fire broke out in their space capsule while on the launch pad at Cape Canaveral - the others were Gus Grissom and Roger Chaffee.

For two years in1964-1966 I was a half-baked physician assigned to Walker AFB in Roswell, New Mexico. For much of that time I was the only internist at that desert outpost despite having had only two years of residency training. Indeed, my only connection with the outside medical world was 200 miles south in El Paso where Col. Robert Moser was chief of medicine at William Beaumont Army Hospital. Moser was sympathetic with my professional isolation and generous with his support and I soon came to think of him as a role model. (Later he became editor-in-chief of *JAMA* and president of the American College of Physicians.) What I didn't know until quite recently was that during that same period my mentor Bob Moser also was closely connected with the space program.

As Dr. Moser wrote in a memoir some four decades later, as a flight surgeon for NASA one of his responsibilities was to determine the fitness of astronauts for the Mercury and Gemini programs. One of them was Ed White who while at West Point had barely missed qualifying as an Olympic 400 meter hurdler. Moser found him to be "the fittest of all the astronauts" and he needed to be because White was selected to be the first American to walk in space and no one knew what physiologic stress that might entail. But there was a problem. Ed White's resting heart rate was only 52, maximum after exercise 70, and some senior officials feared that might cause him to faint during extra-vehicular activity. He was about to be bounced from the Gemini program, but Moser was aware that a slow heart was merely a sign of excellent physical condition.

During the 1940s Paul Dudley White had studied the NYU track star Les MacMitchell when he enlisted in the Navy and his resting heart rate was only 37 (Many years later, Bjorn Borg's resting pulse was reported to be 35.) So Bob Moser and Ed White devised a secret plan. As Dr. Moser described in his memoir, three days before the launch, the two men went to an isolated room and ran a continuous EKG both at rest and while running in place. Then White swallowed a low-dose of atropine sulfate and within a few minutes his resting pulse rose from 56 to 64; his mouth got dry, his pupils dilated and the whole effect passed in about 20 minutes. So Moser gave him three atropine tablets to carry on the flight and instructed him that if monitors at Houston found that his rate had dropped to 50, he would swallow one pill. During the flight his heart rate never went below 62 and during extra-vehicular activity it rose to around 80, so he never needed to pop a pill.

Now fast forward to February, 1968, one year after the tragic Apollo I fire that took the three astronaut's lives and about a year before Neil Armstrong's historic moon landing. By then my two year stint in the Air Force was completed and as a perk of my cardiology fellowship at Mount Sinai Hospital in NYC, I was encouraged to attend the annual meeting of the American College of Cardiology in San Francisco. The featured speaker that year was Dr. Christian Barnard of South Africa, who three months earlier had performed the first human heart transplant, and he received a standing ovation.

I was especially impressed with a relatively obscure cardiologist from the University of Florida, Dr. Robert S. Eliot, who presented a radical new idea about a possible cause of coronary heart disease. He reported on the apparent paradox of myocardial ischemia occurring in young women who had normal coronary arteriograms. Eliot discovered that they had abnormal dissociation of hemoglobin and oxygen - the oxygen bound to red blood cells arrived all right but didn't get released.

Six years later I published a review article ("Oxyhemoglobin Equilibrium in Ischemic Heart Disease," *Journal of the American Medical Association,* August

12, 1974.) No one seemed to be impressed, except me, and by then even Bob Eliot seemed to have lost interest. He was on to something else that I'll soon describe but, again, what I didn't yet know was that this bold cardiologist also was associated with NASA at Cape Canaveral.

Several years later I again heard Dr. Eliot speak at a cardiology conference and this time was amazed at his description of certain unexpected findings from Ed White's autopsy. Writing now, some four decades later, I vividly remember that Eliot projected cross-sectional slides of the astronaut's three major coronary arteries each of which showed almost total occlusions. I recall he speculated that perhaps White's long career as a test pilot had subjected him to extreme and chronic stress. In the earlier talk that I'd heard in San Francisco, Dr. Eliot had described how women with normal appearing coronary arteries could have heart attacks and how a superbly fit astronaut, who had none of the usual known risk factors, could perform for some 20 minutes in space despite having major coronary disease. Again I was impressed that Robert Eliot seemed to be thinking outside the box.

The official report of astronaut White's autopsy was never released and in his lengthy memoir *Inside the Space Race. A Space Surgeon's Diary,* Dr. Lawrence Lamb, the key medical scientist of the man-in-space program, made no mention of it. Indeed, Dr. Lamb had ample opportunity to describe the findings since for 24 years he wrote a nationally syndicated daily newspaper column. Nevertheless, rumors persisted that Ed White had significant coronary artery disease. It's remarkable that the only discussion I could find on-line was an obscure blog called *collectSPACE* in which between 2002 and 2009 various people of dubious credibility weighed in. One posting quoted my friend Colonel Moser (remember he had cleared White) as denying knowledge of abnormal post-mortem findings. However, another posting reported that science writer Al Marsh in a column in *Today* (?) dated March 26, 1972 quoted a NASA official as saying that "the late Ed White…had performed America's first spacewalk despite a severe heart condition that neither he nor NASA doctors knew about." The blog continued:

Dr. Lawrence Lamb, a former NASA doctor, said in a telephone interview from San Antonio [that] White had severe blockage of one coronary artery due to fatty deposits containing cholesterol. The other artery, Lamb said, had enlarged itself to provide an adequate blood supply to the heart muscle. White's severe heart condition was not learned until after the January 1967 Apollo fire.

Dr. Lamb admitted that he had not seen the autopsy but heard of its results through professional sources and speculated that White's superb physical condition "forced his heart to enlarge the one remaining coronary to compensate for the blockage." But why hadn't Dr. Lamb mentioned anything about this in his memoir?

NASA life sciences director Dr. Charles Berry reportedly said that he and other doctors had ordered that special attention be paid to White's heart during the autopsy (?because of the previous concern about his slow heart rate) although before the space walk they'd found nothing during exercise testing to indicate any problem. Chuck Berry didn't recall anything in the report about blockage of a coronary artery and expressed surprise that any doctors outside of NASA might know about the report. (a cover-up?) The same blog cited above, mentioned "a Gainesville cardiologist" (presumably Dr. Eliot, by then working at the University of Florida) who also "heard reports of White's heart condition over the years." Supposedly, that doctor believed that White could have had a heart attack at any time and his case showed that it is possible to have an undiagnosed heart condition.

Dr. Eliot's interest in this subject was kindled in about 1967 when he became a consultant for the space program at Cape Canaveral. During the 1960s there was an extraordinarily high incidence of heart attacks and sudden deaths among young men working on the man-to-the-moon project. Eliot launched an eight year study of these men and autopsy studies of those who died revealed that in 85% of cases the myocardium (heart muscle) had lesions called "contraction bands" - a kind of damage that in animal studies resulted from a large outpouring of

catecholamines, stress-induced chemicals produced by the adrenal glands. Similar lesions had been described in test pilots and also in others who apparently died from fright or emotional shock. These catecholamine-induced lesions could be prevented in dogs by pre-treatment with beta-blockers.

Dr. Eliot noted that Congress made budget cuts after each successful Mercury or Gemini launch and, as a result, about 15% of the highly-specialized technical work force were dismissed; between 1965 and 1973 the skilled work force was cut from 30,000 to 14,000. Unable to find suitable jobs in private industry, these professionals and their families led the nation in drinking, drugs and divorce; one month they were putting in 16 hours days and the next they were out of work or if lucky doing menial jobs. There was a surge in suicides and cardiac related deaths and, as Eliot remarked, “More people died when people were fired than when rockets were fired.”

After Dr. Eliot, himself a life-long workaholic, suffered a heart attack at age 44, he decided to focus his research on how unrelieved or repeated physical or mental stress can be directly harmful to the myocardium. By then he headed a Life Stress Simulation Laboratory at the University of Nebraska and with his team was able to identify a subgroup, about 20% of more than a thousand seemingly healthy men and women when exposed to various kinds of stresses over-responded with major increases in blood pressure, cardiac output and blood vessel resistance. In them the heart was pumping hard against great resistance, akin to driving a car at top speed with the brakes on.

Outward behavior was a poor indicator of so-called hot or cool reactors, perhaps explaining why hard-driving people with Type A personalities don’t get heart disease while some more relaxed Type B personalities do. Some of those who appear externally calm really are seething inside, or as Jane Brody described when reporting Dr. Eliot’s work in the *NYTimes,* there was “turmoil beneath the calm.”

During the 1980s Robert Eliot published many articles and four books in which he described how traditional risk factors account for only about half the cases of coronary heart disease and that stress may turn out to be the most important factor of all. He noted that cardiovascular reactions to stress had evolved to help animals to either fight or flee in response to danger and by running away the effects of stress on the heart were dissipated. But today, “in most of our daily frustrations and no-win situations, there is no one to slug and nowhere to run.” If an intense state of cardiovascular readiness is sustained for long periods, ultimately it can produce damage. The title of one of Dr. Eliot’s books provided this challenge for all stressed-out people: “Is It Worth Dying For?”

ADDENDUM: My brother, Dr. David Nevins, suggests not to forget “Takotsubo Cardiomyopathy” - sometimes called “broken heart syndrome.” First described in Japan in 1990, more than 90% of reported cases are women ages 58 to 75. It is barely known in the United States and rarely diagnosed. Fortunately, most people recover within a month with no long term heart damage. Symptoms and EKG abnormalities mimic those of a heart attack but there is no evidence of coronary artery obstruction and the condition is provoked by emotional or physical stress, e.g. loss of a loved one, domestic violence, receiving bad news.

Although the precise cause isn't known, experts think that surging stress hormones (for example, adrenaline) essentially "stun" the heart, triggering changes in heart muscle cells or coronary blood vessels (or both) that prevent the left ventricle from contracting effectively. Researchers suspect that older women are more vulnerable because of reduced levels of estrogen after menopause. In studies with rats whose ovaries had been removed, the ones given estrogen while under stress had less left-ventricle dysfunction and higher levels of certain heart-protective substances. The most common abnormality is ballooning of the lower part of the left ventricle (apex). During contraction (systole), this bulging ventricle resembles the shape of a tako-tsubo, a pot used by Japanese fishermen to trap octopuses. Presumably astronauts, like anyone else, can suffer from love sickness.

REFERENCES

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