Development of Telemedicine and NASA's Contribution

Charles R. Doarn

In October of 1957, the Soviet Union launched a dog named Laika on an intercontinental ballistic missile. This mission, *Sputnik 2*, provided the first opportunity to monitor the health status of a living mammal while it orbited the Earth. This clearly demonstrated the ability to remotely and wirelessly monitor biomedical conditions where patient and doctor were separated. This concept of wireless monitoring did not start with Sputnik. The Germans used telemetry during World War II to monitor the V2 rockets, and earlier in the 20th century wireless technology was used to monitor the depth of the Panama Canal locks.

As human spaceflight began in the early 1960s with the Soviet launch of Yuri Gagarin, Dr. Stanley White and others from the Space Task Group gathered at Wright-Patterson Air Force Base in Ohio to begin the development of the necessary systems to monitor astronauts in spacecraft in support of *Project Mercury*. While not called telemedicine yet, this capability of monitoring an astronaut in space from the ground and providing a level of medical guidance led to new ways of practicing medicine on the ground. Medical capabilities, including telecommunication links with the ground evolved from one program to another as mission duration and complexity increased. Concomitant to space-based efforts, ground-based efforts began with the use of satellites for educational and medical activities, live surgical transmission in 1964 (Michael DeBakey's Early Bird), in Alaska for remote healthcare, and in support of disasters, including earthquakes (1985 Mexico and 1988 Armenia).[2]

As the *Apollo* program was coming to an end, plans were put in place for a space station program (*Skylab*) and a joint docking mission with the Soviets (*Apollo-Soyuz Test Project*). In support of *Skylab*, researchers at the Manned Spacecraft Center (now Johnson Space Center) developed a telemedicine project to evaluate technology in the desert of Southern Arizona. Space Technology Applied to Rural Papago Advanced Healthcare (STARPAHC) provided an excellent test bed to evaluate technology for possible use in space.[2,3]

As a result of NASA's efforts in space medicine in the late 1960s and early 1970s, a Joint Working Group was established between the U.S. and the U.S.S.R.[1] Over the next several decades, the group of space medicine and life sciences experts worked closely together in a variety of activities. One area of mutual interest was telemedicine. In 1989, NASA worked closely with its Soviet counterparts to use telemedicine to support disaster response in the aftermath of the Earthquake in Armenia.[5] In the early 1990s, the results of the Spacebridge to Armenia led to a number of key activities between the U.S. and Russia. The immediate follow-on projects, the Spacebridge to Moscow and the Spacebridge to Russia, led to the development and evaluation of Web-based telemedicine.[2] Healthcare across the Internet potentially could be accomplished anywhere in the world. When the Spacebridge to Russia was conducted in 1994, using Netscape 1.0 and the World Wide Web, there were not many web sites available or an awareness of what the Web was.[4,6]

During the early part of the Clinton administration, there was a big push to develop the Web as a tool for government, and healthcare was no different. In 1997, NASA was one of the first agencies of the U.S. Government to develop a strategic plan for telemedicine. This in part was directed by NASA Administrator Goldin. An implementing step of this plan was to create a Commercial Space Center that was focused on medical informatics and telemedicine. This was established initially at Yale University and then at the Medical College of Virginia at Virginia Commonwealth University. Over a 10-yr period, this center developed partnerships with government, industry and academia, pushing telemedicine forward. The researchers involved in this effort conducted research initiatives on Mt. Everest, Haughton Crater (Mars Flashline), the Space Biomedical Center/Institute for Medical and Biological Problems in Moscow, NASA Extreme Environment Mission Operations (NEEMO 7, 9, and 12), and in the jungles of South America, resulting in an impressive collection of peer reviewed literature.[7] In many of these activities, researchers pushed the boundaries of information systems, telecommunications, robotics and sensor technologies in alpine environments, under water, the jungle, and in parabolic flight.

NASA's efforts in support of astronauts on the International Space Station have evolved from the 30-yr Shuttle Program as well as ground-based research. While NASA's unique population of astronauts is the primary recipient of medical care, including telemedicine, it is the ground-based research initiatives that have benefitted not only American citizens but people from all over the world. NASA continues to play a role at the Federal level through a variety of functions.

Telemedicine is only one of the many contributions the space program has had and continues to have moving forward.

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From the Department of Family and Community Medicine, University of Cincinnati, Cincinnati, OH.

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