Historical aspects of aeromedical transport and aerospace medicine – review

Aspectos históricos do transporte aeromédico e da medicina aeroespacial – revisão

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ABSTRACT

The history of aeromedical transport and Aerospace Medicine consists in a pleasant journey to the past, with great prospects. This article describes how military medicine and wars advanced our understanding of human physiology, contributing to the development of various medical fields. The journey begins in Greek mythology, with Daedalus and Icarus, moving on to balloons, then on to airships, until we reach heavier than air flying machines. Man experienced a hostile environment unknown to him, low atmospheric pressure, hypoxia and hypothermia were just the beginning. Paul Bert, medical physiologist and father of Aerospace Medicine, already performed studies in hypobaric chambers, even with all the technological limitations of his time. A new era was born, in which man began to understand and master the physiological changes of altitude. The concept of aeromedical transport was introduced during the Napoleonic wars and consolidated in the Franco-Prussian War (1871), when 160 wounded men were transported from sieged Paris on hot air balloons. A great evolution in pre-hospital care and patient evacuation strategies occurred during the wars in Vietnam and Korea, stages that served as a templates for the structures of trauma care today. Wars continue to ravage humanity, taking lives and bringing pain and suffering to those who remain. Paradoxically, it is the same war that provides conditions for research and development of inventions and technology, which propelled the conquering of new worlds. The path is literal. It goes from the ingenuity of Greek mythology that enabled man to fly, to today, making us dream of conquering space, with the same adventurous personality of our predecessors. Here, the sky is not the limit.

Key words: History of Medicine; Aerospace Medicine; Air Ambulances; Transportation of Patients.

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RESUMO

A história do transporte aeromédico e da Medicina Aeroespacial consiste em agradável viagem ao passado, com grandes perspectivas. Este trabalho descreve como a Medicina militar e as guerras trouxeram conhecimentos sobre a fisiologia humana, contribuindo para o desenvolvimento de várias áreas médicas. A viagem inicia-se na mitologia grega, com Dédalus e Ícaro, passando pelos balões inicialmente sem direção, depois seus dirigíveis, até chegar às máquinas voadoras mais pesadas que o ar. O homem experimentou ambiente hostil que lhe era desconhecido; a baixa pressão atmosférica, a hipóxia e a hipotermia eram apenas o começo. Paul Bert, médico fisiologista e pai da Medicina Aeroespacial, já realizava estudos em câmara hipobárica, mesmo com toda limitação tecnológica da época. Nascia nova era, em que o homem começava a entender e a dominar as alterações fisiológicas da altitude. A concepção de transporte aeromédico foi introduzida durante as guerras napoleônicas e sedimentada na Guerra Franco-Prussiana (1871), quando 160 feridos foram transportados da Paris sediada, em balões de ar quente. A grande evolução

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nos cuidados pré-hospitalares e no modelo de remoção de pacientes ocorreu durante as Guerras do Vietnã e da Coreia, palco de estrutura que serviu de molde para os sistemas de atendimento ao trauma da atualidade. As guerras continuam a assolar a humanidade, levando vidas e trazendo sofrimento e dor aos que ficam. Paradoxalmente, é a mesma guerra que fornece condições de pesquisa e desenvolvimento de inventos e tecnologia, as quais propulsionaram a conquista de novos universos. O caminho é literal. Vai da imaginação da mitologia grega em possibilitar ao homem voar, até a da atualidade, que faz sonhar em conquistar o espaço, com a mesma personalidade desbravadora que dos antecessores. Aqui o céu não é o limite.

Palavras-chave: História da Medicina; Medicina Aeroespacial/história; Resgate Aéreo; Transporte de Pacientes.

AIR MEDICAL TRANSPORT

The origins of the air ambulance and of Aerospace Medicine refers us back to the history of War Medicine the care of the wounded in battle as well as to the removal of military personnel and possibly of civilians. The same way that war cause catastrophes for humanity, it also brought progress in medical science and technical-scientific development.

The Romans were the first people to have an organized military medical service. Their injured were transported to the decury stalls, accommodations able to house cavalry and infantry corps composed of 10 soldiers and the place where they received the help needed. They also had the "valetudinarium", which were fixed hospitals destined to the care of the military, gladiators, and athletes. At that time rises the figure of the "hospital assistant", a nurse who assisted doctors in patient care.

In the thirteenth century, Vila Nova, physician in charge of Peter, the Great of Aragon, advocated for collective hygiene and the use of alcohol in treating the wounded.

Although the first reports of injury by firearm occurred in 1346, at the battle of Crecy during the War of 100 Years, the first mention to treatment for this kind of injury is found in the work of the military Bavarian surgeon Henrich Von Polfs Peundt (1461).

The concept of antisepsis was developed by Paracelsus, a Dutch military doctor whose work entitled "The Great Surgery Book" advised washing the wounds with water and not interfering with "nature's excellent action" by avoiding suppuration.

The first manual for the Field Physician, authored by the Polish military Janus Abraham a Gehema, appeared in 1689.

Removing the war wounded became easier with the improvements to the barrow, which made it collapsible and lighter. This was in the late nineteenth century, through the work of one of the great names in Military Medicine, Jean François Percy, a French military physician. The great name at the time, however, was Dominique Jean Larrey, until then considered the most complete surgeon. He was the physician of Napoleon's Grand Armé and was responsible for the creation of the first ambulance on wheels. He was also responsible for organizing, in 1798, the School of Surgery of Cairo, in 1807, the School of Warsaw, and then the School of Military Medicine and Surgery in Spain.[1]

The progress of war Medicine is not limited to land; it also reached the skies. Icarus had dreamed of flying and awakened the dream in humanity. Greek mythology, however, reveals that it was Icarus' father, Daedalus, the best and most known of all artisans and inventors of antiquity, who, faced with the need to escape prison, built two pairs of wings weaving feathers and joining them with wax. Upon completing his invention, Daedalus gave his son the first instructions so that he could conduct his solo flight. Everything was perfect, except for the fact that Icarus, enthralled by the delight at mastering something until then unusual, made the first "human error in aviation" by neglecting his instructor's guidance and plummeting in the "first crash" that led to his death. This mythological account shows the need to constantly develop and make discoveries and inventions possible, as well as the importance of establishing protocols so that there may be safety and success.

The history of aeromedical transport is no different. It begins with hot air balloons. Their use by the military in the nineteenth century happened due to the need for: air strikes to military targets, aerial reconnaissance in captive balloons, i.e., those fixed to the ground by means of a rope, communication, transportation of personnel, equipment, and mail.

The first aerial bombing was attempted in 1849, when the Austrians launched 200 unmanned hot air balloons carrying bombs against the forces that defended Venice. Each bomb was prepared with a timed detonator but the wind blew the balloons back to the Austrian troops. Due to this failure, the idea was abandoned until World War II when the Japanese military used it.

In 1794, the French were the first to use balloons for aerial battlefield reconnaissance during their conflict with Austria. The balloon was designed to remain tied to the ground and take two observers in the

"basket" who, using flag signals or messages dropped in small sandbags, communicated with the ground crew maneuvering the balloon. This kind of reconnaissance was key to French victory for it allowed the French to observe the preparations and movement of their opponents.[2]

The third purpose of using balloons marked the beginning of air medical transport in 1870, during the Franco-Prussian War. After the invasion of Paris, 160 injured soldiers and civilians were evacuated by balloon to places where they could receive medical care.[2-4] Because of wind direction and the fact that the balloons were not directional, they could only go one way: out of Paris.[2] During the Franco-Prussian War, Henri Dunan, distraught by the cruelties of war, created the International Red Cross, establishing the Geneva Conference in Switzerland, which allows health care teams to carry in their helmets, bracelets, ambulances and aircrafts, the official symbol of the Cross, in red, to identify them as healthcare personnel, also responsible for transporting the injured.[5] In 1876, during the war between Russia and Turkey, the "Red Crescent" was adopted in addition to the Red Cross emblem.[6] In June 2006, in the 29th International Conference of the Red Cross and the Red Crescent decided to adopt, for diplomatic reasons, a third emblem, the "Red Crystal", especially for the Palestinian conflict.[7]

Developments in aviation continued and in December 1903, Orville and Wilbur Wright, the Wright brothers, managed the first controlled flight of an airplane with an "engine", with the model Flyer I in the USA. However, it was the Brazilian Santos Dumont, in October 1906, who made the first recorded flight in the history of airplanes, with the 14 BIS. The airplane had been invented.[8]

Removal of the injured by aircraft started to become reality in the United States in 1908, with the first flights of the Wright brothers, and the beginning of air travels with the Zeppelin VII airship.

In the war of Tripolitania of 1911, the first aircrafts were used for military purposes as reconnaissance flights made by an Italian aircraft.

In the first Balkan war in 1912, Bulgarian aviators manually launched small bombs on the enemy troops, the Turks, with great efficiency, generating exceptional impulse to the aviation industry. A little before 1914, the Germans had 1,400 combat aircrafts and the allies (France and England) had about 1,000.

In World War I (1914-1918) planes were used in rudimentary, depressurized air medical transport, in a network system with supplemental oxygen and a single engine that could reach an average speed of 150 km/h. Patients used to be accommodated in compartments in front of the pilot and without any assistance. The objective was the rapid evacuation of the injured to a safe place where they could receive medical care.

In 1918, two air ambulances were already based in Louisiana.

In 1928, the first Air medical Transport (AT) service was established in Australia as the Australian Inland Mission Aerial Medical Service, which later became the Royal Flying Doctor Service. In this period, the interest sparked in several parts of the world for developing airplanes for health care due to the multiplicity of combats after World War I, but especially due to the need to provide immediate aid to the pilots shot down in combat.[9]

In World War II (1939-1945), German and American adapted military transport aircraft into "air ambulances", duly equipped with appropriate stretchers, aspiration and oxygen system, noninvasive ventilation equipment with masks, medications and health professionals to treat the injured. Large aircrafts such as the American DC-Douglas were used, allowing the simultaneous removal of several patients.[10] Flight nurses emerged in this context, marking a historical landmark in nursing care. These nurses were part of the Army and Navy, which had approximately 69,000 of these professionals in their health team.[11]

The advent of AT let to profound changes in medical care strategies, allowing safer hospitals to be set up away from the combat zone and functioning as an air base for the removal of injured patients.[12]

In 1907, Loius Breget elaborated the theory of rotary wings and the current design of the helicopter with center and tail rotors was drafted in 1939 by Igor Sikorsky. In 1945, Sikorsky developed a helicopter rescue in a tanker ship. The first commercial helicopter license in the United States was granted in 1946, to Arthur Young, owner of Bell Helicopters, who designed a simple helicopter rotor. An aircraft with a versatile configuration that requires no takeoff or landing airstrip and able to perform vertical landings, the helicopter was immediately included in air medical transport.

Approximately 20,000 military wounded were rescued by helicopters in 1950 during the Korean war, even if rudimentarily: flying at low altitude with closed stretchers on the ski protector and without a surveillance team during removal. These circumstances revealed the need for the pilot to know the

basics of first aid. The success of these flights in the Korean War served as a stimulus for actions in Vietnam. The need for training health team members transpired during the Vietnam War, paving the way for rotary wing and aerial Intensive Care Unit (ICU). From 1965 to 1972, air ambulance helicopters rescued about one million civilians and military wounded in Vietnam. It was then that the most important Invasive Pressure Lung Ventilator, the BIRD Mark7, was invented by the physician and aeronaut engineer Forrest Bird, and used in military ICU and rescue aircrafts.

The use of helicopters led to shorter intervals for definitive medical treatment, from six to 12 hours, during World War II, to two to four hours in the Korean War. This reduction in time was one of the factors that contributed to the decrease in mortality of wounded from 5.8 to 2.4%. In the Vietnam conflict, total time to reach the definitive care hospital dropped to 35 minutes, leading a decrease in mortality to 1.7%. This experience was later adapted for civilians in the 1960s, in the care of persons injured in motor vehicle accidents on U.S. highways.[13] In the United States, in 1972, the National Highway Transport Safety Administration (NHTSA) published a pioneering work entitled *Helicopters and Emergency Medical Services: NHTSA Experience to Date,* relating several projects on air medical rescue by helicopter.[14] This means of transport has since enjoyed widespread use in several medical emergency services.

The first air medical service associated with a trauma center, with a helipad and air medical base, was successfully organized in 1973 in St. *Antony's Hospital*, in the city of Denver, U.S. Since then, the use of helicopters to transport patients increased considerably. In the U.S., in 1993, there were records of around 136,000 patients transported by helicopter, a considerable amount that tends to increase (Prof. Vieira; Ciências Aeronáuticas – Universidade Estácio de Sá).

Well-trained air medical teams started to crew ever-faster aircrafts such as jets; true flying ICUs. The initial speed of 27 km/h escalated to 900 km/h in pressurized cabins, comfortable environments for patients and medical teams, with strict international standards for speed and safety.[10]

In the twentieth century, progress came quickly in relation to stabilization and transport of critically ill patients. The early resuscitation and timely transfer of appropriately screened patients and well prepared teams were determinant in reducing morbidity and mortality, within the so-called 24 golden hours.

The importance of AT in Brazil becomes clear when its continental dimensions, with 8,514,876,599 $km^{2,}$, are considered. About 184 million people inhabit this space, with concentration of around 42.5% of the population in the Southeastern region.[15] The Amazon Forest, the largest equatorial forest in the world, comprises much of the territory where medical care is often and only possible by boats and helicopters. Another important factor is that most of the health facilities with high degree of specialization are located in the Southeastern region of the country.[15]

The free and humanitarian Air Medical Transport System in Brazil is closely linked to the military, more specifically to the Brazilian Air Force (FAB), the Military Police and the Fire Department. These institutions are responsible for rescues and, sometimes, inter-hospitals removals on behalf of private companies somehow connected to health service plans.

BRAZILIAN LEGISLATION

Any air medical service must be under the technical authority of a medical technical director, trained and certified in prehospital emergency care, with basic knowledge of flight physiology and aviation. Some degree of specialization in Aeroespacial Medicine is also recommended. Every institution or company that conducts air medical transport must be properly registered with the Regional Council of Medicine in the city of the institution's headquarters (CFM Resolution No. 1596 of June 9, 2000).

Air medical transport must comply with specific laws and regulations of the Air Force Command, through the National Agency for Civil Aviation (ANAC), which does not rule over the medical activity but controls the activities of aviation professionals, based on the Aeronaut Law (Law nº 7,183/84 and Law nº 7,565/86) and the Interministerial Decree nº 3,016/1988.[16,17]

An aeronaut, according to the legal provisions cited, is a professional licensed by the Ministry of Aeronautics to conduct activities on board a civil aircraft under a national employment contract governed by labor legislation or a person who conducts activities on board a foreign aircraft in virtue of an employment contract governed by Brazilian law. The following are thus considered aeronauts: the pilot or aircrew commander, the copilot, the flight engineer, the navigator, the radio flight operator, the flight instructor, the air

steward and the operators of special equipment installed in the aircrafts.

It is ANAC's responsibility to enforce the relevant legislation in the system controlled by ANAC, so that ANAC also supervises the activities of air taxi companies.[18]

It is important that professionals working in aerial transport know the legislation, as well as some rules and restrictions that interfere directly in the planning and execution of the AT. As an example, we can mention the rules for overnight flight, which forbids unauthorized aircrafts or aerodromes not approved for such purpose to operate at night, thus limiting or preventing transportation to be performed. Inadequate planning implies in the impossibility of performing transport or requires non-standard transportation to be used, without adequate security, for time constraints. Likewise with the law that regulates the working hours of pilots, created to increase flight safety by avoiding physical and mental fatigue of the crew. Failure to comply with the legislation forestall transport or generate flight risks, endangering the lives of pilots, medical team, patients, and whoever else is on board the aircraft.[17]

When several air medical transport companies were created in Brazil in 1998 the then Department of Civil Aviation (DAC) consulted with the Federal Council of Medicine (CFM) so as to create norms for medical urgency activities in AT, bearing in mind that CFM Resolution No. 1,529/98 already standardized prehospital medical urgency-emergence care.[19] On July 29, 2003 the CFM issued Resolution No. 1,671/03, which revoked Resolution No. 1,529/98 and began to all regulate prehospital care. AT service is part of the medical care system for prehospital urgency-emergency care, and is regulated by the following Ordinances of the Ministry of Health: GM/MS No. 2048 of November 5, 2002 and No. 1863/GM of September 29, 2003, and the resolutions of the Federal Medical Council that regulate prehospital service (CFM 1.671/2003), inter-hospital transport service (CFM 1.672/2003), and AT (CFM 1.661/2003, which revoked the CFM 1596/2000 because it is part of the Administrative Procedures Manual).[20-24]

The Federal Nursing Council (COFEN), through Resolution 260/2001, came to define Aerospace Nursing as a specialization.[25]

These resolutions and ordinances began to classify the types of ambulance and determine equipment, materials, and medications as well as how teams were formed and their composition, screening criteria, obligations, and required documentation.

AIR MEDICINE

The first reference to the physiological changes in higher altitude appear in 1590 in an extraordinary and meticulous description made by the Jesuit priest José de Acosta, who expounded on the illnesses and discomfort experienced while crossing the Paricaca in the Peruvian Andes.[26]

The "flying priest", as the Brazilian Bartolomeu Lourenço de Gusmão became known, was the first in all history of aeronautics to build a balloon to rose freely into the atmosphere in 1709.[27] There is no evidence that there were passengers transported in his balloons, although some sources mention Gusmão himself would have flown in a larger balloon, launched at the parade ground of the Castle of S. Jorge which, after traveling 1 km, fell crashing onto the Terreiro do Paço. [28]

The Montgolfier brothers, Joseph Michel and Jacques Etienne "discovered" in 1782 that the smoke from a fire would cause a silk bag to inflate and fly. On June 5, 1783, they made a public presentation of their "discovery" using with a paper-lined silk balloon: The balloon rose to about 1,830 m, covered over 1.6 km from the starting point, in a 10-minute flight. To evaluate the effects of altitude on living beings, on September 19, 1783, the Montgolfiers placed a sheep, a duck, and a rooster on board the balloon. After landing, the animals were unchanged. Once flight safety for living beings had been tested, the first known human ascent in altitude was made in a balloon attached to the ground, on October 15 in that same year, by Francois Pilarte de Rozier. Approximately one month later, on November 21, Rozier and the Marquis d'Alrandes crossed the city of Paris in a balloon built by the Montgolfiers, performing the first free flight.

With more balloon and airplane flights, reports of changes due to hypoxia, hypothermia, airsickness and flight pressure changes started to appear, followed by reports of accidents and deaths as a result flying. Studies were soon carried out to address these events and make air activities less aggressive and safer. Before World War I, there were 32 publications analyzing aspects of Aerospace Medicine.[29]

Paul Bert (1833-1886), a French physiologist, considered the "Father of Altitude Physiology" as well as

the "Father of Aviation Medicine", developed important theoretical works using hypobaric or altitude chambers, correctly expounding on the causes of altitude sickness and gas poisoning (oxygen and nitrogen). He appropriately described the changes in performance of aviators as justified by the effects of hypoxia, hypothermia, airsickness, and pressure changes.

After the first self-propelled flight, new challenges emerged in adaptation to flight, with more obstacles to be overcome, which were soon understood as problems to be solved by Physiology and Medicine.

The rapid technological expansion in the aeronautical field led to increased speed, altitude, and performance and in the complexity of the flying machine. Consequently, physical parameters and training needs were increasingly being imposed on aviators. The Germans, realizing the value of aviation as a weapon, organized a systematic study of the physiological reactions in airship crews and on pilots in high altitudes, establishing strict criteria for selecting the most suitable individuals for flight training (1910). There was a shift from the original principle that everyone could fly to one that limited flying only to those fit for it, perfect for it.

Some rudiments of Squadron Medicine of were published in England in 1912. That same year, the principles for evaluation of pilot candidates were published in the U.S. This kind of strictness in examinations led to a decrease in the number of approved candidates and to a shortage of pilots deemed fit for military activity, causing the rules to then become relaxed.[29] Moreover, the voracious needs of the war, and the belief that bravery and enthusiasm for flight would be sufficient to train a pilot, led the British to demand nothing else than the criteria already in use for selecting any military personnel for infantry or cavalry. Air battles soon showed relaxing the rules was highly pernicious and that pilots were physically and psychologically unprepared. At the end of the first year of the war, Great Britain made a review of combat casualties. The ophthalmologist William H. Wilmer, an American professor of anatomy at the University of Pennsylvania (1773-1853), reported that for every 100 RAF pilots killed, two were killed by the enemy, eight by mechanical problems of the aircraft and 90 due to pilot error. Wilmer never revealed details of his statistic source.[30-32] Although Wilmer's numbers of "90-8-2" are frequently cited, this statistic never appeared in English aeromedical literature.[33] Possibly as a result of these deaths, in 1916 "The Royal Flying Corps" established strict criteria for selecting and training of pilots. With these measures, the number of casualties by unprepared pilots fell drastically.[29] The most visible result of this service was the creation of judicious rules introduced for selecting pilots and improvements in lodging and eating conditions, which allowed more effective training. Better outcomes were quickly reached: deaths due to physical problems dropped from 60% in the first year to 20% in the second, and to 12% in the third year of war.[30-32]

Statistical data published by Hobson (1995) did not confirm Wilmer's numbers.[34] While 90-8-2% is still frequently cited by air medical authorities, no one ever confronted or tried to explain them. There is no proof of its authenticity or citations by any author or British air medical publication. The official list of British pilots killed in action does not approach this percentage,[33] making this information questionable and not the absolute truth.

The stress caused by altitude flight had been experienced even before World War I, not by airplane pilots, but by the crew in German airships, which used, for the first time, oxygen equipment to maintain crew performance. In 1915 an Aviation Medicine sector was created in the German military health service. This attitude was key to the initial success of the German air force and few serious medical casualties were registered among German pilots. These results emerged from creating a program of physiology research centers focused on the study of man during flight.

In the U.S , selection criteria for American pilots were set by Theodore Lyster in 1916. With these new standards, about 30% of candidates were disqualified, mainly due to eye problems. Lyster established in 1917 as the mission of medical officers of the American Army to help evaluate pilots. Officer were expected to investigate any conditions that may affect the pilot's efficiency, to decide on the conditions, experiments, and tests to determine the ability to fly at high altitudes, to develop and test experiments to provide pilots with oxygen during high altitude flights, to create parameters for assessing the conditions of pilot applicants. [29]

In France, Lyster created a research laboratory to study the problems arising from airborne activities and to support the airborne American Expeditionary Units, establishing in the following year, the first School of "Flight Surgeons," whose purpose was to train doctors in the American Expeditionary Force. Anderson set in 1919 the physical requirements for pilots, different from those described by Americans, but also originating from observations made during the war.

The first Brazilian military fly a balloon in the city of Rio de Janeiro was Pinheiro Guimarães in June 1906. In 1921, Emydio Joaquim Pereira Caldas highlighted in his thesis "On aeronauts' sickness" the role excessive intellectual work as one of the components of this malady, while the 1923 publications focused on ophthalmic and otologic afflictions in aviators. In the same year, the Brazilian Navy sent Lieutenant Pontes de Miranda to the U.S. to attend the "School of Aviation Medicine," where he graduated as a "Flight Surgeon".[29]

The Navy also created in 1927 the Naval Aviation Medicine service and established the First Board of Health Inspection for naval aviators. In the following years, 1928 and 1929, the Army began conducting medical and psychometric tests with the purpose of evaluating candidates for military aviation. In 1929 and 1930, the Navy sent doctors to study Aerospace Medicine in the "Naval Medical School" in Pensacola, and in 1931 the First Board of Health Inspection for aviators was created with doctors specialized in Aviation Medicine, thus creating the first Course of Aviation Medicine in Brazil. The first class graduated in May, 1935.[29]

In 1933, the Army constituted the Medical Board of Military Aviation in the Campos do Afonsos, later transformed into the Medical Aviation Service and later into the Selection, Control and Research Institute, in charge of admission and periodic examinations, besides promoting studies in Psychology, Physiology and Hygiene. In 1937, the Department of Civil Aviation was created under the Ministry of Aeronautics and Public Works to select and supervise civilian aeronauts. The Ministry of Aeronautics of Brazil was created on January 20, 1941.

Specialization courses in Aerospace Medicine, available for doctors of the Brazilian Air Force (FAB) since 1942, became open to civilian doctors in Brazilian airline companies. Among the Special Units we can highlight the Center for Aerospace Medicine (CEMAL) and the Institute of Aerospace Physiology. CEMAL is the central body for medical inspections, designed as part of the medical examinations required to assess the medical fitness of candidates for flight licenses or for periodical renewal of technical skills, whose frequency depends on the type of license. At the Institute of Aerospace Physiology training courses on physiology are taught to military and civilian aircraft crews in Brazil, offering the most modern equipments for teaching and assessing crewmembers. In 1970, the Ministry of Aeronautics began the "Development Plan for Aviation Medicine in the Brazilian Air Force" and in 1972 the Air Force Center for Specialization in Healthcare was created.

The future of Aerospace Medicine is in Astronautics, as well as the creation and maintenance of intermediate stations designed for refueling and spacecraft servicing. These developments might create the need for temporary and, perhaps, definitive fixation of human beings to develop support activities in these bases. All knowledge to meet this challenge will derive from studies in Aerospace Medicine.[29]

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