

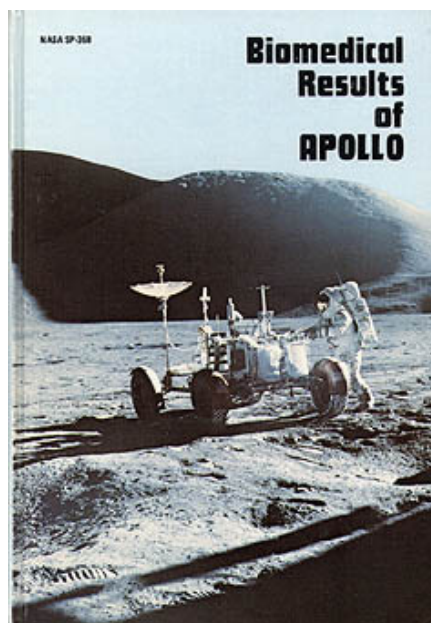


National Aeronautics and Space Administration

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SP-368

Biomedical Results of Apollo



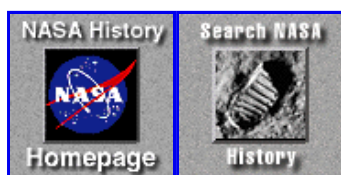
Managing Editors

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Lyndon B. Johnson Space Center

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[41] SECTION II**Crew Health and Inflight Monitoring**

The health of Apollo crewmembers was a matter of genuine concern. An inflight illness, particularly should it occur during a critical mission phase, could have had serious consequences. To minimize the chance of illness, an extensive health maintenance program was conducted to ensure the highest of health standards. This section describes the clinical practices which were followed and certain special projects conducted to obtain information bearing on the health of astronauts.

CHAPTER 1**CLINICAL ASPECTS OF CREW HEALTH**

by

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Introduction

[43] While the primary goal of the Apollo Program was to land men on the moon and return them safely to Earth, there were other very important medical objectives. The earlier Mercury and Gemini programs had raised some concerns about the health and safety of future crews. For example, the high metabolic energy expenditure of extravehicular activity during the Gemini missions was unexpected. Before Apollo astronauts could safely explore the lunar surface, reliable predictors of energy cost and real-time monitoring techniques had to be developed. Physiological changes were noted in individual crewmen, some more consistently than others. The most important of these changes was in cardiopulmonary status demonstrated by decreased exercise capacity, loss of red blood cell mass, and cardiovascular deconditioning demonstrated by a decrease in the effectiveness of antigravity cardiovascular responses during posflight stress testing.

At the end of the Gemini program, with 2000 man-hours logged in space, it was clear that man could engage in relatively long space flight without any serious threat to health. However, clarification was still required in many areas. First of all, because of the small number of individuals who flew in space and because of the variability of their responses, it was impossible to distinguish between space-related physiological changes and individual physiological variations. Secondly, for those changes which were directly related to space flight, the relatively short mission durations precluded the identification of trends.

In view of the foregoing considerations, four medical objectives were specified for the Apollo Program:

1 Ensuring crew safety from a medical standpoint. This objective required that every effort be made to identify, eliminate, or minimize anything which posed a potential health hazard to the crew.

[44] 2. Improving the probability of mission success by ensuring that sufficient medical information was available for management decisions.

3. Preventing back-contamination from the lunar surface.

4. Continuing to further the understanding of the biomedical changes incident to space flight. This objective was formulated to detect, document, and understand changes occurring during space flight.

The program to ensure crew safety commenced long before the Apollo Program itself with the development and implementation of the medical selection and screening program for astronauts. Apollo astronauts were drawn from a pool of individuals who were thoroughly screened to preclude any physical or physiological problems which would jeopardize either the mission or the astronaut candidate. Later, special measures were taken to further protect the health and enhance the safety of those astronauts chosen for specific Apollo missions. These included preflight medical examinations, a health stabilization program, drug sensitivity testing of astronauts for all medications aboard the spacecraft, and other measures.

The preflight medical program was designed to preclude, as far as possible, the development of any clinical medical problems during space flight. Since no preventive medicine program, however carefully conceived, can ever guarantee the absence of illness or disease, medications were carried onboard the Apollo spacecraft. The contents of the medical kit were revised as need indicated throughout the Apollo Program. Onboard bioinstrumentation was provided to monitor vital signs for rapid diagnosis of any physiological difficulty in a crewmember and to provide medical information required for mission management. Additional information was transmitted via voice communication between the crew and the ground-based flight surgeons. During extravehicular activity, methods were added to provide metabolic rate assessment. In addition to heart rate, oxygen consumption was monitored along with inlet/outlet temperature of the liquid cooled garment worn by the crewmen.

Opportunities for inflight medical investigations were severely restricted on the Apollo missions because of conflict with the principal operational objectives. Furtherance of the understanding of the effects of space flight on human physiological functioning had to rely almost exclusively on comparison of preflight and postflight observations. These were carefully selected to focus attention on the areas which appeared most likely to be affected, for example, cardiovascular function. Other areas were also investigated for unforeseen changes and corroborative information.

The sections which follow describe medical procedures and findings for Apollo astronauts in the preflight, inflight, and postflight phases of the Apollo missions.

Preflight Procedures and Findings

The procedures implemented in the preflight period for Apollo missions had five major objectives. These were:

1. The discovery of latent illnesses during the process of selection of astronauts and preparation for missions.
- [45] 2. The implementation of the health stabilization program and other preventive measures.
3. Determination of individual drug sensitivity to the contents of the Apollo medical kits
- 4 Providing baseline data against which to compare postflight data for determination of space flight effects.
5. Prevention of any situations which might delay or otherwise interfere with operational aspects of the missions.

The procedures performed in the preflight period ensured improved performance of flight tasks and, with rare exceptions, prevented the outbreak of illness inflight. This outcome was, in part, the result of medical screening and selection programs designed to provide physically competent crews. Observation and semi-isolation programs also helped to detect latent ailments which might have produced frank symptoms during flight. Finally, a training course was presented to astronauts to acquaint them with stresses of space flight and their effects upon the human organism.

Medical Screening/Examinations

Preventive health care in a population which has been chosen for a particular job begins with the medical selection of that population. Rigorous astronaut selection standards were established to identify:

1. Individuals who were physically capable of performing astronaut duties; specifically those possessing the necessary physical and psychomotor capabilities and not subject to incapacitating physiological disturbances when exposed to the various stresses of space flight.
2. Individuals who were free of underlying physical defects or disease processes which could shorten their useful flight careers.

Apollo astronauts were initially medically screened by techniques which varied only in minor degree from those applied to the first seven Mercury astronauts. The standards used closely approximated U. S. Air Force Flying Class I Standards, except in the selection of scientist-astronauts where visual standards were relaxed to qualify a sufficient number of candidates. These examinations were performed at the U. S. Air Force School of Aerospace Medicine, with final review and medical acceptance of candidates by the NASA Lyndon B. Johnson Space Center medical staff. Listed below are the components of the examination used for medical selection.

1. Medical history and review of systems.
2. Physical examination.
3. Electrocardiographic examinations, including routine electrocardiographic studies at rest, during hyperventilation, carotid massage, and breath holding, a double Master exercise tolerance test, a cold

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