Air Evacuation of Citizens During the COVID-19 Epidemic

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BACKGROUND: The coronavirus epidemic originated in China, having its epicenter in Wuhan. This was the first place in the world to adopt social distancing measures to contain the disease on January 23rd, 2020. After the initial isolation, several countries started making diplomatic plans to evacuate and repatriate their citizens, with the permission of the Chinese authorities. Due to the high risk of exposure of the transported passengers, evacuations were conducted with preventive measures against contamination by biological agents.

CASE REPORT: We report the air evacuation of 39 passengers from China to Brazil. Five passengers were transported to Poland and the remaining 34 went to Brazil, where they remained in quarantine for 14 d. The mission was triggered on February 4th, named "Operation Return to Brazil" (Operação Regresso à Pátria Amada Brasil), and conducted by military personnel of the Brazilian Air Force. The mission was accomplished in 6 days; the flight from Wuhan lasted 25 h 20 min; and, additionally, there were on-ground preparations.

DISCUSSION: Only with adequate isolation and protective measures was it possible to air evacuate the potentially contaminated passengers in the initial phase of the pandemic. Specific protective equipment (Personal Protective Equipment – PPE) is mandatory for missions in which the properties of the potentially contagious biological agent are not fully known, as was the case. Due to the risk of contamination of passengers and the likely evolution of the transport into an aeromedical evacuation, protocols stating the minimum safety conditions for this kind of patient transport must be followed, with consideration for the patient as well as the crew.

KEYWORDS: aerospace medicine, air ambulances, coronavirus infections, military personnel.

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On December 31st, 2019, China reported the occurrence of an unknown acute respiratory syndrome affecting residents of the city of Wuhan. In January 2020, the World Health Organization (WHO)[8] released the results of the first analyses of the genetic sequence of the virus and proved that it was a new type of coronavirus, named 2019-nCoV (COVID-19). There was then great concern in the face of a disease that could spread quickly around the world, causing different impacts.[4]

The world was facing a new virus, unlike what happened in 2014 during the Ebola outbreak when the U.S. Centers for Disease Control and Prevention[3] issued guidelines for the air medical transport of patients with procedures that should be performed in an asymptomatic patient who developed symptoms during flight, especially when transporting several patients at the same time. For example, a public health emergency of international concern was declared by the WHO in 2014 with the Ebola outbreak.[3] A protocol was developed in order to ensure evacuation safety for patients and crewmembers, to minimize the impact on the fuselage, and to minimize the logistical requirements for personnel and final protective equipment while maintaining appropriate precautions in

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preparing for any foreseeable flight problems. Yet in the beginning of the coronavirus pandemic, the recommendations we have in place today did not exist yet.

The rapid spread of the novel coronavirus in the world has affected several health systems, initiating a serious global health crisis due to the large number of people infected in a short time. Numerous new cases appeared in several Asian countries, followed by countries in Europe and other continents, prompting WHO to declare a pandemic on March 11th, 2020.[1]

The recent events of COVID-19 challenge healthcare systems around the world. The aeromedical movement of patients with potential infectious diseases presents challenges for crews. The National Disaster Medical System's U.S. Department of Health and Human Services aeromedical evacuation teams directly supported 39 flights, carrying more than 2000 people. Infection control precautions focused on source and engineering controls, personal protective equipment, work safety practices to limit contamination, and containment of the area of potential contamination.[2]

SARS-CoV-2 is a betacoronavirus with the ability to spread easily. As of March 31st, 2020, the total number of infections and deaths from SARS-CoV-2 in the world was 754,948 and 36,571, respectively, according to WHO.[9] A year and a half later, in October 2021, these numbers reached 243,857,028 cumulative cases of infections and 4,953,246 cumulative deaths, according to WHO.[10] Human-to-human transmission occurs through close contact with an infected person by handshaking, droplets of spittle, sneezing, coughing, secretion, or contact with contaminated objects or surfaces (cell phones, tables, cutlery, knobs, toys, keyboards, computers, etc.). Aerosol transmission is also possible. Its incubation period for infection in humans varies from 2 to 14 d. The clinical symptoms presented by most patients are fever, respiratory tract symptoms (e.g., dry cough, dyspnea, coryza, sore throat), and other consistent symptoms, including myalgia, gastrointestinal disorders (diarrhea, nausea, vomiting), anosmia, and/or ageusia (loss of sense of smell and/or taste).

In Brazil, the joint action of the Ministries of Health (MH) and Defense was highly relevant due to the Armed Forces performance. Among the actions conducted, we highlight the "Operation Return to Brazil," which promoted the rescue of 34 Brazilian citizens who were in the province of Wuhan, China, the epicenter of the epidemic at that time.[7] The Institute of Aerospace Medicine (IMAE), belonging to the Brazilian Air Force (BAF), was summoned on February 1st to conduct the air evacuation initially of 39 Brazilians back to Brazil.

The air transportation of patients potentially contaminated by a biological agent transmitted by air rendered the mission unprecedented, with the need for detailed planning. This article reports an unusual and interesting aeromedical event, describing how the air evacuation of Brazilian citizens took place from the epicenter of the COVID-19 epidemic in Wuhan to Brazil. The mission was conducted by BAF military personnel and entitled "Operation Return to Brazil", being a remarkable milestone for the Brazilian Air Force, especially for the IMAE Health Military. It is noteworthy that we are currently observing great advances in studies on the disease, its transmission potential, and possible effects or sequelae, in addition to the implementation of tests and vaccines worldwide. However, at the time of Operation Return, it was a new situation, full of challenges with large gaps in knowledge and information.

CASE REPORT

On January 23, 2020, the rapid spread of the novel coronavirus led the city of Wuhan to adopt the measure of social distancing to contain the disease. After the isolation, several countries made diplomatic plans to evacuate their citizens.

The IMAE was designated by the Brazilian Air Force Command to participate in the mission because it is the reference unit in the teaching of all personnel involved in aeromedical evacuation actions in the event of chemical, biological, radiological, and nuclear defense (CBRN MEDEVAC) involving these kinds of threats. In addition to being responsible for this training in an Air Force context, the Institute regularly conducts and continually updates the doctrines and training related to this theme. Therefore, the military personnel of the Institute have specialized technical training, as well as specific equipment, to perform CBRN MEDEVAC.

On February 1, IMAE began to plan and conduct the CBRN MEDEVAC of initially 39 Brazilian citizens who were in the city of Wuhan, China, back to Brazil. The removal of Brazilians from Wuhan was only possible with the prior permission of the Chinese authorities, which had been granted through diplomatic channels in both countries. The mission was officially launched on February 4 and entitled "Operation Return to Brazil" and was conducted by BAF military personnel [IMAE medical teams and crew of the Special Transport Group (STG)].

The operation needed to be executed with detailed planning, with emphasis on procedures to ensure the safety of those involved. The following phases were carried out:

1) Preflight: Started with the preparation of the aircraft configuration and the provision of the material to be used in flight. Next, the planning of how the screening and health assessment of the returnees would be done before boarding the aircraft. All crewmembers who would be on board received guidance on the use of PPE and on the specific places (stations) for PPE donning and doffing in flight. Having in mind the preparation for onboard health care, a bed with emergency equipment for complications was set aside, in case of need. Separate equipment for onboard assistance, if necessary, were: multiparameter heart monitor, respirator, infusion pump, aspirator, supplemental oxygen, isolation stretcher, resuscitation equipment, backpack with supplies (orotracheal tube, syringes, briefcase with laryngoscope, ambu bag with mask bag reservoir, etc.), and a backpack with medication (dexamethasone, dipyrone, dobutamine, dramin B6, scopolamine butylpromide, tenoxicam, sodium nitroprusside, diazepam, midazolam, atropine sulfate, adrenaline, haloperidol, hydrocortisone, clexane, paracetamol, etc.) for emergency care on board.

The medical team performed a screening of passengers prior to boarding the aircraft, in the lobby of the airport in Wuhan, with a short questionnaire on symptoms presented in the last 48 h, temperature measurement, oroscopy, and pulmonary auscultation;

2) In Flight: The mission lasted 6 d, and the journey from Wuhan to Anapolis with passengers on board lasted 25 h 20 min. Attention during this trip was focused on the management of PPE to minimize the risk of contamination due to prolonged contact with potentially contaminated passengers until their return to the country. Meals were restricted, taking only a few longer stretches on the way back, so that the removal of masks would be avoided. A constant evaluation of the passengers was also carried out, with temperature monitoring, cleaning with alcohol gel, and changing the passenger's masks every 4 h.
3) Postflight and Quarantine: Three collections of material (nasal and oropharyngeal) were performed for coronavirus detection tests (RT- PCR) in each passenger and crewmember during the quarantine period, in addition to daily temperature and vital signs monitoring of the passengers (at least three times a day), and preparation for medical care, if necessary. None of the passengers had any symptoms related to COVID during the quarantine. There were only two emergency visits during this period, one dental and the other due to a simple ankle sprain, caused by a fall from his own height, by one of the repatriates.

Two STG EMBRAER 190 VC2 aircrafts had been assigned to the mission. IMAE selected among its staff, for each aircraft, a health team composed of three doctors, two nurses or nurse technicians, and one Control Element (a military person responsible for maintaining control of biosafety on board). In addition to the military, one doctor and one nurse (civilians), from the MH were added to the group, one for each aircraft.

In a transport like this, distance, adequate resources, destination resources, and potential risk of contamination must be taken into consideration, which require a team prepared both for performance and for mission planning. Due to the high risk of an accidental exposure of the passengers to be transported, evacuations were carried out with prevention for possible contamination by a biological agent.[1] The qualifications, theoretical and previous practical knowledge were provided the IMAE team who had the training and security necessary to perform in a real event.

Major challenges are faced when planning repatriation in a confined and restricted environment, such as that of an aircraft. As it was a mission with a high risk of contamination by a biological agent, still little known by the international scientific community, planning the mission required a detailed risk calculation. Many issues needed to be discussed to minimize the risks of transmission among passengers as well as professionals of both the aeromedical and flight crews. Coupled with all the common difficulties in the aeromedical transportation of potentially contaminated patients, there was added concern about the decreased performance and fatigue of the aeromedical crew on a flight that would be extremely long and would cross several time zones. There was also a concern with the amount of PPE that would be required to assist flight and aeromedical crews during the duration of the flight.

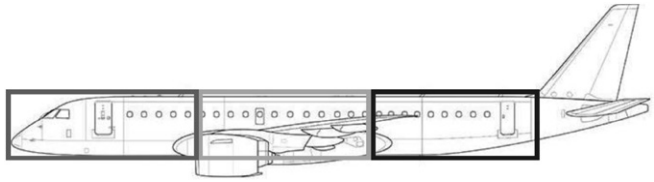

Fig. 1. Zone divisions in the VC-2 Embraer 190 aircraft (side view). The front section was the Cold zone, the middle was the Warm zone, and the back was the Hot zone.

To mitigate the risks on board, the aircraft was divided into three distinct zones according to the potential for contamination it offered (**Fig. 1**):

- Cold zone: the safe place, without imminent risk of exposure to the biological agent. Used by the pilots;
- Warm zone: the transition place between the cold zone and the hot zone. Used as a storage area for materials and supplies needed to serve the passengers. Also used for PPE donning and doffing, in addition to functioning as a rest area for the Health Team; and
- Hot zone: the place where passengers remained for the entire flight. As it offered a greater risk, access to the interior of this area was restricted to professionals suitably attired and essential for the operation (doctors, nurses, and military flight attendants).

The PPE used to enter the Hot Zone was Level C[5], and consisted of: uniform composed of a long-sleeved shirt (camouflage service uniform) and pants; protective suit (waterproof jumpsuit with hood and elastic at the ankles—type Tyvek® and Duvek®); three pairs of procedure gloves sealed with waterproof tape, like duct tape (the first pair of gloves sealing the long-sleeved shirt, the second one sealing the protective gown, and the third at the end, without sealing); N-95 mask for respiratory protection; and goggles. The N-95 masks were continuously worn by all military staff on board the aircraft, regardless of the area they were in.

All preparation for the mission was aimed at the safe transportation of the 39 passengers from the epicenter of the COVID-19 epidemic (Wuhan, China). Of these, five passengers were of different nationalities and were transported to Warsaw, Poland. The remaining 34 passengers were Brazilians, who were transported to the city of Anápolis, in Brazil, where they remained quarantined for 14 d after landing.

Before arriving in China, an online anamnesis (medical history) of the passengers was carried out by the MH to assess symptoms, health conditions, or other relevant data for the planning of the mission. One of the factors taken as relevant data was the fact that people ages 60 or over are considered a risk group.[6] Of the 34 passengers who were transported to Brazil, only 2.5% belonged to this age range, as can be seen in **Fig. 2.** Other previous pathologies had also been investigated to guarantee a planning that met the needs of passengers in a safe manner. Only five passengers made use of continuous

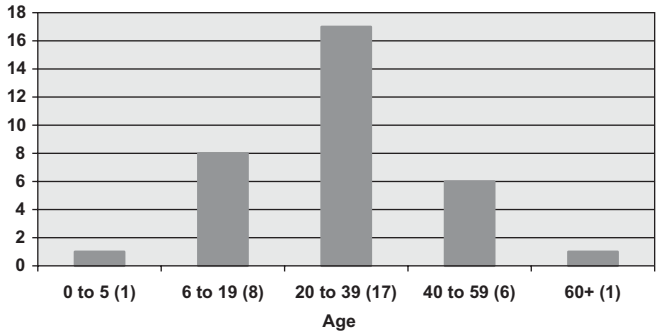

Fig. 2. Age of passengers transported in the air evacuation in January 2020.

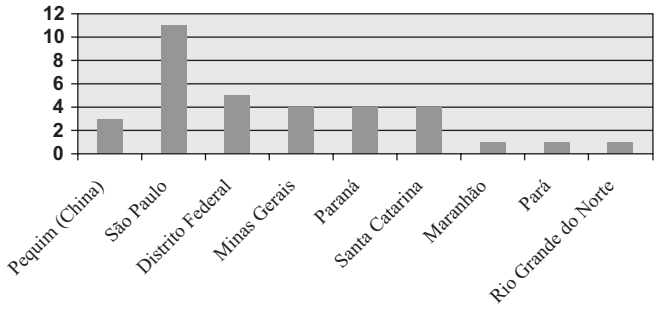

Fig. 3. The destinations of the passengers, after the quarantine was over: Pequim (China) = 3; São Paulo = 11; Distrito Federal = 5; Minas Gerais = 4; Paraná = 4; Santa Catarina = 4; Maranhão = 1; Pará = 1; and Rio Grande do Norte = 1.

medication. This survey of the patients' profile was of great importance for the planning of the mission. Based on these data, calculation was made for medications, equipment, PPE, and supplies that might be necessary in case of complications during air transportation.

In the Wuhan Airport lobby, medical screening was performed consisting of anamnesis, temperature measurement, pulmonary auscultation, upper airway evaluation (anterior rhinoscopy and oroscopy), and oximetry. All patients denied contact with patients with COVID-19. They also denied any symptoms that could suggest a COVID-19 infection. The use of any medications was not described, except for continuous use, such as, for example, medication for controlled systemic arterial hypertension. All screening assessments were within normal standards and all passengers were then allowed to board. At the aircraft door, asepsis was performed with alcohol gel and replacement of surgical protective masks. The time taken to change the passengers' masks was counted from that moment on, changing every 4 h of use.

Another relevant factor was the destination of the passengers after the end of the mission. Considering that there were still no cases of infections in Brazil, the decision was to carry out 14-d quarantine for passengers and crew at the air base located in the city of Anápolis (landing place). During the quarantine period, materials were collected three times to perform the RT-PCR exam to detect COVID-19 in all those inside the plane (passengers and crew). The first collection was made at the time of arrival in Brazil, the second was on the 7th day of the quarantine, and the third was on the 14th day, all of which tested negative. The destinations of the Brazilian passengers, after the quarantine was over, were distributed in eight states of the country, as shown in **Fig. 3**.

DISCUSSION

Only adequate isolation and protection measures made possible the air evacuation of passengers who could have potentially been contaminated with COVID-19 during the initial phase of the pandemic. The qualification and continuous training of the teams was a determining factor for the success of the mission, as well as experience with previous real cases, though not COVID-related.

Specific PPE is mandatory in missions in which the potentially contagious biological agent is not completely known, as in the case of the referred mission. The medical and technical teams who perform these evacuations must be trained in the proper use of the equipment to prevent contamination during service, in waste handling, and in the removal of one's own PPE.

Owing to the risk of contamination of passengers and the likely evolution of the transport into an aeromedical evacuation, it is recommended to create the minimum conditions for patient transport. The setup of a bed with the availability of equipment, the capacity to carry out procedures, and medication necessary for complications on board, besides the specific knowledge, are key for the preparation of the aircraft configuration, being essential for the safe transportation of these passengers. Dividing the aircraft into zones is a necessary measure to create protective barriers, which is essential for the biosafety of the work teams.

Currently, the prevention of SARS-CoV-2 contamination in the air transport of patients must be carried out through the use of PPE. If the transport is carried out in a country with a higher incidence of the disease to a country with a lower incidence, it is advisable to present proof of vaccination and to perform the RT-PCR examination up to 2 d before the air evacuation.

The use of personal protective equipment and the biosecurity of the transport scene are critical to the success of any mission. To sum up, capacity building, constant training, and well-executed planning are the main factors for the success of any type of aeromedical evacuation mission, especially those involving chemical, biological, radiological, and nuclear agents.

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