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The Aeromedical Realities of Space Travel

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IT IS AN HONOR and privilege to address this great congress of aviation medicine as a representative of both the Aero Medical Association and the United States Air Force. I bring to you the warm felicitations of both organizations and their best wishes for a most successful meeting.

The past of aviation medicine and its progress to the realities of space travel cannot properly be discussed from the point of view of one nation alone. You need only be reminded that the need for and the recognition of aviation medicine as an organized science began on this continent with the interest of many groups.[8] Therefore, it is most fitting that this Third European and First World Congress of Aviation Medicine take place in such an historic environment and under such appropriate auspices.

It was in Europe in the war of 1914-1918 that flying operational experiences taught that human error rather than enemy action contributed to the majority of aircraft losses. This led to the rapid development of aviation medicine as a science to assist the flyer. Following World War I, aviation medicine was firmly recognized at the first international conference in this specialty in Rome in 1919. Later in this country, in nearby Brussels, in 1935 there was an outstanding conference on an important function of aviation medicine. This was the Third Congress of L'Aviation Sanitaire.

In the delightful and stimulating surroundings of Louvain, we are aware that this is the birthplace of many notable contributions to science. Of interest to flight surgeons concerned with the use of oxygen and other gases, was the work of a Capuchin friar, Jean Baptiste Van Helmont, who was educated in Louvain in the sixteenth century. This learned

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scholar originated the word "gas" which he derived from Paracelsus' use of the Greek *chaos* for the general sense of air.[6] Each bit of information contributed by many such pioneers in all branches of science over the years, with Paul Bert's monumental *La Pression Barometrique*[4] as an outstanding example, has added significantly to the knowledge now embodied in the specialty of aviation medicine and supported man's progressive attempts to project himself into space.

The earliest steps into space began in November, 1783 on this continent with the first manned flight of a free balloon piloted by the French apothecary from Metz, Francois Pilatre de Rozier, with Marquis d'Arlandes as a passenger.[2] Thus was begun primitively the pattern for today's probings of our upper atmosphere by modern balloonists in sealed gondolas. These ventures into the atmosphere to space-equivalent altitudes by balloon ascensions are marked, prior to Simons' monumental feat in 1957, by the pioneering flights of Piccard in Europe in 1931 and 1932,[11] and in the United States by the National Geographic Society—U. S. Army Air Corps stratospheric ascensions in 1934 and 1935 of *Explorer* I and II.[12,13] These progressively upward steps to space are depicted in Figure 1. It is of interest to note that in the flights of the 1930's an artificial atmosphere was first used in a sealed compartment to conquer one of the major problems of space flight—hypoxia. Studies similar to present investigations were carried out by scientists on samples of atmosphere, and on cosmic rays and their effects on fruit flies, ozone, the absorption of carbon dioxide in a closed atmosphere, spores and bacteria, and the problems of communication. The aviation medical aspects of the *Explorer* I and II flights, which reached an altitude of 11.5 miles and 13.71 miles, were reported by a flight surgeon, Captain Harry G. Armstrong, later surgeon general of the Air Force.[3] Thus was undoubtedly kindled the spark which led this indefatigable investigator, when commandant of the United States Air Force School of Aviation Medicine, to establish the first department of space medicine in the world at that institution in 1949. A further sequel was the organization of a Space Medicine Branch of the Aero Medical Association in 1950.

I cannot leave the subject of balloon ascensions and historic flights without calling to your attention a further debt that America has to the old world. That was the first ascent of man into the air of the new world which took place on January 9, 1793 when a Frenchman, Jean Pierre Blanchard, took off from Philadelphia and landed 15 miles away at Woodbury, New Jersey.[7] To illustrate again the similarity to present-day experimenters, the only passenger with M. Blanchard was a small black dog, undoubtedly now a spiritual confrere of the recent intrepid voyager, Laika. This same Blanchard was the pilot of an earlier pioneering flight, the first over water from England to France on January 7, 1785, when he was accompanied by the first flying physician, Dr. John Jeffries of Boston.[2]

Thus the conquest of space began. As knowledge grew in all scientific fields, man's perpetual desire to increase the speed, altitude, and duration of flight resulted in the dynamic progress in aviation we know today. Aviation medicine has advanced with and supported the developments of the aeronautical sciences. Now, in the present most dramatic transition period of aviation history, man, due to aviation medicine, has attained space-equivalent capability. His goal, as it has been with each successful step up the vertical frontier of space, will continue to be "onward to the stars."

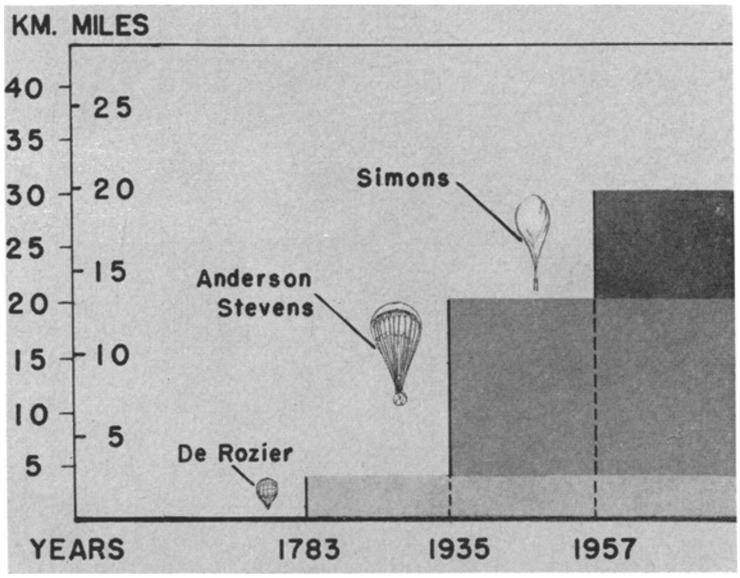

Fig. 1. Man's progressive steps into space by balloon.

When we speak of reaching the stars, we frequently talk glibly of space flight and outer space. Here pause must be made to analyze our present position and determine how far we have penetrated the infinite universe in which our small planet Earth exists. To gain a proper perspective and outline obtainable goals for the future some orientation is necessary. Photographs of the heavens have been made in a sky survey conducted by the Palomar Observatory and the California Institute of Technology.[10] The telescope used in the survey, the Big Schmidt, with a 48-inch mirror is able in its maximum range to capture clear, high-definition photographs of heavenly bodies as distant as a billion light years. The extent of this measure is realized when we consider that just one single light year calculated at the speed of light of 186,000 miles a second is equivalent to a distance of 5.8 million million miles. The objectives of this sky survey were to increase man's knowledge of the celestial bodies and other phenomena in the Milky Way, the the galaxy of which the solar system containing the earth is a part. In Figure 2 is the *cone nebula,* photographed with the more powerful 200-inch reflector of the Hale telescope, which can double the range of penetration into space to the almost incomprehensible distance of two billion light years. If, through some miraculous development, man could project himself from the earth at the speed of light he would not reach the vicinity of this beautiful area depicted in the heavens for 20 million centuries.[10] Based on present concepts of space and time, this goal of space flight is beyond our attainment. However, it does illustrate how inclusive and in-

Fig. 2. Detail of Cone Nebula. Photographed with 200-inch Hale Telescope.

correctly we frequently use the terms "space" and "space flight." When we draw closer to the earth and direct our attention to this planet's nearest star, the sun, which is only 8.3 minutes away by speed of light time, or a mean of 93 million miles, we see that again we are forced by time and space factors to relatively limited space travel. Under present concepts, a trip to the planet Pluto located in our solar system but farthest from us and the sun—a distance of five and one-half hours at the speed of light or fifty years in supersonic flight—would be beyond one man's active lifetime.[1]

Perhaps in some future generation a reorientation in, or a totally new theory of, relativity will permit true space exploration to other areas within our own Milky Way galaxy, or to those thousands of other galaxies now measured as billions of light years away. We must recognize the futility of this type of space travel today and return from these metaphysical regions to present-day atmospheric flight and the role of aviation medicine. The distance between any neighboring galaxy system averages two billion light years of distance. A representation of what our own Milky Way galaxy may look like when viewed from afar is seen in Figure **3**, a photo of a *spiral nebula* in Andromeda, a neighboring galaxy. It is not unlike a large wheel seen edgewise, with

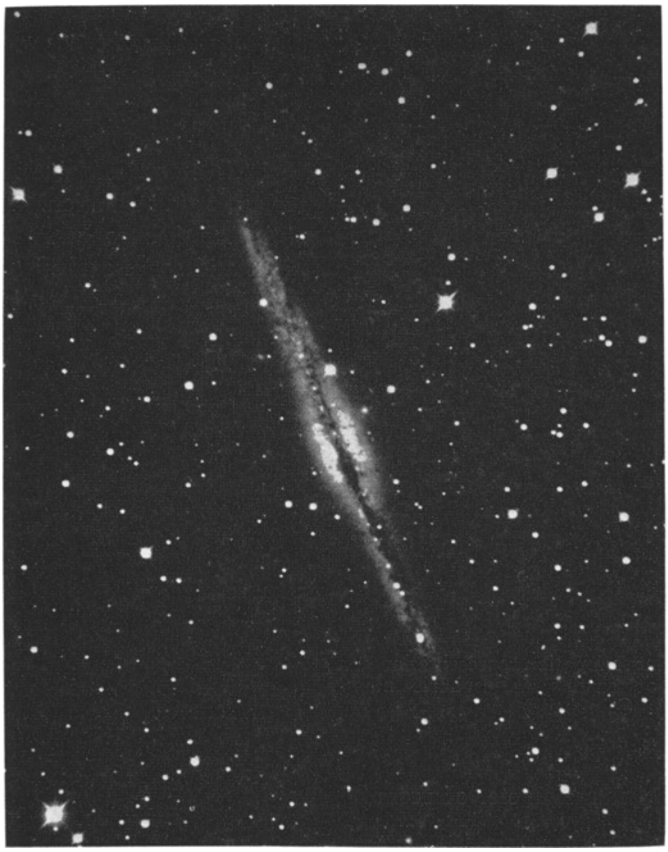

Fig. 3. Spiral Nebula in Andromeda. A galaxy similar in shape to the Milky Way galaxy in which our solar system is located.

rounded streamline projections at its hub on either side. Buried in a similar wheel-like formation of the Milky Way, which has a diameter of from 80 to 100 thousand light years and a thickness of 10 thousand light years, is our own solar system. A manned mission from earth would have to travel 15,000 light years just to cross the Milky Way's nearest frontier before it could be claimed that intergalactic travel had commenced.[10]

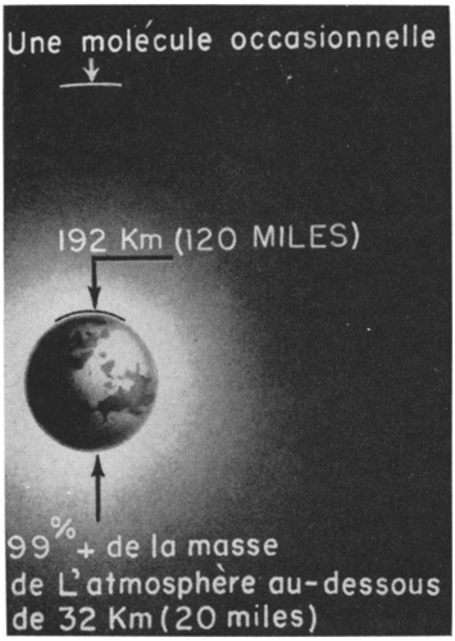

Fig. 4. Diagrammatic representation of distribution of earth's atmospheric mass. (From P. A. Campbell[5])

Our immediate attention must be focused on a very small area of the universe that is our own frontyard. Though we may speak facilely of space travel, we are really referring only to the further extensions of height, duration and speed that have always been the goals of man's increasing penetration of the atmosphere.

The atmosphere of the earth can be considered for significant functional purposes to extend to 120 miles with approximately 99 per cent of its mass within 20 miles of the earth (Fig. 4).[5] The remaining 1 per cent may extend from 6,000 even to 60,000 miles, dependent on various interpretations of molecular distribution. At the present, man has conquered atmospheric flight and space-equivalent flight. The next important step prior to entering true space will be circumplanetary flight at the outer fringes of the atmospheric layer. The attendant medical problems of such flight, of which this audience is well aware, have been analyzed and most have been solved. Many of these problems will be discussed at the meetings of this congress. Progressively, the objectives are clear and a timetable has been drawn.[9] Following earth satellite flights and the unmanned lunar probes, the next goal of man will be the moon, a distance of about 240,000 miles, or 1.3 seconds if measured at the velocity of light, or, if measured in projected flight times, one day to one week dependent on the trajectory of flight and the initial velocity of the vehicle. Figure 5 is a photograph of the moon at fourteen-day stage with a 48-inch Palomar telescope. A closer view of a portion of the surface facing future explorers is seen in Figure 6, made with the more powerful 200-inch Hale Telescope.

The successful accomplishment of lunar flight will pave the way for further exploration and interplanetary travel which, while similar from a mathematical and medical point of view, will be more extensive in having a greater number of major phases. There will be problems associated with markedly-extended times of flight, new navigation methods, strain on present communication techniques, entry into unknown atmospheres and radiation belts, and the fact that some requisite knowledge as the precise composition of planetary masses is still unknown. Venus and Mars, the most intriguing planets as well as the closest to earth, with Venus only six minutes away measured in speed of light time or 26 million miles, and Mars twelve and one half minutes away or 35 million miles, will undoubtedly merit attention first. Here consideration must be given to flight time which will consume years rather than days under hoped for conditions of travel. Because of the cloud cover of Venus, nothing concerning its surface is known. Venus will be a surprise planet when visited by the pioneer astronauts.[1] Much more is known about Mars. Conditions on its surface are very similar, with regard to temperature and pressure, to stratospheric conditions eleven miles above the earth's surface.[14]

Fig. 5. Moon at age fourteen days. Photographed with 100-inch Hooker Telescope.

As techniques improve, and the many problems of vehicular propulsion, guidance, and internal environment for longer voyages are conquered, the further exploration of our solar system can become a reality. Future scientific exploration will be impossible, however, without the continued contributions of aviation medicine, or flight medicine, as it should now properly be called. The eventual benefits to mankind from the research endeavors in the basic medical problems

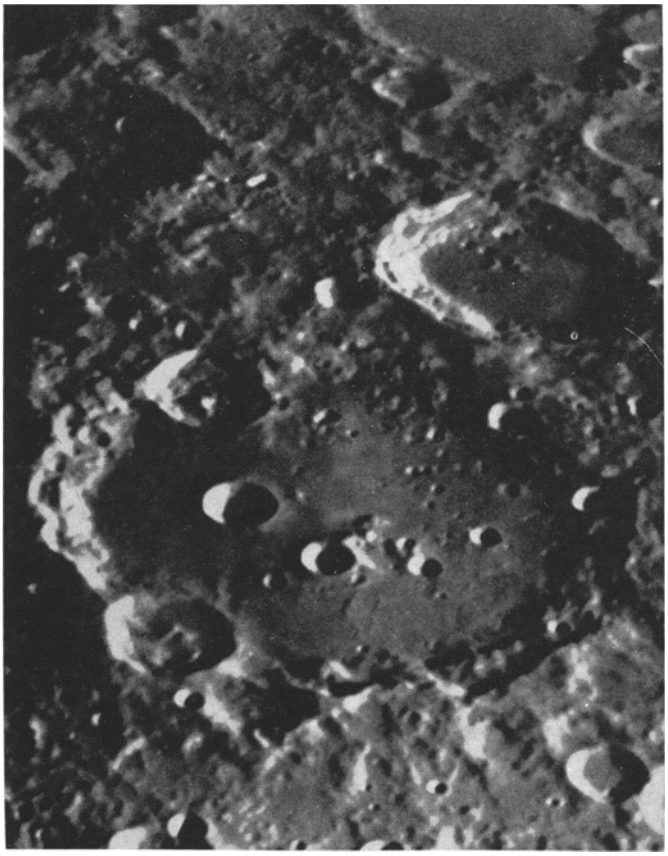

Fig. 6. Region of Clavius of the moon. Photographed with 200-inch Hale Telescope.

associated with space flight are unlimited. Many notable dividends to medical progress have been made through past activities of aviation medicine. Contributions have been made in oxygen and carbon dioxide studies, pressure breathing, dysbarism, cardiovascular and respiratory dynamics, and body temperature response. In public health, advances have been made in the practical field of bringing rapid succor through airlift to stricken communities, in the air transport of critically ill patients, and in the development of protective measures for crash deceleration. In addition, progress in preventive medicine has been made in the control of disease factors precipitated by global air transportation.

Untold possibilities for increased knowledge are in store for the future in the exploration of new environments, new worlds, and a radical change of earthbound perspective. Man must be studied in this new situation by a careful analysis of his systemic capabilities and limitations. Research must be directed to the biochemical and biophysical reactions of the central nervous system, to problems of the special sensorium and impulse transmission, and to musculoskeletal, respiratory, cardiovascular, gastrointestinal, genitourinary, humeral and glandular activities. We can hope that the phenomenal discoveries awaiting us in all scientific fields, as man's endless exploratory quest continues, will also aid in solving many of the baffling medical problems now facing us here on earth.

A view of our small planet following its orderly course in the infinite universe containing billions of more suns larger than ours, each with its own planetary system, cannot fail to make one appreciate the universal brotherhood that unites earthly humans into one family. With such an outlook, international goals become as one. Through meetings such as this world congress, with its mutual exchange of information, progress into the future is assured. Aviation supported by aviation medicine has shrunk world dimensions, making all nations neighbors. The next step into circumplanetary flight on the fringes of our atmosphere, an environment shared equally by all inhabitants of a revolving earth, will contribute even more to this sense of one family and one world.

Medicine with the noblest humanitarian goals serves as a common denominator to human brotherhood and everlasting peace. Aviation or flight medicine and its extension into space is at the forefront of that relationship, to speed the day when nations are composed of men of good will, when human dignity is respected, and the common good is the goal of all people. Advances gained in scientific knowledge of the earth, the solar system and the universe, will benefit all mankind as we continue our quest higher and higher, closer to the secret of life itself.

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