Dr. Sherman Vinograd and His Contributions to the Skylab Medical Program

Mark R. Campbell

We often read about the historical accomplishments of many of the early researchers in the space program. They led us from a very superficial (and sometimes actually false) understanding of the pathophysiology of spaceflight to the much more sophisticated (but still embryonic) knowledge that we experience today. I recently became aware of the accomplishments of a space medicine pioneer who is relatively unknown, but had an enormous impact on space medicine research during the glory years of the space race and especially on the Skylab Medical Program.

Sherman P. Vinograd was born on January 24, 1921, in Milwaukee, WI, to Ukrainian immigrant parents. He finished his undergraduate studies in 1942 at the University of Wisconsin and then earned his M.D. at the University of Wisconsin Medical School in 1946. He was commissioned as an officer in the U.S. Navy and served in the Naval Medical Corps. He then became a pilot at the Naval Air Station in Pensacola, FL, and so was one of the few pilot-physicians in the Navy (as was Joe Kerwin, one of the Skylab astronauts who benefited from Dr. Vinograd's work at NASA).

Dr. Vinograd fulfilled the roles of the Chief of Medical Science and Technology and the Director of Biomedical Research at NASA Headquarters from 1961 until 1979 (**Fig. 1**). In this role he shaped, organized, and directed NASA's program of medical research as a well-planned program of studies. This was carried out in not only NASA laboratories, but also in university, industry, and other government laboratories all over the country. It produced a large substrate of information through its bed rest studies, vestibular, bone, neuromuscular, hematology, and cardiovascular researches. It also produced several valuable practical spin-offs, such as an accurate bone densitometer for common clinical use in monitoring osteoporosis.

He was responsible for establishing the In-flight Medical Experiments Program in preparation for the Apollo series of manned spaceflights. This program was a series of carefully designed flight crew studies derived from proposals by scientists both from within and outside of NASA to evaluate human responses to spaceflight. It consisted of medical experiments and the accompanying equipment necessary to perform them that were flown aboard the Mercury, Gemini, Apollo, Apollo Soyuz Test Project, and Skylab manned spaceflight programs. As this equipment could be carried aboard virtually any post-Apollo space vehicle by virtue of its rack and module design, it was used for many years.

Dr. Vinograd also helped expand the continuing ground-based medical research program conducted at NASA. He developed a supportive research and development program necessary to provide pertinent ground-based data and to advance state-of-the-art medical measurement technology, a major development of which was the Integrated Medical and Behavioral Laboratory Measurement System (IMBLMS).

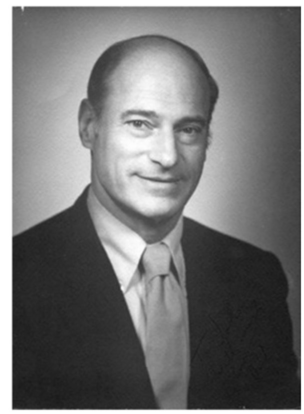

Fig. 1. Dr. Sherman Vinograd in 1964.

On September 14, 1963, NASA and the DOD signed a joint agreement that all studies and working groups involving a manned space station were to be conducted as joint projects.[2] In October of 1963, Dr. Vinograd was the founding member of the Manned Orbiting Laboratory Biomedical Experiment Working Group (MOL BEWG). This was a joint NASA and Air Force working group made up of 23 participants to address all of the life science issues concerning a future manned space station. They had five intense meetings which resulted in a final report produced on January 22, 1964. This was immediately after the 34-h Mercury flight of Gordon Cooper, but before the start of the Gemini Program, when our spaceflight experience was minimal. They identified eight critical issues and made several key conclusions:

Medical Issues Identified by the MOL BEWG, January 1964[3]

- Cardiovascular decompensation: Mercury Atlas-9 (Cooper) flew in May 1963 with severe orthostatic intolerance; Brooks AFB water immersion experiments showed extensive plasma loss.
- Mineral studies and bone loss
- Muscle catabolism
- Radiation dosage
- Vestibular dysfunction
- Sleep/fatigue
- Metabolic studies
- Countermeasures – exercise

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Conclusions of the MOL Biomedical Experiments Working Group[3]

- "Progressive cardiac decompensation due to prolonged exposure to weightlessness is highly likely and the CV system must be carefully and regularly measured."
- Needed preflight, in-flight, and postflight data collection.
- Basic chemical lab was necessary, but no other invasive medical tests.
- Critical that a physician be on board as a member of each crew.
- Ground simulation of spaceflight should be conducted for 100 d; Skylab Medical Experiments Altitude Chamber Test (SMEAT) conducted by Crippen, Bobko, and Thornton in 1972 was 56 d.
- No animal experiments would be needed.
- Atmosphere of 7.0–14.7 psi; mixed O_2/N_2.
- Minimal volume – 300 cu ft/man; MOL design was 600 cu ft/man, Skylab was 4200 cu ft/man.
- Could not make definite scientific conclusions about the medical effects until four men had experienced continuous spaceflight for 1 yr each.
- Onboard centrifuge (4–15 ft radius) will be a critical component. (This was considered a provocative test for cardiovascular decompensation, a predictor of reentry physiological performance, was felt to be an important countermeasure, and considered essential if the station did not have artificial gravity.) It is important to realize that LBNP was not invented and researched until 1964 as it essentially replaced the goals of the centrifuge.

It is interesting to compare the list of medical issues above with the actual medical experiments flown onboard Skylab in 1973:[1]

- M071: Mineral Balance (Bone)
- M074: Specimen mass measurement
- M078: Bioassay of body fluids
- M092: Lower body negative pressure (cardiovascular decompensation)
- M093: Vector-cardiography
- M110: Hematology/Immunology
- M131: Vestibular dysfunction
- M133: Sleep/fatigue
- M151: Time and motion study
- M171: Metabolic studies
- M172: Body mass measurement

The close similarities reflect that this working group was the initial basis for Skylab medical research. The MOL BEWG, its findings, and their conclusions were classified at the time as they involved the Air Force Manned Orbiting Laboratory. A recent search in the Air Force and NASA archives reveals no reference to the existence of this group or to its findings. Extensive and detailed documentation of the working group can only be found in Dr. Vinograd's archives.[3]

At the conclusion of the MOL BEWG, the Space Medicine Advisory Group was formed with Dr. Vinograd as the chair and Col. Andres Karstens (Air Force MOL Bioastronautics) as cochair. The 20 members were from the academic life science community and not NASA or the DOD. They functioned as guidance for the in-flight and ground-based medical experiments eventually proposed for the Gemini and Apollo Programs and they were the foundation for the Skylab medical research program. Although the group functioned in a continuous and dynamic fashion until the end of the Skylab Program, they produced an extensive initial report in August 1964.[4]

Clearly, Dr. Vinograd's major accomplishment during his career was in conceptualizing, establishing, and chairing the Space Medicine Advisory Group and with defining the Earth-based and space-based research and life-support requirements for a manned orbiting research laboratory which eventually became Skylab. This Group designed a carefully planned study using highly qualified, specialized members of the scientific academic community (almost all were outside of NASA). This would result in the creation of the comprehensive and well-organized Skylab Medical Program. This was then well implemented by Robert Johnson and Lawrence Dietlein at the NASA Johnson Space Center into the highly successful Skylab mission of medical research.[1] Dr. Vinograd was heavily involved from the very initial discussions in the earliest years and was the key person in planning the Skylab medical research roadmap. For this, he was awarded the Space Medicine Branch Strughold Award in 1983.

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