Skylab Biomedical Accomplishments—Paving the Way to the International Space Station

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A Beginning

As human spaceflight began to emerge in the early 1960s, there was limited knowledge on what impact there might be on the human being. Early work by the United States Air Force's Bioastronautics Program, which basically was using animal models and of course the Manhigh Studies, led to a number of questions that had to be answered. The June 6, 1960 issue of *Time Magazine* highlighted these questions and challenges, especially the 'different roads' the US and the USSR (Russians) would take. This limited knowledge was evident at the beginning of NASA in 1958, when one of the first actions were to enable the Bioastronautics Program to be point on the new field of Space Medicine for NASA. Additionally, the Central Intelligence Agency published a monograph on Space Medicine within the Soviet Space Program in late 1950s. Since this was an emerging field with limited data, this period is considered the starting point of space medicine.

During the decade of the 1960s, NASA positioned itself to land a man on the moon before the decade was out. This was accomplished through the successful programs of Mercury, Gemini, and Apollo by July 1969 with Apollo 11. Over the course of the decade, NASA learned that humans could survive and function in space. The Soviets also learned a lot through their successive missions, which differentiated from the United States (U.S.) in duration. The U.S. missions, through NASA were short term, whereas the Soviet missions were long duration, measured in months not days or weeks. The longest mission of the U.S. was Gemini 7, which lasted14 days in 1965. A key issue was how to monitor crews in space. The concept of telemedicine was integrated beginning with the Soviet Launch of Sputnik II and a dog name Laika. This permitted ground controllers the opportunity to monitor the physiological parameters of orbiting astronauts and cosmonauts during their spaceflights.

New Direction

As the U.S. successfully explored the moon with Apollo 11-17 (1969–72), plans were being developed for a space station. In fact, it was being discussed in the very early days of NASA. The buildup of the Apollo Program, left several unused Saturn V rockets. The plan was to modify these into a smaller rocket and outfit an orbiting complex called Skylab. Figure 1 illustrates the first launch system of

Figure 1. Skylab launch system.

Figure 2. Completed Skylab Station in orbit.

Figure 3. Dr. Kerwin and a medical exam in space.

Skylab. Figure 2 shows the completed system in space.

Before the Skylab missions began, a ground-based program was conducted. This program was called Skylab Medical Experiment Altitude Test (SMEAT). Concomitant with the Gemini and Apollo medical knowledge, SMEAT served as a testbed to prepare for Skylab 2, 3, and 4. Each of these missions increased in duration from 28 days to 84 days. Skylab 2 include the first physician in space, Dr Joe Kerwin. Figure 3 shows Dr. Kerwin examining a fellow crewmember. The Skylab missions provided an excellent opportunity to conduct a wide variety of biomedical experiments to further amplify knowledge about human survival and capabilities in low Earth orbit.

In preparation for Skylab and the development of the necessary medical system to be used on the station, NASA embarked on two development programs. The first was the development of the Integrated Medical and Behavioral Laboratory Measurement System (IMBLMS) (Pool 1972) . The second was a telemedicine testbed, Space Technology Applied to Rural Papago Advanced Health Care (STARPHAC). The 1960s and early 1970s were a challenging time in the U.S. for a variety of reasons. The Nixon Administration wanted to show the American public that its investment in space could be beneficial terrestrially. Consequently, NASA developed the STARPAHC project as a testbed to both evaluate technology for space and contribute terrestrial applications (Simpson 2020).

Success

The Skylab mission produced a plethora of scientific knowledge and lessons learned. Changes in several body systems, including neurovestibular, cardiovascular, endocrine, and musculoskeletal were observed. Space motion sickness was better understood and the loss of calcium, phosphorous and nitrogen were also found. While there were numerous peer reviewed publications that resulted in this work, the Biomedical Results from Skylab highlight the scientific results (Johnston, 1977; Michel, 1976). In addition to the biomedical results, the expanded volume on the station permitted more opportunities to evaluate various capabilities, including inflight physicians, more movement around the station as compared to the lesser volume available in the Gemini and Apollo capsules. Other lessons learned include dealing with an inflight mishap with the heat shield and solar array being torn away and another damaged.

Future

From the beginning of human spaceflight, its have faced many challenges. The opportunities today in both exploration and commercial development of space, continue a record pace. This growth would not be possible without the lessons from Skylab. The foundation of the International Space Station (ISS) and volume of available space is based on what the Skylab. Missions and space-based platforms for the foreseeable future will not come anywhere close to the capabilities of the current ISS. Nevertheless, all parties involved in this future will no doubt look back at those who have come before and the success and failures they encountered. NASA publish a special publication in 2017 entitled "Engineering, Life Science, and Health/Medicine Synergy in Aerospace Human Systems Integration" also known as the "Rosetta Stone Project." Edited by Williams and Doarn, it lays out a cogent argument of the conflicts that may arise between engineers, life scientists and physicians. Dr. Kerwin's position as an astronaut physician provided a strong medical presence, that remains vital to this very day.

Space flight is not for the faint of heart. One must always look at the past to learned what others did and be prepared for the unknown!

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