CLASSICS IN SPACE MEDICINE

Henry JP, Augerson WS, Belleville RE, Douglas WK, Grunzke MK, Johnston RS, Laughlin PC, Mosely JD, Rohles FH, Voas RB, White SC. ***Effects of weightlessness in ballistic and orbital flight: a progress report.*** **Aerosp Med 1962; 33:1056–68.**

This Classic described in great detail the evolution and progress of U.S. space medicine from 1946 through 1962. The authors worked in the NASA Life Science Division and included in their report information from three suborbital flights (one chimpanzee, two humans) and three orbital flights (also one chimpanzee, two humans).

There had been no difficulties tolerating launch and re-entry stresses that included noise, vibration, acceleration, and splashdown impact. Graphs of the acceleration profiles for all of the flights were included and fell well within known tolerable limits (maximums of 8 G during launch and 11 G during re-entry). The exception was the suborbital flight of the chimpanzee Ham, who experienced 17 G due to a steeper than planned trajectory, but even that was well tolerated. Postflight physical examinations and pilot performance evaluations were described as normal.

The paper focused on the effects of weightlessness, as scientists had previously expressed concerns about the ability to maintain orientation (1) and vestibular function (2). However, parabolic flight experience from 1954-57 and other research led to predictions that the use of visual cues would maintain orientation and allow rapid adaptation to weightlessness. Furthermore, U.S. ballistic flights involving mice and monkeys from 1948-1952 had shown no significant physiologic effects due to short periods of weightlessness.

The Soviets had reported normal physiological function with dogs in suborbital and orbital flights as well as on four manned orbital flights. Neurovestibular function also appeared to be normal with the exception of the second flight, where cosmonaut Titov experienced sypmptoms resembling seasickness during most of his flight. The Soviets then adopted a new “diversified” program of centrifuge training and in-flight exercise and reported that the next two cosmonauts had no sickness. They also found that reentry accelerations following 3-4 days of weightlessness were well tolerated.

The paper gave details of the U.S. suborbital flights that used the Mercury capsule and a Redstone rocket, MR-2, MR-3, and MR-4, indicating that physiology was normal and performance was unimpaired during weightlessness. The chimpanzee orbital flight of Enos (MA-5) was successful and physiological parameters, behavior, and performance tasks (extensively tested) were felt to be comparable to the preflight data and centrifuge runs. The data from John Glenn’s orbital flight in a Mercury capsule launched on an Atlas rocket (MA-6) showed that physiological parameters were the same as the preflight centrifuge runs with the exception of an elevated heart rate during severe reentry oscillations caused by unplanned retention of the retro-rocket pack. He displayed continuous high levels of performance throughout the flight and showed no problems with neurovestibular function, respiration, swallowing, micturation, or visual acuity. Orientation was never impaired and he did not experience any symptoms resembling motion sickness. The flight of Scott Carpenter (MA-7) confirmed those findings. Although we now know that there were serious pilot performance issues on MA-7, these were not mentioned or discussed in the Classic.

The authors concluded that there were no problems with orientation, but there might be a neurovestibular dysfunction termed “space sickness” which would hopefully be amenable to acclimation. They were still concerned that longer duration spaceflights would cause a decrease in cardiovascular function due to the loss of blood volume, changes in vascular reactivity, and pulmonary blood redistribution, which might lower tolerance to reentry acceleration. Other unknowns included potential problems of digestion, sleep disturbances, behavioral problems, and loss of bone and muscle mass. The authors speculated that exercise countermeasures could be developed to prevent bone loss and muscle deconditioning.

BACKGROUND AND COMMENTARY
by William Augerson, M.D.

I was honored to be listed among the authors on this classic paper, but writing and assembling the material was a complex effort and very much reflected the leadership of Dr. Jim Henry. Jim was an authentic genius who came from the British system of brilliant but eccentric academic scientists. Jim had done pioneering research in developing partial-pressure suits for the USAF and collaborated closely with Dr. Otto Gauer in pioneering physiology research. Together, they demonstrated the “Henry-Gauer reflex,” whereby increased intra-atrial pressure induced reflex diuresis, thus controlling intravascular volume; this led to the later recogniton of the role played by naturetic peptides secreted by the atria. We encountered this effect in a massive way in our research at Johnsville that simulated weightlessness with water immersion followed by exposure to reentry G profiles in the centrifuge. Jim did not mention any of this work in this Classic, but all of us predicted that there would be an increase in total urine volume following arrival in orbit as fluid was re-distributed in microgravity. Jim was very creative, opinionated, and usually right. He also had an interest in the neurophysiology of the religious experience.

I first became aware of Jim’s early New Mexico mouse flights when I was in medical school at Cornell and he gave a talk there. This inspired me to write several letters to the Army Surgeon General in the mid-1950s, suggesting that the Army V-2 and other ballistic missile tests should support biological experiments rather than sending up sand payloads to simulate warheads. He was not much inspired by this, but later on when Gen. Medaris and Dr. Von Braun pressured him for support, someone on his staff remembered the letters and put me in touch with the personnel in Huntsville and then later helped me to get an assignment to Wright-Patterson AFB.

The classic paper is a bit curt about the 1959 ballistic flight of a Jupiter rocket that carried primates Able and Baker. Although the flight provided some operational and clinical experience, no performance data were obtained. The “back-story” is one of high-level Washington political concerns interfering with the ability to do science. I was involved in the design of the life support system for Able and, together with Joe Brady at the Walter Reed Army Institute of Research, had designed several suitable performance tests, trained several rhesus monkeys, and accommodated them to the restraint system. However, very late in the project, someone at a high government level learned that the monkeys had been obtained in India and felt that would pose a political problem. A Presidential decision was made—we could only use “native born” rhesus monkeys. Behavioral research was the casualty, since we had no time to train new monkeys.

We obtained astronaut centrifuge data for the Redstone profile just shortly before launch when NASA advisors insisted. We had not put much effort into that because the G levels were lower than those for the Atlas launch, but I started a crash program with several of the astronauts at the Johnsville Navy centrifuge, bumping some Ames research. This was annoying to the Ames scientists, but gave us data to compare to the MR flight data as well as experience with the onset of G that was steeper than in the Atlas training runs.

Had I been in a position to change the classic paper, it would have stated more clearly that the retro-rocket firing and reentry G would feel greater to astronauts following a period in microgravity, perhaps reflecting increased sensitivity of the vestibular system to acceleration. Some of us had anticipated something like “space motion sickness” related to both vestibular dysfunction and fluid redistribution. It is interesting that the Classic mentions some Soviet candor in reporting on this matter. I am still amazed about how long it took NASA before they publicly reported space motion sickness, which was dubbed “space adaptation syndrome” as an attempt to put a positive spin on the problem.

REFERENCES

1. Gauer O, Haber H. Man under gravity-free conditions. In: German Aviation Medicine, World War II, Vol. 1. Washington, DC: Office of the Surgeon General of the Air Force; 1950.
2. Haber H, Gerathewol SJ. Physics and psychophysics of weightlessness. J Aviat Med 1951; 22:180.

Classics in Space Medicine are selected from among more than 250 space medicine articles published prior to 1965 in this journal under its previous title, *Journal of Aviation Medicine*. The series is edited by Mark R. Campbell, M.D.

This article will be available for download from LibrarySmart via www.asma.org

Reprint & Copyright © by the Aerospace Medical Association, Alexandria, VA.

DOI: 10.3357/ASEM.26008.2009