Aerospace Medicine in Germany: From the Very Beginnings

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The roots of German Aerospace Medicine are in Berlin. High altitude research was performed by physiologists like Nathan Zuntz and the very first Army flight surgeons, Koschel and Flemming. With the founding of the Scientific Society for Aeronautics in 1912, a medical committee was established to determine guidelines for the physical examination of flyers. In World War I aviation medicine became a military science, which came to an end with the Treaty of Versailles. In 1927, with the establishment of the first Aeromedical Institute in Hamburg, Ludolph Brauer restarted the civilian academic aeromedical research effort, which, thereafter, fell more and more under military influence. At the end of World War II, German scientists were invited to work at the USAAF Aero Medical Center (AMC) in Heidelberg (1945–47), to gather the results of German aeromedical research performed before and during the war. Some of this group of German scientists were invited to work in the USA. In Germany, on the other hand, the effect of this "brain drain" was a period of stagnation. In the 1950's, a new civilian institute of aviation medicine was established in Bonn. It grew to be the nucleus of the DLR Institute of Aviation Medicine in Cologne. The German Air Force Institute of Aviation Medicine was founded in Fuerstenfeldruck in 1959, and in the GDR the Institute of Aviation Medicine was established in 1961: the first East German cosmonaut S. Jaehn 1978 (Soyuz-31), was succeeded by the first West German astronaut, U. Merbold in 1983 (Spacelab).

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THE ORIGINS OF AEROSPACE medicine in Germany can be traced to the altitude ascents for meteorological research performed under the guidance and support of the German Association for the Promotion of Airship Travel, founded in 1881 in Berlin, in cooperation with the first German Aviators Battalion, established in 1884. As a result, the meteorologist Arthur Berson reached the altitude record of 9155 m in December 1894. Along with the development of Zeppelin-type airships and later on of aeroengine-powered airplanes, high altitude-related phenomena gained ever increasing importance. The need for oxygen systems and altitude protection equipment continued from these early days of flight up to the space age (12).

High altitude research was performed by the German physiologist Nathan Zuntz and the very first Army flight surgeons Koschel and Flemming. An Austrian scientist, the physiologist Hermann von Schroetter, was the one who introduced the meteorologists Arthur Berson and Reinhard Suering to hypoxia symptoms in a "pneumatic chamber." In 1901, during a high-altitude ascent to 10,500 m (a new record altitude) in the hydrogen balloon "Preussen," glass-tube mouthpieces were used instead of the suggested face-fitting oxygen-masks. On descent, both scientists lost consciousness, but survived. Therefore, as early as 1903, von Schroetter recommended the use of a sealed pressurized gondola, like the one used by Auguste Piccard in 1931 (11,13). In 1909, the year of the first International Aeronautical Exhibition (ILA) in Frankfurt, Germany, von Schroetter published his aviation medical handbook "Hygiene of Aeronautics;" 3 yr later his second book, "Hygiene of Aeronautics and Aviation" was published. In the same year, Nathan Zuntz issued a book on "Aviation Physiology and Hygiene" (18,21).

Coincidently with the foundation of the Scientific Society for Aeronautics in 1912, a medical committee was establihsed to determine guidelines for the physical examination of flyers. Koschel's contribution, "Health Requirements for Aircraft Pilots," was published just before World War I, in 1914. The increasing air travel led to rising numbers of aircraft accidents. In Germany, for example, 42 fatal accidents were recorded in the years from 1908 to 1912; 14 of them occurred in the military. As the main causes of flight accidents, the then chairman of the aeromedical committee, Dr. Friedlaender, stated the pilot's opinion: failure of aircraft equipment, the pilot's mindlessness, glide, the innate clumsiness, feeling of loneliness, and a sudden craving for sleep. This example clearly shows how differently the human factors were rated when identifying the causes of flight accidents (1,5,11,12).

In World War I, aviation medicine became a military science. In 1916, the Commanding General, Army Air Force, established a medical department, headed by Koschel. Consequently, a multi-stage medical examination, observing the principles of flight psychology, also preceded the pilot training.

After World War I, all German aeromedical activities were suspended by the Treaty of Versailles, which forbade all military and civilian flying (12). Not until 1927,

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with the establishment of the first Aeromedical Institute in Hamburg, did Ludolph Brauer restart civilian academic aeromedical research, focusing mainly on altitude physiology. His Institute became fully operational as "Hamburg University Institute of Aviation Medicine and Climate-Research" in 1931, and was equipped with two altitude-chambers (3). At the University of Wuerzburg the physiologist Hubertus Strughold—in the sixties named the "Father of Space Medicine"—held the world's first lecture on "Physiology of Man in Flight" in 1928; he gained experience from flight-tests performed upon himself (6). At the same time, the flight surgeon Ernst Gillert performed high-altitude self-experiments in an altitude-chamber up to 14,300 m at the DVL-research-establishment Adlershof in Berlin, even before the pilot W. von Neuenhofen reached an altitude record of more than 12,700 m on May 26, 1929, in the aircraft Junkers W 34. As a result, the need for a pressurized cabin, such as that installed in the aircraft Junkers Ju 49 in 1928, or a pressure-suit, was realized (9,12). Klanke developed an altitude-protective pressurized suit in 1934 and used it in more than 300 ascents up to 6,000 m. At higher altitudes this suit was impractical due to its lack of flexibility. The use of artificial joints could not improve its practicability. In World War II Tietze of the Draeger-Company developed several kinds of pressure-suits, but they were not used in military aviation. For example the rocket-powered interceptor Messerschmitt Me-163 "Komet" with a top-speed of Mach 0.84 (1003 kmph at low altitude in 1941) could climb up to 12 km within 3 min; the total time of ascent, at altitude and descent was shorter than the time-reserve (TUC): hypoxia-symptoms were never reported (12,16).

Besides altitude-physiology, acceleration research was another topic of interest. In the early 1930's the effects of prolonged in-flight acceleration were first studied by the flight surgeon Heinz von Diringshofen. To obtain more standardized conditions than possible in flight, examinations were supplemented by those done on a centrifuge, which was operated at the Air Ministry's Aeromedical Research Institute in Berlin from 1935 to 1945 (4,12). The physiologist Otto F. Ranke was one of the first to use X-rays to demonstrate the decreased filling of the heart of test-animals exposed to high G_z-forces. These results were cross-checked on men in flight. The flight surgeon Buehrlen exposed himself to up to 17 G_x over 2 min on the centrifuge and found the supine and prone position effective to sustain high-G_z-forces in flight. In dive-bombers like the Junkers Ju 87 "Stuka," pilots used to crouch forward and strenghten their muscles through the pullouts. In addition, these widely accepted maneuvers were accompanied by increasing the intrathoracic pressure by grunting an e-sound (M-1 maneuver). Most likely, no attempts were made to develop and introduce anti–G-suits in Germany because it seemed to cause more trouble than it was worth (4,12,17,19).

The period of well-organized aviation medicine under military direction had started even before the official establishment of the German Air Force in 1935, and was followed by the period of war-geared

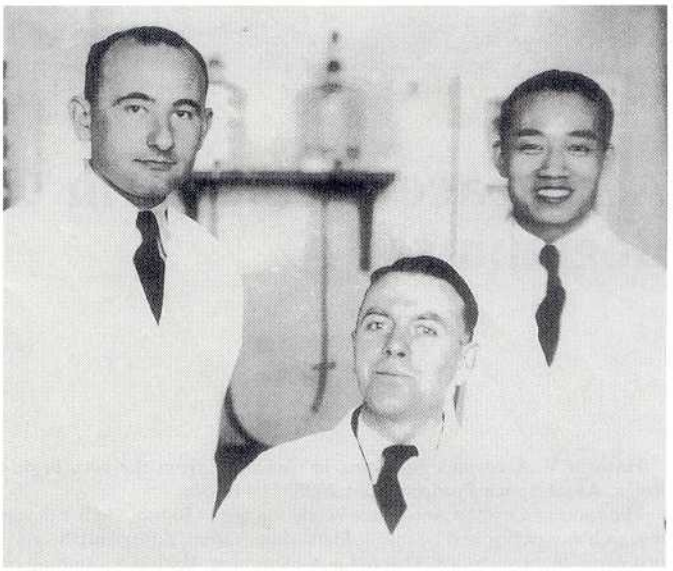

Fig. 1. Hubertus Strughold (center) with a Chinese (Dr. Tsu Te Chang) and a Yugoslavian Scientist at the Air Ministry's Aeromedical Research Institute in Berlin, about 1938.

scientific work until 1939. The leading institution was the Air Ministry's Aeromedical Research Institute in Berlin. This center was under the guidance of Strughold from 1935 and was staffed by highly motivated and qualified scientists who could work in a rather liberal academic atmosphere (15) (**Fig. 1**). None of them were "Nazi" members. The International Symposium on Aviation Medicine, held in Berlin in 1937, was attended by representatives from several countries. The Ninth Annual Scientific Meeting of the Aero Medical Association was held in New York City the same year (Oct. 1–3, 1937). Foreign delegates and invited speakers were elected Honorary Members of the A.M.A. One of them was Strughold, who stated: "The airplane is changing the world. The distance between countries is shrinking. . . . We all can fervently hope that this is leading to a better understanding among nations" (20). In the same year, the British Wing Commander Philip Livingston visited Germany and was received with courtesy and openness and was given a comprehensive tour of all aeromedical establishments, which demonstrated to him the advanced knowledge, experience, and resources in this particular field of science (8). W. Randolph Lovelace II, M.D., from the US was another flight surgeon visiting German Aviation Medical Centers just before World War II (in 1939) (20).

At the end of World War II, many German scientists were invited to work at the USAAF Aero Medical Center in Heidelberg, which existed from 1945–1947, in order to gather the results of German aeromedical research performed before and during the war. In consequence, a 2-volume handbook, "German Aviation Medicine World War II" was published by the Department of the U.S. Air Force in the U.S. in 1950 and reprinted in the '70s. Furthermore, "Space Physiology" was introduced as a new subject by the German scientists Otto Gauer and Heinz Haber in Heidelberg with their paper

"Man under Gravity-Free Conditions." Both of them had been part of a group of German aerospace medicine specialists, invited by the legendary General Harry G. Armstrong to work in the US (2,7,12,13).

In Germany, on the other side of the coin, the effect of this "brain drain" was a period of scientific stagnation. There was no central Aviation Medical Organization, nor federal standards or regulations. In the 1950's a new civilian institute of aviation medicine was established in the then capital of Bonn. The German Air Force Institute of Aviation Medicine (FlMedInstLw) was founded in 1959 in the Bavarian Fuerstenfeldbruck. In the East German Democratic Republic an Institute of Aviation Medicine (ILM) was established in 1961, when the Berlin Wall separated West from East. Also in 1961, the German Society of Aviation and Space Medicine (DGLRM) was (re-)founded and Heinz von Diringshofen was elected the first president. Since 1972 it has been an affiliated organization of the AsMA. The Society's first annual scientific meeting was held in Munich, Oct. 8–9, 1963. The DGLRM hosted an International Congress of Aviation and Space Medicine in Munich in 1973, and in Hamburg in 1993. In 1991 a German Academy of Aviation Medicine was founded by the DGLRM and the Lufthansa Commercial Holding to improve the educational capacities of Aviation Medical Examiners in Germany (10,12).

Additional progress was achieved as the civilian Bonn institute was transfered to Cologne. It was concerned with problems encountered by man in air- and spacecraft operations. In addition, its point of interest is supplemented by projects of underwater medicine. Though Space Physiology and Medicine were inherently of interest, the public and political interests were not space-minded. The more progressive German Ministry for Nuclear Energy and Space Research was established in 1962, 5 yr after "Sputnik." Nor did military aviation medicine sponsor space research activities. This was changed in the early 1970's, when a German Flight Surgeon had an important role in the NASA ground support team for the Apollo-Soyuz-Mission and the Skylab-Mission. This experience was advantageous during the medical screening of German scientist-astronauts. But "the East" took the lead once more: The first East German cosmonaut was S. Jaehn onboard the Soyuz-31 in 1978; he was followed 5 yr later by the first West German astronaut, U. Merbold, onboard the Space Shuttle Spacelab (12).

The most recent aerospace medicine consolidations relate to German reunification. Thereafter the former Institute of Aviation Medicine (ILM) of the German Democratic Republic in Koenigsbrueck, Saxony was renamed the Division II—Training in Aviation Physiolgy of the Fuerstenfeldbruck-based GAF Institute of Aviation Medicine, which celebrated its 40th anniversary in 1999 (**Fig. 2**). Its other divisions are: I—Aeromedical Examination, III—Research and Training Aviation Medicine, IV—Ergonomics, V—Forensic Medicine and Medical Investigation of Aircraft Accidents, and VI—Aviation Psychology. It is of distinct importance that in Germany all military aersopace medical responsibilities and interests of Army, Navy and Air Force are under the leadership of the Surgeon General GAF (12).



Fig. 2. The author in the historic MBB-centrifuge of the GAF Institute of Aviation Medicine in Fuerstenfeldbruck in 1990.

The strong aerosopace medical programs of Germany continue to grow and forge links with those of the AsMA and its international membership.

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