WHITE SC, BERRY CA. *Resume of present knowledge of man's ability to meet the space environment.* Aerosp Med 1964; 35: 43–8.

In this Classic paper, Drs. Stanley C. White and Charles A. Berry summarized the operational experience of the medical team at the NASA Manned Spacecraft Center during the first three Mercury orbital flights, each lasting less than a day. The paper also discussed information reported by the Soviets from the manned flights of Vostok I-IV, one of of which stayed in orbit 4 days. At this point, the U.S. was preparing to launch its first full-day Mercury flight.

White and Berry reported that all of the American astronauts had undergone extremely thorough physical examinations and medical testing by flight surgeons and selected sub-specialists during selection and annually therafter as well as pre- and postflight. They reported that in-flight monitoring consisted of telemetry of EKG, blood pressure, temperature, and respiration supplemented with postflight analysis of film from onboard cameras. The Soviets had reported additional variables, including in-flight EEG, electro-oculography, and galvanic skin response. The only abnormal finding was orthostatic hypotension for 21 hours postflight accompanied by engorgement of the leg veins. Physiologic responses in the normal range included heart rates of 56-170 bpm and aberrant EKGs, including nodal beats, premature atrial contractions, and premature ventricular contractions. The Soviets had reported no abnormalities in physical examination, pilot performance, or the additional monitored parameters on any of their flights with longer periods of weightlessness. White and Berry noted that pilot performance in orbit had shown that "man is quite capable of adequate spacecraft control activity and that he may be relied upon as a competent link in the man-machine spacecraft systems," as a result of which each flight plan had "further reduced the automatic [spacecraft] activity and provided more necessary pilot input." However, the authors criticized then-current monitoring methods because they did not provide any data "which would tell the ground monitor whether the nervous system of the pilot was capable of the peak performance necessary."

The authors emphasized the value of evaluating multiple variables as instrumentation problems frequently dropped data or produced apparently abnormal measurements. In-flight problems with the life support system included high cabin temperature due to heat generated by the electronics as well as cabin outboard gas leaks exceeding the 600 cc/min that was considered acceptable for the Mercury capsule. Although they occupied a pressurized capsule at all times, the Mercury astronauts wore full pressure suits as an emergency back-up system; continuous improvement to those suits led to increased joint mobility and greater dexterity of the gloved hand. The authors pointed out that this allowed development of suits that could support extravehicular activity in the Gemini program, already under development.

The astronauts consumed a 2550-calorie, low-residue diet and had no problems with mastication (1), metabolism, intestinal absorption, or micturation (2). A mechanism to drain urine without loss of suit pressure was incorporated as the Mercury program progressed. Defecation was not necessary in Mercury flights, but the authors noted that the Soviets reported normal defecation on their longer flight and waste handling using fecal bags was planned for U.S. Gemini and Apollo flights.

Radiation was not a problem (3). Due to the low orbital altitude well below the Van Allen belts, Schirra received 13 mrad to the skin and 160 mrad to the eyes, which was very close to predicted. The Soviets reported that the cosmonauts on their flights received 10 mrad/day.

Despite dire predictions of the response to the "isolation" of space (4) and adverse physiological effects due to the lack of gravity (5, 6), neither the U.S. or the Soviets reported problems. Vison proved to be effective in maintaining orientation and pilot proficiency was normal in performing complex visual motor coordination tasks (7, 8). The Soviets had reported normal sleep on three flights. The nausea reported by Titov was felt to be an individual idiosyncratic response as it had not been experienced on the U.S. flights or on the longer duration Russian flights. They acknowledged that flights of increasing duration with exposure to longer periods of weightlessness would provide further knowledge, but felt that humans could operate safely in weightless flight without jeopardy, thus validating the system designs in progress for future Gemini and Apollo flights of up to 2 weeks. The authors concluded, "The flight experience indicates that the changes in man occurring while he is exposed to the space environment will be a gradual one rather than the catastrophic event predicted in some of the early literature, that no sudden and bizarre events have been seen" and "Any catastrophic event will have its origin in vehicular failure rather than with man."

Background

Stanley C. White, M.D., had a distinguished career in the USAF and aerospace medicine, including working with the Air Force's Man-in-Space and Man-in-Space-Soonest Programs. He joined NASA as a member of the Space Task Group in October 1958 and was involved in Mercury astronaut selection in early 1959 as well as development of the Mercury capsule life support system and spacesuit. He was then Director of Medical Operations until July 1962 and then Chief of Crew Systems until 1963 when he was transferred to the USAF School of Aerospace Medicine (USAFSAM) at Brooks AFB as Director of Aerospace Medicine. He was closely involved in bioinstrumentation development, radiation issues, and human factors engineering.

Charles A. Berry, M.D., had been a part of the space program since its inception. He completed his aerospace medicine residency at USAFSAM in 1952. While practicing aerospace medicine with the USAF, he became involved with the selection of the first astronauts. He served as USAFSAM's Chief of Aviation Medicine and then as the Chief of Flight Medicine in the office of the USAF Surgeon General Office before joining NASA in 1961 as a Mercury medical monitor and became the Director of Medical Operations in 1962. He was later the Director of Life Sciences until 1974.

The development of medical operations during the early stages of Project Mercury was often controversial and the authors of this Classic fought hard to keep the program in an accelerated phase (there was pressure to perform more animal flights and more suborbital flights prior to the orbital missions). They were helped by competition with the Soviet program and the success of U.S. studies of animals during sub-orbital flights on Little Joe and Mercury-Redstone. To quote from a NASA review in 1965 (9): "A universal debate concerning whether man could survive in the hostile environment of space was carried on by all of the scientific disciplines and numerous problems were identified which might jeopardize man and thereby make his chance of survival tenuous if at all possible. The fact that the problems concerning survivability originated from the varied scientific disciplines gave emphasis to their plausibility." A high-level review in 1961 was extremely critical of NASA organization and management, particularly the medical aspects. However, after several animal sub-orbital flights culminating in the 1961 flight of a chimpanzee (Ham), it was agreed that the existing Mercury spacecraft life support, environmental control, and instrumentation systems should be used without modification.

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

DOI: 10.3357/ASEM.2771.2010

We owe a great debt to the early NASA Project Mercury medical team that enabled the first manned suborbital and orbital flights to occur despite such controversy and criticism. They risked their careers and reputations with little scientific data to support them and instead worked from an operational viewpoint. Each success became the basis for further exploration into the unknowns of space medicine. Without the authors' willingness to make these difficult operational decisions, the Mercury program could have been slowed or even terminated before proving the viability of human spaceflight.

Comment by Dr. Stanley C. White

Dr. Berry and I graduated from the first residency class in aviation medicine. Upon completion, he went off into a normal track of clinical assignments, while I went into research and development assignments. I was working on pressure suits, altitude research, and supporting flight research. We rejoined our careers when Dr. Berry was assigned to be a medical monitor in Project Mercury.

Up until the formation of Project Mercury, the pilot had always been considered a given constant in the planning of flight operations. This was possible through the continuous progression of flight experience in aviation with increases in speed, altitude, acceleration, and duration. Having an experienced test pilot made it possible to avoid making the human element a variable in the test operation. However, this test model had increasingly become suspect in the several years before Project Mercury as the flight tests of the X-series of vehicles had included major advances in altitude, speed, acceleration, emergency escape, and other life support requirements and it was with this background that the X-15 and Mercury programs began. The non-flight related medical community was oriented to seeing and treating "sick people" and not healthy people in an unusual, highly stressful, and dangerous environment. Their ability to advise us on "healthy" individuals was limited and somewhat suspect. Therefore, we were entering into what is now truly pioneering steps in the field of preventive medicine, which, before this, had been oriented to the global population with large-scale statistical population research. As a result of the above, we were on a rather tight set of work constraints imposed medically, physiologically, and politically (no failures were allowed but we had to meet the schedule). Some of our advisors from outside NASA wanted us to fly 100 flights carrying monkeys and wanted a statistical demonstration of success before exposing a man to the flight. We responded to them by noting (besides taking years and impossible to fund) that animal flights are the highest risk to success because a monkey, although trained, could not contribute to the control of the craft if something went wrong, where a man could participate in the flight and override and bypass failed systems.

REFERENCES

1. Ward J, Hawkins W, Stallings H. Physiological response to subgravity - mechanics of nourishment and deglutition of solids and liquids. J Aviat Med 1959; 30:151–4.
2. Ward J, Hawkins W, Stallings H. Physiological response to subgravity - initiation of micturation. J Aviat Med 1959; 30: 572–5.
3. Schaefer HJ. Evaluation of present-day knowledge of cosmic radiation at extreme altitude in terms of the hazard to health. J Aviat Med 1950; 21:375–418.
4. Ruff GE. Psychological effects of space flight. J Aviat Med 1961; 32:639–42.
5. Armstrong HG, Haber H, Strughold H. Aeromedical problems of space travel. J Aviat Med 1949; 20:383–417.
6. Gauer O, Haber H. German aviation medicine in World War II. Washington, DC: U.S. Government Printing Office; 1950.
7. Haber H, Gerathewohl S. Physics and psychophysics of weightlessness. J Aviat Med 1951; 22:180–9.
8. Gerathewohl S. Comparative studies on animals and human subjects in the gravity-free state. J Aviat Med 1954; 25:312–419.
9. Link MM. Space medicine in Project Mercury. Washington, DC: NASA; 1965. Report No.: NASA SP-4003.