Aeromedical Transport

Basic Aspects of Aeromedical Transport

Dr. Nicolás Arrocha Rodríguez, National Aeronaval Service (SENAN) of Panama

All photographs provided by author

Humankind's first step embarking on the adventure of conquering air and space was planted in antiquity through the story of Daedalus and his son Icarus. The Greek myth states that the protagonists were able to escape from their confinement on the island of Crete using wings Daedalus made by affixing bird feathers together with wax. By this epic action, the two became the first humans able to achieve the sought-after goal of flight and, therefore, are considered aeronautical pioneers.

However, their adventure ended tragically when Icarus, entranced by the flight and newly acquired freedom, disobeyed the advice given by his father to avoid flying close to the sun. His actions resulted in the sun melting the wax that held the young man's wings together, causing him to fatally fall into the sea.

This myth became reality centuries later, when brothers Wilbur and Orville Wright, in the United States, and Alberto Santos Dumont, in Brazil, again undertook that primeval attempt to soar through the air, but now under different conditions. It was only a question of time until aviation managed to develop and fulfill its historical purpose, yielding a variety of contributions accross a wide range of human activities.

Medicine is one of the areas that directly benefited from the rise of aviation. Patient airlift soon became the best option for preserving life and reducing possible complications stemming from the delay in receiving care. From the beginning stages in the development of aerial navigation, aviation has consolidated its relationship with medicine through aeromedical transport or evacuation, becoming a fundamental element in saving lives. Soon it became common to use rotary-wing or fixed-wing aircraft to remove injured people from conflict zones, natural disaster areas, or in civilian areas, due to injuries or illness, and take them to a medical facility with sufficient medical-surgery capability.

When speaking colloquially about patient airlift, we tend to use very frequently the term medevac (*medical evacuation*) to refer specifically to aeromedical evacuation; however, this term does not necessarily imply the use of aviation. The term refers to the transfer of ill or wounded people by either air or ground methods.

The care team designed for aeromedical evacuations is made up of medical and technical personnel. Depending on circumstances, personnel can perform in one of two specific scenarios, based on whether the intervention occurs as a primary or secondary action.

A primary aeromedical evacuation implies that the medical airlift team is first to arrive on the scene. In this case, the team will be in charge of conducting an evaluation and providing the initial care in place, using available resources. In a secondary aeromedical evacuation, the intervention occurs when the victim has already received attention before aircraft arrival, for example when patients are already hospitalized or being taken care of in an emergency hospital unit. In both instances, airlift fulfills the function of moving people to continue care or carry out diagnostic evaluations when resources are not available at the point of origin.

Background

According to some, the first time aerial transport was used to shorten the transfer time for injured people took place during the siege of Paris in 1870. In the middle of the Franco-Prussian War, and being unable to use conventional ground routes, 160 injured French soldiers were evacuated by employing hot-air balloons. Among the main conflicts during the twentieth century, aerial transport proved to be a quicker and more efficient alternative to ground transportation, given the need to take care of injured soldiers on the battlefield.

When WWI (1914–1918) broke out, aviation was used for the first time as an active element within the conflict. However, those first aircraft were designed with the exclusive aim of carrying weapons for combat and had limited space. Thus, their presence as a transportation means for ill and injured soldiers was not very relevant. The aircraft at that time did not have the minimum accommodations for the transport of patients, and when this was done, the injured soldiers were airlifted without the presence of medical personnel and in many cases were not protected against environmental changes such as low temperatures and oxygen pressure due to the flights' altitude. During that period, the French doctor Eugene Chassaing (1876–1968) came into the picture, considered by some as the father of medical aviation. In 1918, Chassaing carried out the first medical airlift in history, and it was the beginning, a more structured method of medical transport.

WWII (1939–1945) brought substantial changes to patient airlift. As part of the crew that would accompany the injured during airlift, one could count on personnel trained in medicine as well as having knowledge of the physiology of flight, meaning better care during transportation. The US Air Force created, in 1942, the first aerial squadron of medical ambulances, by order of Lt Col David N. Grant, first surgeon of the Army Air Forces, which established and defined medical procedures for handling airlifted patients. In February 1943, the first training of flight nurses in the Army Aerial Evacuation Service commenced.

The Korean conflict (1950–1953) presented a very different battlefield than the two prior wars. The majority of the territory that makes up the Korean peninsula is rugged, with a mountainous topography that made difficult the use of ground vehicles; thus, rapid mobilization became fundamental. Medical units in the field had to turn to helicopters to transport injured soldiers from distant zones to military hospitals, known as Mobile Army Surgical Hospital (MASH) units, popularized later by the "MASH" TV series in the 1970s.

The Bell H-13 helicopter was especially suited at that time for aeromedical transport due to its versatility and maneuverability and was easily identified by its bubble-shaped cabin. Due to physical space limitation, injured soldiers were airlifted on stretchers placed on the outside of the helicopter, supported on the skids on each side of the aircraft. In order to provide the patient with a certain degree of protection from the wind, the patient's torso was covered with a capsule. Airlift considerably reduced the time elapsed between the moment the injury occurred and arrival at the care center during the conflict. This contributed to a reduced mortality of 2.4 percent, compared to 8.8 percent during WWI.

The Vietnam War (1964–1975) took place in a scenario very different to the one experienced in Korea. Vietnam is located in Southeast Asia, a region covered by abundant rainforest vegetation, which, together with an irregular terrain and the presence of large rivers, created natural obstacles for the prompt mobilization of injured troops via ground transportation. This made the use of helicopter Medevac fundamental, a task for which the Bell UH-1 Iroquois helicopters provided a decisive contribution. These aircraft carried out evacuations under fire, where the possibility of direct damage to personnel and rescue teams was very high. This led to the development of the scoop-and-run technique, as well as the need to begin or continue medical care in flight. During this conflict, care for the injured improved, ultimately reducing the mortality rate to 1.7 percent.

In the 1990s, short and long reach aircraft, mainly the Bell UH-1V and UH-60 Blackhawk, used for the transport of injured people during the Iraq War in the Persian Gulf brought a capability far superior to that of their predecessors. The many lessons learned considerably changed the profile of aeronautical medicine as it applied to patient airlift. Notable technological advances in patient airlift, mainly in the training of medical personnel, as well as flight equipment, have set new directions in the care of airlifted patients.

Physiological Effects during Flight

The exposure of an ill or injured person to airlift generates a physiological response very different to the one expected during a ground or maritime transfer. While we cannot emphasize enough the benefits of aeromedical transport, it is necessary to recognize the effects the body will experience in the face of physiological changes.

During the development of aeromedical transport, the presence of four relevant variables to the survival of the person airlifted need to be considered. The variables that exert direct or indirect effects on the victim are the medical condition of the patient, the resources available on board, the aircraft itself, and the conditions of the aeronautical environment.

Figure 1. Physiological effects during flight

The proper identification of the interaction of these components gives us a chance to generate actions to counteract them or at least, to mitigate their effects. Thus, the airlift of patients starts with the aircraft still on the ground, providing the opportunity to evaluate the risks or benefits the patient will be exposed to, in order to reduce the complications of the most likely scenarios that can arise during transfer. During flight, the team responsible for the patient will depend exclusively on their knowledge and experience, as well as the support equipment available on board (figure 1).

Patient Condition

The morbid or traumatic status and the complications derived from the conditions present in a patient before the transfer can put him or her at a disadvantage, requiring serious considerations during flight. This stresses the importance and need for diligence in the medical evaluation of the patient, in addition to obtaining a good clinical history. It is important to detect medical conditions that could compromise proper lung ventilation, the transit through the alveolocapillary membrane, and the transfer of oxygen to the tissues. These conditions could be due, for instance, to fractured ribs, unstable thorax, pneumonia, bronchitis, pneumothorax, hemothorax, and so forth, in addition to cardiac situations like arrythmia, heart attack or heart failure, that can worsen or become more complex during the flight. Patients with these afflictions have poor oxygenation worsens when submitted to a hypoxic environment, if the proper measures are not taken.

Available Resources

The minimum requirements needed to give vital support to the patient during the airlift must be present in the transport aircraft. The effort of the personnel giving care must be geared to maintaining the stability of the patient's condition in addition to offering the best possible comfort.

To that end, there must be equipment for the integral management of the airway and the administration of supplemental oxygen, which must be sufficient to cover needs during the flight in addition to sufficient medicine available for the care that may be required. A heart monitor-defibrillator is essential for airlift, as well as equipment to monitor vital signs, preferably digital, since the noise inside the aircraft can make it impossible to measure by conventional means. The use of portable equipment for the administration of intravenous therapy or mechanical ventilation is also a good option for the care of the patient in flight. All this equipment must have the ability to work in a stand-alone mode during prolonged trips in order to avoid interference with the aircraft's equipment.

Aircraft

First to consider is the space available inside the aircraft. This can change according to the type or model of aircraft that is being used. In some cases, a small area can be a significant limitation, if the use of extensive support equipment is required or if a large number of victims need to be transported.

Furthermore, beyond physical capability, the aircraft has some inherent characteristics that can directly affect the welfare of the airlifted patient. Among these, three important factors stand out: noise, vibration, and acceleration:

- **Noise**. Engines are the main source of noise in an aircraft, easily surpassing our tolerance of 85 dB, and therefore can limit the auscultation capacity of patients or the employment of any other evaluation variable that depends on hearing. Noise can, on top of direct acoustic trauma, generate stress, anxiety, tiredness, fatigue, dizziness, nausea, or vomiting, in patients as well as in the crew. Eventually, the continuous exposure of the crew to noise can result in the loss of hearing if protection measures are not taken.
- **Vibrations**. Aircraft generate vibrations in a wide range of frequencies. Helicopters, for example, generate vibrations between 12 and 28 Hz or more depending on their structure, with the most harmful in 4 to 15 Hz range. The harmful effects of vibrations are produced by the *resonance phenomenon*. This occurs when frequencies generated by the engines of the aircraft match the natural frequencies of the human body, which can induce organs and tissues to vibrate, resulting in increased friction between them. The harmful effect of vibrations worsen if the patient is subject to direct contact with the structure of the aircraft.
- **Acceleration**. The effect produced by the acceleration of an aircraft is based on the principle contained in *Newton's Third Law of Movement*. Taking into account that acceleration forces operate in three axes, longitudinal (z), transversal (x) and lateral (y), their effects will always manifest themselves around the person to a greater or lesser degree, but more so in fixed-wing aircraft than in rotary-wing aircraft. The forces generated on the first two axes are the ones that exert a larger physiological load, depending on the position adopted by the patient during the flight. In a fixed-wing aircraft, the biggest impact of the acceleration force on the transversal axis manifests itself-when taking off or landing. If in an aircraft we have a patient lying face up (*dorsal decubitus*), with his head directed toward the nose of the aircraft, when the aircraft takes off (accelerate) it will cause the displacement of fluids in the direction of the inertial vector; that is, opposed to the traveling direction of the aircraft, toward the feet of the patient. During landing (deceleration), keeping the patient in the same position, the displacement of fluids and consequently the inertial vector, will be in the direction opposite to the deceleration, towards the patient's head.

Environment

The aeronautical environment has always been considered hostile for human beings, even more so for a person physically compromised. As we rise into space, atmospheric pressure diminishes with a proportional reduction of oxygen pressure, nitrogen, and other gases that comprise it. Our primary interest is focused on oxygen, which, with this pressure reduction, loses the capacity to diffuse from the pulmonary alveola to the circulation system.

The scarcity of oxygen supply to the human body as the aircraft gains altitude consequently causes hypoxia (Dalton's Law). Hypoxia, depending on time exposure and intensity, deteriorates organs and systems and accentuates adverse physiological effects in an injured or ill person.

There is another particularity in the aeronautical environment also related to the reduction of atmospheric pressure due to altitude. It consists of the expansion or volume increase of gases as the aircraft ascends (Boyle's Law). Inside the human body, this expansion affects all the gases contained or trapped in cavities. Patients (or crew) that show flu symptoms can easily present symptoms of barotitis or barosinusitis due to the air trapped in the middle ear or nasal sinuses, respectively. Patients having a disease or injury that affects intestinal motility (*paralytic ileus*), that have required recent abdominal operations or in those who, due to diagnostic studies, have required the insufflation of gas in the abdomen, will present those effects. The expansion of trapped gases is produced in a proportion that varies between 5 to 7 percent of the volume for each 1,000 feet (300 m) of rise.

Environmental temperature also presents a modification in direct proportion to flight altitude as the temperature diminishes at an approximate ratio of 2° C for each 1,000 feet of elevation. This variation increases the risk of hypothermia in patients if corrective measures are not taken.

Finally, in-long trips or at a high altitude, there is another environmental factor, which is caused by the reduction of humidity. As a consequence of this decrease, dehydration in people increases, indicated by signs of dryness of the eye conjunctiva and in the oral and nasal cavities. Additionally, the risk of fluid loss is greater in the transport of patients with burns.

Personnel Competencies

The promptness, versatility, and autonomy of movement provided by aircraft give a great advantage in the survival of injured personnel. This, above all, is crucial in places where regional terrain restricts ground transportation. However, this invaluable tactical advantage diminishes significantly if we do not have proper care on board. Thus, all personnel involved in the direct care of a patient during flight must have the necessary basic and specific competencies in emergency medical care, in addition to knowing the principles of flight physiology.

The preparation of personnel responsible for providing care during flight demands knowledge about aerospace and flight physiology and an understanding of how this continuous aggression on the human body can have undesired consequences. The introduction to aerospace physiology as a key tool starts with the knowledge of the principles stated in the laws of gases (chart 1), which explain the behavior and effect of gases in the human body. In aerial transportation it is important to determine the effect of the gases in the human body and in the equipment used for care.

This is an essential part of the training of personnel in basic vital support, advanced vital support, advanced vital heart support, vital support of prehospitalization trauma, triage, extrication, and other competencies. Additionally, personnel must be familiarized with the location and use of biomedical materials and equipment within the aircraft.

This preparation and care undoubtedly provide a series of advantages for the patients, among which is the prolonging of care during transit from the medical center. Of great importance is the quality of the initial care, since this can prevent, in many cases, complications or the need for further treatment. It is also of great importance to properly prepare the person to be transferred by taking into account the nature of their injury or illness. Even personnel who carry out uncomplicated programmed transfers from a less capable hospital to a more sophisticated facility must also have this general knowledge.

Chart 1

Gas Laws and Their Physiological Meaning

Boyle's Law. Indicates an inverse relationship between the volume and pressure of a gas at a defined altitude. It explains the pneumatic dilation of the gases contained as the altitude increases.

Dalton's Law. Indicates that the sum of partial pressures of the gases that make up the atmosphere constitutes atmospheric pressure. It explains why hypoxia is produced by altitude.

Graham's Law. Gases diffuse from a place where their pressure is elevated towards another where the pressure for that gas is lower. It explains the passive transportation of oxygen through the alveolocapillary membrane to the blood.

Henry's Law. The amount of gas dissolved in a liquid is directly proportional to the partial pressure exerted by that gas over the liquid´s surface. It explains how decompression illness is produced, a risk observed with more frequency in people who dive and very rare in aeronautical personnel.

Preparation for Aeromedical Transport

Detailed information is essential in aeromedical transport. Evacuation requests must be correctly documented, in such a way that the diagnosis causing the patient to be airlifted is understood. They must also have a recommendation on the type of aircraft that is most appropriate, personnel that must accompany the flight, support equipment necessary, as well as the number of victims and the final destination of the aircraft. It must also account for verification and reception of ground transportation for the patient once the flight is completed. All this with the understanding that an aircraft equipped with all the requirements might not be available, for example unavailability of a pressurized aircraft for patient airlift at high altitude.

At the moment the use of aeromedical transport is required, the team responsible for the mission must ask at least three basic questions in relationship to the request:

- Can the patient's clinical condition be corrected in nearby facilities?
- Would the patient's situation be aggravated by the conditions of the aircraft itself?
- Do we have the minimum vital support required on board to take care of the patients during the flight?

The intent of the first two questions is to evaluate the risk to carry out the patient transfer by aircraft. The degree that the status of the patient may be compromised with the physiological changes during the flight must also be evaluated. Finally, the capability to carry out the transfer, based not only on the competencies of the medical crew but also available resources, must also be evaluated. If the patient needs emergency service or intensive therapy, the availability of specialized personnel and the necessary support equipment, in addition to a controlled environment, must also be taken into consideration, as this capability could be limited during flight.

Considerations before the Flight

As previously discussed, among the processes that can compromise the life of the patient during airlift are hypoxia and the expansion of trapped gases. Thus, the preparation and care of the patient must precisely take this into account in order to take the appropriate steps.

First, the presence of illnesses or injuries that can be affected by altitude needs to be assessed. All situations that affect correct lung ventilation, with pneumothorax and hemothorax presenting the biggest risk, must be resolved before even thinking about airlifting the patient. In the case of a patient with indications of a fracture at the base of the skull, the presence of trapped air within the cranial cavity presents a scenario that demands evaluation of the risk versus the benefit of the airlift.

Those patients who are admitted to an intermediate treatment unit or cared for at an emergency facility have the advantage of having complementary exams that allow better definition of their clinical profile. The information about the patient's condition by means of their vital signs is complemented to a great extent by the lab tests available: glycemia, a complete hemogram, values of recent arterial gases, and so forth. A suitable option, where there is no gasometry, is determining the oxygen saturation by means of pulse oximetry. It is also recommended that the patient's hemoglobin value remains above 7.5 g/dl. Of equal importance is the contribution of special studies such as X-rays, computerized tomography scans, and so forth.

All patients who are going to be airlifted require essential guidelines to be followed:

- First priority is to guarantee a permeable airway or establish one according to the condition of the patient, with the purpose of assuring an adequate oxygen supply during the flight. If the patient requires the administration of supplementary oxygen, options run from utilizing a simple mask with a reservoir bag to intubation in order to obtain a permanent airway.
- One or two permeable venous paths must be maintained, according to the patient's needs, for the correction of volemia or the administration of medicines. Stability for osteo muscular injuries, either in their limbs or spine, through the use of a trauma table, cervical collars, splints, and so forth, must be provided. Provisioning for the possibility of hypothermia is needed as well, above all in the transfer of patients in a state of shock or in the case of pediatric patients.
- For those patients with gas accumulation in their digestive system due to paralytic ileus, surgical operations, or treatments, one can turn to the use of nasogastric or rectal probe. Also, in patients with a history of digestive bleeding, the placement of a probe is recommended since the distension of the digestive tube can reactivate a contained bleeding.
- The correct installation and function of equipment for monitoring and support of the patient should be verified: pleural tube, blood pressure gauge, heart monitor, mechanical ventilator, capnometer, pulse oxymeter, oxygen tank pressure gauge, and so forth. Attention must be paid to all support devices that may contain air, such as endotracheal tubes, probes, or inflatable splints among others, as the air contained in their internal components can increase the pressure on the a patient's tissues or surrounding structures. Thus, replacing the air with water is recommended.
- Safety measures need to be taken to verify that all equipment is fixed and secured before takeoff the flight. If there are several patients in the transfer, it is recommended

that the patient most severely compromised embarks last, so that patient will be the first in getting out of the aircraft after landing.

- In some patients, it is possible that their own medical condition generates a state of anxiety, a condition that can also be magnified by the flight. This can be caused due to the person never having flown before or due to a bad prior flight experience. In both cases, if the person is conscious, it is appropriate to interact with the patient to reduce anxiety.

Considerations during the flight

The medical crew in flight must directly monitor of the patient, to detect changes in clinical condition as well as the support equipment that is being used. The intent should be to carry out the fewest interventions possible during the flight, with the exception of those needed as a result of the patient's condition itself. The monitoring of the patient's status with the use of a heart monitor and pulse oxymetry are of great importance during the flight. The use of supplemental oxygen, if necessary, and its administration must match the saturation levels of the patient according to the flight's altitude.

The crew must be capable to carry out procedures in flight when, for safety reasons, the aircraft has to abandon the scene quickly or because the evacuation site is in a hostile zone. The presence of turbulence is not unusual in flight, and this, plus the stress to which the patient is subjected, can induce nausea or make the patient vomit, for which it is necessary to have suction equipment on board as well.

Considerations at the End of the Fight

Before descent, the medical crew must secure support equipment and the patient. Those procedures whose execution is not essential should wait until after landing. Once on the ground, the aircraft crew should await a clear order to start disembarkment. The delivery of the patient to the receiving team on the ground should include a report on the patient's condition during the flight, as well as any drugs administered or procedures accomplished, and its importance should not be minimized under any circuntance.

Perspectives of the Aeromedical Evacuation

Medical aerial transport has presented, from the beginning, major challenges for medical care and will continue in the future. However, the benefits of aerial transport in saving lives are priceless.

The readiness of personnel to act in the most diverse scenarios guarantees the ability to provide a quick response to meet medical necessities. In order to fulfill this principle, training programs must be developed to improve the readiness of aerial transport medical crews. As discussed, aeromedical transportation is far from being the simple expedited transfer of an injured or sick person, instead it represents the sum of human and technological advances and efforts to guarantee continuous quality care. ❑

References

Acuña, Faustino, and Eduardo Chávez Márquez. "Aeromedical Transportation: Fiction and reality." Trauma 4, n°2 (2001): 70–76.

www.medigraphic.com/pdfs/trauma/tm-2001/tm012f.pdf.

Hernández, Noé. M., and Carlos E. Ramos Olivera. "Transporte aeromédico del paciente crítico" (Aeromedical Transport of Critical Patients). Revista de la Asociación Mexicana de Medicina Crítica y Terapia Intensiva 21, n° 4 (2007): 2006. www.medigraphic.com/pdfs/medcri/ti-2007/ti074h.pdf.

Rajdl, Eduardo. "Aerotransporte: Aspectos básicos y clínicos" (Aerial Transport: Basic and Clinical Aspects). Revista Médica Clínica Las Condes 22 n°3 (2011): 389–396.

www.clc.cl/clcprod/media/contenidos/pdf/MED_22_3/389-396-dr-rajdl.pdf.

Illescas Fernández, Gerardo J. Manual de transportación aeromédica por helicóptero (Aeromedical Tranportation Manual by Helicopter). Madrid: Editorial Alfil, 2007.

Pérez Hidalgo, Ignacio. "Preparación del paciente para evacuaciones aéreas" (Patient Preparation for Aerial Evacuations). Emergencias vol 9, n°1 (1997): 35-43.www.medynet.com/usuarios/jraguilar/helicopt%202.pdf.

Russomano, Thais, and João de Carvalho. Fisiologia aeroespacial: conhecimentos essenciais para voar com segurança (Aerospace Physiology: Basic Knowledge to Fly Safely). Porto Alegre: Edipucrs, 2012.

Canaveris, Gerardo. Historia de la Medicina Aeronáutica (History of Aeronautical Medicine). Buenos Aires: Editorial Dunken, 2014.

Temporal, Waldo, Avelino M. Ottoni de Carvalho, Cláudia Paraizo Garcia, Geraldo da Fonseca Oliveira, Luiz E. Neves Pannain, Marcia Fajer, Maria Luiza P. Santiago Pereira, et al. Medicina Aeroespacial (Aerospace Medicine). Rio de Janeiro: Editora Luzes, 2005.

Velasco, Carlos. Francisco Ríos, Juan José Cantón, Vicente Velamazán, and José Azofra García. Medicina Aeronáutica: Actuaciones y limitaciones humanas (Aeronautical Medicine: Actions and Human Limitations). Madrid: Thompson Editores, 2002.

Martin, Terence. *Aeromedical Transportation: A clinical guide*. Hampshire: Ashgate publishing, 2006.

Hurd, Williams W., and John G. Jernigan. *Aeromedical Evacuation: Management of Acute and Stabilized Patients*. New York: Springer-Verlag: 2003.

McNeil, Edward L. *Airbone Care of the Ill and Injured*. New York: Springer-Verlag, 1983.

Torres, Andrés, and Eduardo Contreras. "Alteraciones fisiológicas durante el transporte aéreo de pacientes" (Physiological Alterations during Patients' Airlift). *Revista Médicas UIS* vol *21*, n°2 (2008): 86–93.

Revistas.uis.edu.co/index.php/revistamedicasuis/article/download/1130/1528/

Torres, Andrés, y Eduardo Contreras. "Transporte aeromédico de pacientes" (Aeromedical Transport of Patients). *Revista Médicas UIS* vol 2 n°2 (2008): 94-102.

Revistas.uis.edu.co/index.php/revistamedicasuis/article/download/1131/1529/

Soto Figueroa, Rodrigo, Sandra Pintos Toledo, and Carolina Jeria Huerta. "Evacuación aeromédica de pacientes críticos: experiencia institucional, revisión de principios técnicos y recomendaciones" (Aeromedical Evacution of Critical Patients: Institutional Experience, Review of Technical Principles and Recommendations). *Revista Chilena de Medicina Intensiva* vol 23, n°2 (2008): 65-74. medicina-intensiva.cl/revistaweb/revistas/indice/2008-2/3.pdf

Abarca Villarroel, Sebastián. "Evacuación aeromédica de pacientes críticos adultos. Consideraciones de enfermería" (Aeromedical Evacuation of Adult Critical Patients. Medical Care Considerations. *Revista Chilena de Medicina intensiva*. Vol 28, n°1 (2013): 19-26.

https://www.medicina-intensiva.cl/revistaweb/revistas/indice/2013-1/pdf/4.pdf.

Dr. Nicolás Arrocha Rodríguez, is active in the National Aeronaval Service (SENAN) of Panama as coordinator of aeromedicine of the Aeronaval Medical Department. Aeronautical Medical Examiner. Course for Specialization in Aerospace Medicine, Brazilian Air Force University. Human Factors in Aviation, Higher Institute for Professional Aeronautical Education (ISFPA, by its Spanish acronym). Postgraduate work in higher education, diplomacy in emergency medicine. Member of the Iberoamerican Association of Aerospace Medicine. Professor of aeromedical transport in emergency and disaster medicine degree, Specialized University of the Americas (UDELAS, by its Spanish acronym).