Evolution of Space Medicine at NASA

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INTRODUCTION: From the very beginning of America's human spaceflight program, space medicine has been at the forefront. There has been a variety of diverse individuals, over six decades, whose contributions helped shape what space medicine is within NASA today.

METHODS: An extensive review of historical documents (including reports, manuscripts, advisory committee reports, and oral histories of key individuals) related to space medicine, aerospace medicine, and life sciences at NASA Headquarters was performed.

RESULTS: Early in NASA's history, oral histories from individuals in key leadership positions were obtained. In addition, repeated searches of the archives provided a plethora of material on space medicine and life sciences from the first two decades or so, but it is somewhat sparse over the most recent four decades. Each of these sources helped develop a historical narrative of those key individuals who were in senior leadership positions at NASA Headquarters beginning in 1958 through the present time.

DISCUSSION: A review of the archived material tells a compelling story of how and why space medicine developed in the way it did at the agency level. The inspiration and the individual personalities, concomitant with the early influence from the U.S. Air Force, laid the groundwork for this discipline as it relates to human spaceflight.

KEYWORDS: space medicine, leadership, life sciences, history, NASA.

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"Space medicine is still an infant science – but no other frontier of medicine is more exciting. In determining the need and role of various human parts, their creation and their possible substitution, you shall be probing the origins of life itself."

President John F. Kennedy
Aerospace Medical Center
San Antonio, TX, 1963

At the end of World War II, a select group of German scientists were permitted to emigrate to the United States as part of Operation Paperclip.[1] This group of individuals helped the United States build a space program that launched humans to the Moon and returned them safely back to Earth. Beginning with the Mercury missions through to the International Space Station (ISS), each mission has been supported by men and women who have received extensive training in aerospace/space medicine.[2]

The term "space medicine" was first used in the late 1940s by Hubertus Strughold.[3,4] He was one of those Operation Paperclip scientists and was, in fact, joined by other notable scientists, including physicist Heinz Haber and aerospace physiologist Otto Gauer.[5] While there had been keen interest in flying higher and higher in jet-powered aircraft, there was little understanding of what would happen to humans in space. From the end of the war and well into the early 1960s, some questions were answered and some required much more in-depth study.[6,7]

In the United States, the National Advisory Committee for Aeronautics (NACA) served as the foundation for aeronautical research from 1915–1958.[1] There was an emerging thought within the U.S. military, academia, NACA, and the Eisenhower Administration at the time that while there was significant

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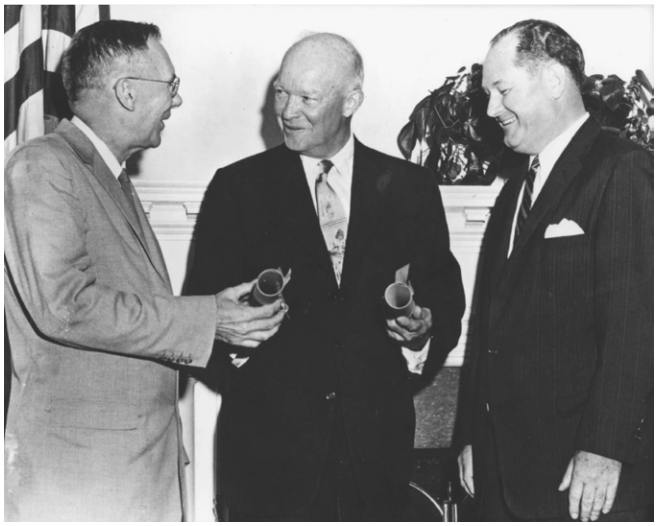

Fig. 1. President Eisenhower presents the Space Act to Drs. T. Keith Glennan (left) and Hugh L. Dryden (right). (Courtesy of NASA)

knowledge, it was a formidable task to put a human into space. Sputnik, a 58-cm-diameter (about 1.9-ft) sphere launched on October 4, 1957, by the Soviet Union, changed all of the thinking in the United States and accelerated the establishment of the National Aeronautics and Space Administration (NASA) in 1958.

In the year leading up to the Space Act (**Fig. 1**), Dr. Hugh Dryden, the NACA director, established the Stever Committee, which was also called the Special Committee on Space Technology, chaired by Dr. Guyford Stever.[8] This committee and the President's Science Advisory Committee recommended to the President that a "civil space program" be established. On October 1, 1958, with the Space Act signed by President Dwight Eisenhower, NACA became part of NASA. This enabled NASA to have immediate access to personnel, assets, and programs already in progress.

As a new federal agency, NASA had a lot of experience and knowledge on the first day due to the vastness of NACA's efforts dating back to pre-World War I. In addition, the U.S. Air Force (USAF), established from the U.S. Army Air Corp in 1947 under President Harry Truman, had a significant experience base in aerospace medicine.

Throughout the 1950s, well-known physicians, including Harry Armstrong, Hubertus Strughold, Bernard Shriever, and W. Randolph Lovelace participated in a number of bioastronautics activities as well as subject-matter expert committees (see **Table I**).[8] These committees and the individuals on them influenced NASA's aerospace medicine and life sciences functions. Several of the chairs and members of these expert committees became leaders in aerospace medicine at NASA in the agency's early years.

It is important to note that at NASA's birth, all "aerospace medicine" expertise in the United States was amalgamated in the USAF. Therefore, it made perfect sense to detail some of these experts to the nation's new space program to help build it.

It is also relevant to understand that when NACA became NASA on October 1, 1958, the Space Task Group (STG) was the team of experts already ensconced at Langley with a focus on the emerging Mercury program. The STG eventually moved in its entirety to Clear Lake, TX, where it became the Manned Spacecraft Center (MSC) (1961) and, eventually, the Lyndon Baines Johnson Space Center (JSC) (1973). The STG had military physicians engaged in crew selection and monitoring as well as strong and authoritative management structure in Robert R. Gilruth and Maxine Faget.[9]

METHODS

An extensive review of historical documents (including reports, manuscripts, advisory committee reports, and oral histories of key individuals) related to space medicine, aerospace medicine, and life sciences at NASA Headquarters was performed.

RESULTS

Early Beginnings

In the early 1950s and into the 1960s, research opportunities that might enable the collection of new knowledge on the impact of space on human beings were limited to animal species. Furthermore, the initial focus remained on "meeting the

Table I. Summary of Advisory Committee/Boards in Support of NASA.[8]

COMMITTEE/BOARD NAME	CHAIR	YEARS OF EXISTENCE
NACA Space Task Group Committee on Space Technology (a.k.a. Stever Committee)	Horton Guyford Stever	1957–1958
Ad Hoc Group on Human Factors and Training—Special Committee on Space Technology (Sub to Stever Committee)	W. Randolph Lovelace, II	1957–1958
NASA Life Sciences Committee (a.k.a. Lovelace Committee)	W. Randolph Lovelace, II	1958–1960
Ad Hoc Bioscience Advisory Committee (a.k.a. Kety Committee)	Seymour S. Kety	1959–1960
Life Sciences Working Group	Bernard Maggin	1960–1963
Space Medicine Advisory Group	Sherman P. Vinograd	1963–1964
Aerospace Medicine Advisory Committee	Harry C. Holloway and others	1977–1992
Aerospace Medicine and Occupational Health Advisory Committee	Ronald C. Merrell	1994–2002
Committee on Aerospace Medicine and Medicine in Extreme Environments	Carrol E. H. Scott-Conner Jeffrey Kahn	2002–Present
ISS Advisory Committee	Thomas P. Stafford	1994–2024

mission objectives," which were on building and launching spacecraft. In addition, the research community at large had differing opinions on the need to proceed with humans in the system. Therefore, not much research was undertaken in the first decade of human spaceflight. It was not until the later Gemini missions, that some biomedical research was conducted. This was primarily because of longer duration of the missions.[10,11]

Once NASA was established and the first selection of astronauts was underway, the STG with military doctors [including Stanley White (USAF), William Augerson (U.S. Army), and Robert Voas (U.S. Navy)] supporting medical efforts, NASA brought William Douglas from the USAF on board as the astronauts' personal physician in 1959. These individuals supported space medicine efforts for NASA at various locations, including Wright-Patterson Air Force Base, the MSC, and a number of other sites involved in selection and training of the seven Mercury astronauts.

In addition to these early pioneering physicians, there was and continues to be a small cadre of physician leaders developing NASA's space medicine expertise across seven decades. The USAF continues to have significant impact on NASA to this very day, in addition to the emergence of the U.S. Space Force. While there has been a large number of physicians supporting human spaceflight at the NASA field centers, including JSC and John F. Kennedy Space Center, it is the leadership at NASA Headquarters in Washington, DC, that has led the effort. This effort has evolved from advocacy to one of policy formulation and technical authority. While JSC and John F. Kennedy Space Center were "operationally oriented," it has been the efforts in Washington that helped 1) provide the authority for the field centers to accomplish their tasks and address those salient issues that impact the agency; 2) respond to the U.S. Congress and the Administration; and, most importantly, 3) support men and women in the extreme environment of space.

It was not always as transparent as it is today. Many of the challenges faced in the early days can be attributed to personalities, leadership style, attitudes, and the juxtaposition of physicians and engineers. The following is a historical summary of those individuals who have been at the forefront of space medicine development at NASA as an agency. It is not meant as a denigration of those men and women at the field centers. The sole purpose is to record for history who was involved in establishing the foundation with which space medicine is practiced today and into the future for NASA as America's Space Agency.

NASA in 1958

To understand the growth of space medicine within NASA, we must first go back to NASA's beginning and gain an understanding of the political challenges and turmoil that were present at that time. While Soviet activities in rocketry and the first satellite, Sputnik, clearly pushed the Eisenhower Administration to act, there were many who felt the military could do this work or that the new Advanced Research Project Agency could take on the task. Eisenhower prevailed and the "civilian" space agency was formed, absorbing several military-based activities.

For the first several years of NASA's existence, there was much consternation within the military, U.S. Congress, and the scientific community that this new agency was redundant and unnecessary. In Congressional hearings in 1959–1960, USAF General Bernard Shriever implied that the new NASA was duplicating USAF efforts.[12] When it came to understanding the "human" in the system of rockets and spacecraft, the USAF clearly had the expertise.

In addition, the STG, which started at NACA's Langley Flight Center in VA (ground zero for America's new space program), had been involved in the selection of the Mercury Program astronauts and was very independent and autonomous in its thinking and operational tempo.[7] The STG was under the direction of Gilruth and Faget, and it also included engineering experts Chris Kraft and Glynn Lunney. In 1960, the "Life Systems Branch, which included the Aerospace Medical Section," was under the direction of Faget's Flight Systems Division. Gilruth arranged to borrow physicians, flight surgeons, and psychologists from the U.S. Army and Navy. The "Gilruth" system, empowered by the "NACA do-it-yourself in-house tradition," was highly skilled and very capable.[9] Faget's organization included the Life Sciences Division under the leadership of USAF Colonel Stanley White.

As the concept of a civilian space agency took shape and became law, President Eisenhower nominated T. Keith Glennan of Case Institute of Technology as the first NASA Administrator and NACA's Director, Hugh Dryden, as the deputy administrator. Tasked with moving NACA into the space agency that led America to the Moon and beyond, the leaders brought expertise to the new NASA through individuals influenced by relationships they had previously forged. One such relationship involved a prominent physician and researcher from Cleveland, OH, Dr. Clark T. Randt. This is where space medicine and life sciences begin to be a major part of NASA. These two disciplines, although distinctly different, have often been integrated in the same organization.[13]

Space Medicine and Life Sciences in 1958

As stated earlier, the STG had a life sciences effort under Stanley White. This group was involved in the selection of the Mercury astronauts and the development of the systems and processes for monitoring crewmembers during the short-duration flights.

In 1958, Administrator Glennan established an advisory group with a focus on space and life sciences. The Stever Committee, the Lovelace Committee, and the Kety Committee were instrumental in providing guidance to the budding NASA in the area of life sciences.[8] While the summary of these boards are highlighted in earlier literature, it is important to note that several members from these committees became leaders in life sciences/aerospace medicine within NASA during its formative years.[8] **Table II** delineates where the space medicine and life science functions have been managed and coordinated within NASA Headquarters and the individuals who served in senior roles.

Table II. NASA Headquarters Space Medicine Leaders.

YEAR	ORGANIZATION	NAME
1959–1960	Special Assistant for Life Sciences to the NASA Administrator (Special Advisory Committee for Life Sciences)	Clark T. Randt, M.D.
1960–1961	Office of Life Sciences (OLS) (Director)	Clark T. Randt, M.D.
1960–1961	OLS (U.S. Air Force detail as assistant/deputy director)	Col. Charles Roadman M.D.*
1961–1962	OLS (Director)	Col. Charles Roadman M.D.*
1962–1963	Office of Manned Space Flight (OMSF), Space Medicine Directorate (Director)	Col. Charles Roadman M.D.*
1963–1964	OMSF, Space Medicine Directorate (Director)	Col. George Knauf, M.D.*
1964–1965	OMSF, Space Medicine Directorate (Director)	W. Randolph Lovelace, M.D.*
1965–1967	OMSF, Space Medicine Directorate (Director)	Gen. Jack Bollerud, M.D.*
1966–1967	Division of Biotechnology and Human Research (Director)	Rufus Hessberg, M.D.*
1967–1970	OMSF, Space Medicine Directorate (Director)	Gen. James W. Humphreys, M.D.*
1968–1970	Medical Research and Operations, Manned Spacecraft Center (Director)	Charles A. Berry, M.D.*
1971–1973	OMSF, Life Sciences Programs Division (Director)	Gen. James W. Humphreys, M.D.*
1973–1974	OMSF, Life Sciences Programs Division (Director)	Charles A. Berry, M.D.*
1974–1979	OSMF/Office of Space Science (OSS), Life Sciences Programs Division (Director)	David Winter, M.D.
1971–1980	OMSF/OSS, Life Sciences Programs Division, Bioresearch	Sherman P. Vinograd, M.D.
1971–1980	OMSF/OSS, Life Sciences Programs Division, Space Medicine	Rufus Hessberg, M.D.
1979–1982	OMSF/OSS, Life Sciences Programs Division (Director)	Gerald Soffen, Ph.D.
1976–1978	OSS, Life Sciences Division, Medical Operations (Chief)	Arnauld E. Nicogossian, M.D.
1978–1983	OSS, Life Sciences Division, Operational Medicine Office (Manager)	Arnauld E. Nicogossian, M.D.
1983	OSS, Life Sciences Division, Space Medicine Branch (Chief)	Arnauld E. Nicogossian, M.D.
1983–1992	OSS, Life Sciences Division (director)	Arnauld E. Nicogossian, M.D.
1992–1996	Office of Space Flight, Chief Medical Officer	Arnauld E. Nicogossian, M.D.
1994–1900	Office of Life and Microgravity Sciences and Applications (OLMSA) (Associate Administrator)	Arnauld E. Nicogossian, M.D.
1988–1995	OSS, Life Sciences Division, Operational Medicine Office (Manager)	Donald F. Stewart, M.D.
1994–1997	OLMSA, Aerospace Medicine and Occupational Health (Director)	Earl W. Ferguson, M.D., Ph.D.
1996–1999	OLMSA, Aerospace Medicine and Occupational Health (Director)	James D. Collier, M.D.*
1999–2001	OLMSA, Aerospace Medicine and Occupational Health (Director)	Richard S. Williams, M.D.*
2001–2002	Chief Health and Medical Officer (CHMO)	Arnauld E. Nicogossian, M.D.
2002–2016	Office of the CHMO	Richard S. Williams, M.D.*
2008–Present	Office of the CHMO (Deputy CHMO)	Vince Michaud, M.D.*
2016–Present	Office of the CHMO	James D. "JD" Polk, D.O.

*U.S. Air Force detailee or service

Chronology of Leaders (1958–2024)

Clark T. Randt (1959–1961). As a researcher in weightlessness and professor of neurology at Case Western Reserve, Clark T. Randt was an acquaintance of Glennan and a member of the Lovelace Committee.[8,] Randt joined NASA as the Director of the new Office of Life Science (OLS) in 1960 (**Fig. 2**). The Lovelace Committee was a special group of experts who were part of the Stever Committee.[7] In addition to the Stever Committee, the Kety Committee recommended the establishment of a dedicated OLS to control all life sciences functions, including aerospace medicine, at NASA. These functions included space biology, flight medicine, biology, space medical sciences, and behavioral sciences.

Randt brought a strong commitment to management and accountability to the NASA Headquarters OLS. He was supported by an aerospace medicine expert, USAF Colonel Charles H. Roadman. Roadman served as the lead for aerospace medicine function in Randt's organization. Randt's real challenge was that the STG was fully in charge of its tasks and did not require much in the way of direction or accountability to NASA Headquarters. His lines of communication between the NASA Administrator and the MSC were often dysfunctional or, at least, not ideal. Randt was often at odds with Abe Silverstein, Director of the Office of Space Flight Programs. The basis of this was OLS's desire for animal research in Mercury before humans flew. This caused a deep rift between the researchers, physicians, and engineers.[13,14]

Even though Randt had developed a 10-yr plan, the first strategic plan for life sciences, it received limited attention from his superiors, and he was in a position of limited or no authority over the functions for which he was responsible. As highlighted in a December 1991 report on Space Life Sciences in NASA, "… once the OLS promptly found itself in the midst of the struggle which have plagued the descendants throughout the ensuing years…. engineers and physical scientists who viewed biomedicine as a support function for the manned flight program."[13]

The OLS, one of the original offices at the very beginning of NASA, was under scrutiny. In fact, many in the military and the scientific establishment within government and academia felt that NASA's efforts in this field were redundant and devoid of any expertise. Congressman Emilio Daddario of Connecticut even released a statement challenging why NASA could use the USAF labs to meet its requirements, hoping to eliminate redundancy.[14] In the early 1960s, the NASA Administrator commissioned the Life Sciences Working Group under the direction of Bernard Maggin.[15]

Maggin's committee recommended the dissolution of the OLS and reorganization. Randt resigned and Roadman assumed

Fig. 2. (left to right) Clark Randt*, General Charles Roadman**, George Knauf**, W. Randolph Lovelace*, General Jack Bollerud**, General James W. Humphries**, and Charles Berry*. (*Courtesy of NASA, ** Courtesy of the Aerospace Medical Association)

the responsibility of the OLS in November 1961.[13] The OLS was abolished and its functions were distributed to new offices: the Office of Manned Space Flight (OMSF), the Office of Space Science, and the Office of Advanced Research and Technology. "Brigadier General" Roadman and the aerospace medicine function were absorbed into OMSF. This move helped mollify some of the fears felt by Congress and the military. Roadman was seen as a clinician, biomedical scientist, and medical administrator: a good choice to bridge the gap between life scientists and engineers.

Charles H. Roadman (1960–1963). Charles Roadman had a distinguished career as a physician and USAF flight surgeon and was devoted to the military model of biomedicine and not the academic model that Randt had followed. In June of 1960, Roadman (Fig. 2) was assigned by the USAF from the Directorate of Research and Development Headquarters USAF to serve as a special assistant for aerospace medicine to Randt in the NASA OLS. He also had responsibility for the agency's occupational health effort.[15] Appointed Deputy Director in February 1961, he became the Acting Director when Randt resigned in April 1961. With the dissolution of the OLS, Roadman was assigned as the Director of Aerospace Medicine with OMSF immediately after the aerospace medicine function was aligned in a new Directorate of Space Medicine within OSMF. The occupational health functions were assigned to Dr. David Stoddard.[16]

Roadman supported the Mercury Program in the development of the medical support for NASA's first manned missions. This early work served as the foundation for the Gemini and Apollo missions in the 1960s and early 1970s. Roadman was operationally oriented and was at odds with Randt's vision. It is at this point that life sciences' functions were split between human and nonhuman efforts. During Randt's tenure and at the beginning of Roadman's, there was a line item in the NASA budget for space medicine. Once the function was absorbed by OMSF, this line item was deleted, which effectively minimized the strength of the office. Life sciences and, more importantly, space medicine lost program status. However, funding to support Roadman and space medicine

was received from OMSF. Once Roadman returned to the USAF, USAF physician George Knauf, Roadman's deputy, became the Director of the Space Medicine Directorate, which included bioastronautics functions.

George Knauf (1963–1964). George Knauf was on detail to NASA from the USAF. Both he and Roadman had little interest in challenging the autonomy of the STG or enhancing their positions at NASA. Once Knauf (Fig. 2) was appointed as the Director, he agreed to the elimination of the budget line for space medicine and permitted the change from key office within OMSF to staff office. This change reduced Knauf's role. The space medicine functions from the early days of NASA were to 1) review and coordinate all NASA medical programs, including the field centers; 2) coordinate all NASA medical programs with outside agencies; 3) advise administrators on medical support programs; and 4) review and coordinate the total NASA medical program. Knauf also worked closely with the Department of Defense Bioastronautics Program and Project Mercury, where he was intimately involved in the development and organization of the medical recover support system. Knauf was also responsible for getting Lieutenant Dee O'Hara assigned from Patrick Air Force Base to Cape Canaveral to work with USAF flight surgeon Lieutenant Colonel William Douglas, the astronauts' personal physician.

W. Randolph Lovelace (1964–1965). W. Randolph Lovelace was instrumental in the early days of NASA (Fig. 2). As a former USAF flight surgeon and an international aerospace medicine expert, he was appointed as Chair of NASA Special Advisory Committee on Life Sciences and was involved in the selection of Mercury astronauts.[17] In 1964, he became the Director of Space Medicine. Lovelace's time in this position was short due to a premature death in an aviation accident in 1965.[11] He was temporarily replaced by Orr Reynolds until Jack Bollerud assumed the role. During this time, the MSC and STG saw an increase in autonomy and limited control from NASA Headquarters.

Jack Bollerud (1965–1967). As a USAF detail, Brigadier General Jack Bollerud served as the Acting Director of Space Medicine upon the death of Lovelace (Fig. 2). He recommended that a more structured approach to life sciences organization be established. He felt that the Life Sciences Directors Group was ineffective and there were too many redundancies and no cohesiveness for the betterment of NASA.[7] Bollerud presented a report, Staff Study of the Structuring of Life Sciences Activities within NASA. During this period, the life sciences function, including space medicine, had gone from a key office within NASA management to a distributed and ineffective function. Bollerud believed consolidation and reorganization would resolve many of these issues. Associate Administrator Robert Seaman, using Bollerud's report, authorized a review of all NASA's life sciences activities. During Bollerud's tenure, the office was eliminated.

James W. Humphreys, Jr. (1967–1970). Dr. Seamans personally asked General James Humphreys, who had served as the chair of the Life Sciences Directors Group, to return to NASA and oversee the life sciences and aerospace medicine functions (Fig. 2). He served as the Director of Space Medicine, and in 1970, his responsibilities were expanded to include all of life sciences as the Director of Life sciences.

Concurring with Seaman, Bernard Maggin and Robert Bell were tasked by Humphreys with conducting a review of all life sciences and medical programs. This Life Sciences Study Task Group, under the direction of Maggin, began to review these activities. This review found problems between the OMSF Directorate of Space Medicine and MSC Directorate of Medical Research and Operations at the MSC, primarily regarding authority and responsibility.[15] The report recommended a reorganization of activities. Humphreys split the functions into three offices: 1) Office of Advanced Research and Technology, 2) Office of Space Science and Application (OSSA), and 3) OMSF, which is where space medicine was placed. The merging of space medicine and life sciences in this period was also recommended by the Space Science Board of the National Academy. This reorganization provided many opportunities for spirited debate within the physical and engineering science disciplines.

Humphreys, who was a colleague of Charles Berry in the USAF, did not want to interfere with MSC activities and programs. He was also responsible for bringing David Winter from the U.S. Army to the NASA Ames Research Center.

Charles Berry (1972–1974). At the beginning of NASA's human spaceflight activities, Dr. Charles Berry was on loan from the USAF as a member of the Mercury Astronaut Selection Committee and an aeromedical monitor for Project Mercury (Fig. 2). He became the Chief of Medical Operations at NASA MSC in 1962 and later served as the Director of Medical Research and Operations at the MSC. During his time at the MSC, he provided leadership and medical and research management of the Mercury, Gemini, Apollo, and Skylab programs. In 1972, he became the Director of Life Sciences at NASA Headquarters. Dr. Berry's career at MSC, including operational experience of all NASA's manned efforts to date, provided an excellent foundation for leading NASA's life sciences and space medicine function at the agency level.

During this time period, the life sciences function at NASA Headquarters was in the OMSF. Dr. Berry also initiated the development of international activities with the establishment of the Joint Working Group between the United States and the USSR.[18]

David Winter (1975–1979). In 1975, the life sciences functions moved from OMSF to the Office of Space Science (OSS), where Dr. David Winter was named director by NASA Administrator Fletcher to interject new life and stronger leadership in the agency's life sciences functions (**Fig. 3**). This was a direct result of yet another review of leadership style and capability. Dr. Winter was

Fig. 3. (left to right) David Winter, Gerald Soffen, Rufus Hessberg, B. Sherman Vinograd, Arnauld E. Nicogossian, Richard S. Williams, and James "JD" Polk. (Courtesy of NASA)

a medical scientist and neurophysiologist from the NASA ARC. During his tenure, he focused the life science's function on a variety of disciplines, including medical aspects of manned spaceflight operations and occupational health. He was supported in his office by several physicians, including Sherman Vinograd, Rufus Hessberg, and Arnauld Nicogossian. It was during this period that NASA began to develop its medical policy structure – an effort led by Nicogossian and JSC's Sam Pool.[11]

Gerald Soffen (1979–1982). The challenges at the NASA Headquarters that brought Winter to Washington were the same that eventually resulted in his departure and the appointment of Dr. Gerald Soffen (Fig. 3). Soffen was a biophysicist and seasoned project scientist, having worked on the Viking Project. He was a researcher with limited medical knowledge, especially with regards to human spaceflight. With little direction from the top and continual budget reduction during the Reagan years, which resulted in more challenges to life sciences functions, Soffen moved away from a focus on the Shuttle Program research initiatives to more basic biological research. In October 1982, Soffen resigned and OSSA came under the direction of Bert Edelson, who appointed Nicogossian as Director of the Life Sciences Division.

While the life sciences function from the early 1970s until the early 1980s was under near constant scrutiny, the space medicine functions within the OSSA and OMSF continued under the leadership and medical expertise of Drs. Rufus Hessberg and Sherman Vinograd (Fig. 3). They both had distinguished USAF careers and brought those skills to NASA Headquarters to support the ongoing development of space medicine.

Arnauld Nicogossian (1978–2001). As the Apollo Program was terminated, several new projects were in development or scheduled for launch. These included the Apollo Soyuz Test Project (ASTP) (1975), Skylab (three missions in 1973), and the Space Shuttle (1981–2011). Dr. Nicogossian served the longest of any physician at NASA, beginning in 1976 at JSC (Fig. 3). His initial work was as a crew surgeon for the ASTP. Shortly after this mission, he joined Dr. Winter's Life Sciences Division at NASA Headquarters, where he initially served as Chief of Medical Operations until 1978. The position changed to Manager, Operational Medicine, which he held until 1983, when he was appointed Director of the Life Sciences Division, replacing Dr. Soffen.

In these earlier years at NASA Headquarters, Nicogossian worked closely with colleagues at JSC to develope policies,

procedures, and a structure for space medicine that was unique and fulfilling to NASA's mission, especially the Space Shuttle Program.[19] As NASA returned to flight in 1988 after the Challenger accident, several missions were dedicated to life sciences research, all of which was under the direction of Nicogossian's Life Sciences Division.

In 1994, NASA reorganized under Daniel Goldin by merging several organizations together under a new Office of Life and Microgravity Sciences and Applications. This office, with a budget over $500 million, included all functions of life sciences, aerospace medicine, and occupational health. However, funding for operational medicine still came through the OMSF. This marked the first time since the 1960s that all health-related issues and policies were in the same organization.[19] As this new office was taking shape, the Space Station Program was redesigned to include Russia as a full partner and a series of missions docking the Shuttle to the Mir space station. As the Associate Administrator of OLMSA, Nicogossian's role, along with his staff, was to help shepherd the development of the multinational collaboration in medical support for the redesigned ISS Program.[20] In 2001, the title of Chief Medical Officer was established with an office reporting directly to the NASA Administrator.

Additional Personnel Supporting Space Medicine in 1980–Present

As the Space Shuttle Program and Space Station Program (initially Space Station Freedom) became operational, there were a number of physicians that supported Dr. Nicogossian at NASA Headquarters within the Life Sciences Division, Office of Space Sciences and Applications, and the Office of Life and Microgravity Sciences and Applications. These supporting roles included Manager of Aerospace Medicine and Deputy Chief Medical Officer. A number of these matriculated from NASA JSC, including Drs. James Logan and Donald F. Stewart. During the 1990s, the USAF rotated aerospace medicine physicians through NASA, including Drs. Earl W. Ferguson, James D. Collier, and Richard S. Williams. Dr. Vince Michaud joined NASA during Dr. William's tenure in more recent years.

Richard Williams (2001–2017). In 1998, Colonel Richard Williams rotated into NASA as a USAF detailee to support Dr. Nicogossian and the aerospace medicine function for the Office of the Chief Health and Medical Officer, which reported directly to the NASA Administrator. Upon Dr. Nicogossian's retirement in 2001, Dr. Williams assumed the role of Chief Health and Medical Officer (Fig. 3). During his tenure, he oversaw the completion of the ISS, the retirement of the Space Shuttle, the initial steps of the commercial space program, and the development and implementation of the Health and Medical Technical Authority. This authority was a direct result of the Space Shuttle Columba accident.

Working closely with his counterparts among the international partners, Dr. Williams helped formulate medical policy for the ISS Program and establish the foundation of the To Research, Evaluate, Assess, and Treat Astronauts (TREAT) Act, which was eventually signed into law in March 2017. Dr. Williams worked with NASA administration and all the NASA centers to strengthen medical policy and enhance NASA's occupational health program. Dr. Williams brought Dr. James D. Polk into the Office of the Chief Health and Medical Officer in 2016.

James D. ("JD") Polk, D.O. (2016–Present). In 2016, Dr. JD Polk left academic medicine to rejoin NASA (Fig. 3). Dr. Polk garnered his expertise in aerospace medicine as a NASA flight surgeon at JSC, in support of the Shuttle and ISS programs, and he served as Chief of the Space Medicine Divisions at JSC as well. Since Dr. Polk assumed this role, NASA's Moon to Mars and commercial programs have grown significantly. With the launch of commercial crew on various spacecraft, vehicle design, and servicing, the operational tempo has created an opportunity for space medicine to be in the development conversation, as it relates to humans and the systems that support them.

In conclusion, for seven decades, space medicine has evolved from limited knowledge and a select few experts to a fully-fledged discipline. What was the purview of military physicians in the 1950s becoming what it is today is a direct result of the individuals who lead the field. The stability of space medicine at NASA has been influenced by many individuals, but it has been the leaders presented here that led the way. The past 40 yr have been led by the last three individuals mentioned above. While leadership styles and longevity have differed, crew health and safety have always been and will always remain the main focus of space medicine.

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