Research Article

"Cross-national Strategic Aeromedical Evacuation (Strat AE) flights during COVID-19 and Ukrainian Crisis in the European Air Transport Command (EATC) "

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ABSTRACT

European Air Transport Command (EATC) is an integrated command of seven nations. One of its core capabilities is that of Strategic Aeromedical Evacuation (Strat AE). During the global COVID-19 pandemic and the Ukrainian crisis, EATC has proven, that acting in concert is a valuable, effective, reliable option. This is achieved by pooling and sharing aircraft and personnel, thus having privileged access to a diverse fleet and pool of experts. Cooperation is based on a common set of rules and regulations. This ensures, that EATC is capable of addressing any problem with expertise. During the COVID-19 pandemic 1060 COVID-19 positive patients were transported in 198 missions. Neither death nor transmission of the disease were reported during those Strat AE flights. There were 986 military cases transferred , mostly routine priority (91,4 %). The other 74 cases were civilians, who were transported in 17 missions, 81,1 % of which were categorized as urgent. During the Ukrainian crisis, 251 patients were transported, 112 of which were military and 139 were civilians, including 30 children. Among the recorded injuries were cerebro-cranial, abdominal and chest injuries, as well as fractures (180) and amputations (48) of the extremities. EATC is recognized as a center of expertise within the aeromedical evacuation domain, where interoperability and harmonization of concepts are keys to safety and success . Cross-national missions, where a patient is evacuated by an aircraft and medical crew provided by another nation, offer maximum flexibility. Complex situations, such as the COVID-19 pandemic and the Ukrainian crisis, have shown, that multinational cooperation is not only achievable but also provide robust, effective and reliable solutions, in particular for Aeromedical Evacuation (AE).

INTRODUCTION

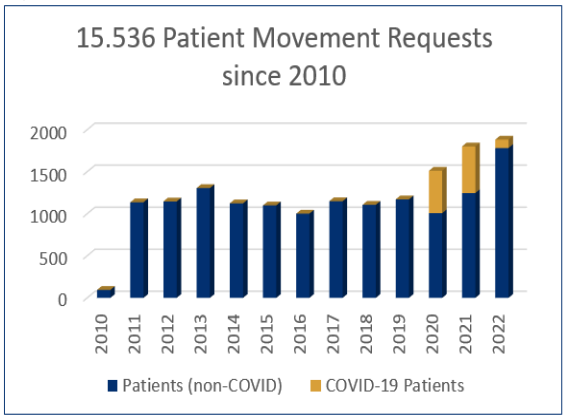
The European Air Transport Command is a multinational military command, located at Eindhoven Air Base in the Netherlands. Based on a Technical Arrangement (TA) between the Participating Nations (PNs), it was inaugurated on September 1st 2010 and currently consists of the following seven PNs: Belgium, France, Germany, Italy, Luxembourg, Netherlands and Spain. The PNs operate their military air mobility assets (150 assets located at various national air bases) in this single command entity with one common set of rules and regulations regarding the pooling and sharing of their air mobility capabilities, the exchange of information and experience and the training in a multinational environment. The relationship between the partners is based on an innovative and flexible business model, where nations transfer authority over designated assets to EATC (Transfer of Authority – TOA), with the possibility to revoke this Transfer of Authority at any given moment and with national caveats in effect. EATC manages the fleet under its operational control (OPCON) in order to perform the requested air transport services. The financial model, on which the international partnership is based, is also innovative. The exchange of services is based on the "Equivalent Flying Hour" (EFH): this is the cost of one (1) C-130 flying hour. The price of all other aircraft types offered within the framework of the Air Transport and Air Refueling Exchange of Services (ATARES) arrangement are calculated against this C-130 reference. This cashless arrangement facilitates mutual support through the exchange of services and it is the currency used among the EATC PNs. Organized in an operational and a functional pillar, this multinational command, facilitates the effective and efficient utilization of the limited resource of air transport capacities and capabilities. The goal of EATC is to enhance the scope and flexibility of the operational capabilities of the member nations through cooperation and coordination and to provide reliable air transport, air-to-air refueling and last, but not least, aeromedical evacuation services.

Strategic Aeromedical Evacuation

For EATC, Strat AE includes all AE from foreign destinations back to the patients' home nation or a nearby EATC PN[i] . This can be the result of operational activities and deployments, logistic and support missions, humanitarian missions, trainings and exercises, permanent postings abroad or any other reason for temporary or long-term activity outside the nation's borders. Mostly, it is the final phase of the patient's medical repatriation, which guarantees, that a patient, deployed will be repatriated for diagnostic or therapeutic purposes[ii] The basic principles for Strat AE are laid down in several civilian and military documents and standards, such as NATO standardization agreements (STANAGs)[iiiiv] and International Air Transport Association (IATA) Medical Manual[v]. EATC plans and coordinates worldwide Strat AE missions and this coordination is carried out by the Aeromedical Evacuation

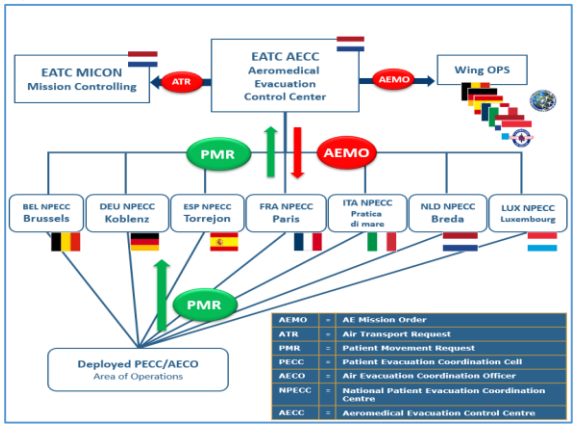
Control Center (AECC), an special branch inside the operational division of EATC. Since its establishment in 2010, AECC has coordinated an average of 1110 patients annually for a total of 15536 patients. The continuous upward trend over the last three years is evidence an increasing trust the PNs place in EATC and its capabilities.

Figure 1. EATC Strat AE since 2010



The AECC Branch is a multinational medical team of five flight surgeons (Dutch, French, German, Italian, and Spanish) and four flight nurses (Dutch, French, German and Italian), led by a German Branch Head. All staff members are experienced in aeromedical transport as well as in aviation and space medicine. The AECC is able to receive transport requests electronically from the PNs, in the form of a Patient Movement Request (PMR), in order to assess and validate the patient's eligibility and suitability for air transport. Taking into account the patient-specific medical needs and in close cooperation with other branches of EATCs' operational division, AECC then provide the requesting nation (RN) several options to perform the mission. The organization of a Strat AE remains a national responsibility and AECC does not replace or override the national coordination structures called National Patient Evacuation Coordination Centre (NPECC). They handle the various requests from different operating areas and coordinate the evacuation of all patients of the respective PNs. Once the PMR has been received, AECC is able to provide various solutions, such as dedicated AE aircraft or performing StratAE as addition to missions already planned ("*routine missions"*). Once the mission proposal is accepted by the Requesting Nation (RN), AECC issues an Aeromedical Evacuation Mission Order (AEMO). This document includes mission data, as well as medical advice and recommendations for patient management, facilitating both health management in flight by the medical crew on board and seamless and optimal transport of the patient between medical facilities. In the event that AECC does not find a suitable mission or asset for the patient, or the mission proposal offered is not acceptable to the RN, AECC issues an Aeromedical Evacuation Statement, thus returning the responsibility for patient management back to his nation. In this case, the patient will be transported by a civil airline or service provider or using national assets not under EATC OPCON. Aeromedical advice on appropriate patient management is provided by AECC none the less.

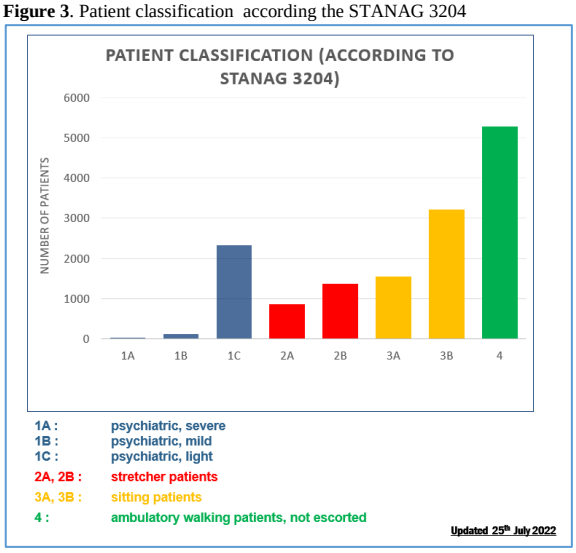
Figure 2. Coordination of Strat AE missions under EATC OPCON.



Since its foundation, the number of patients transported with Strat AE missions under EATC OPCON has steadily increased. This is due to the fact that EATC has managed to create synergies and to increase interoperability. The nations' confidence in EATC finding the best solutions and services to their request has grown continuously. Using the flexibility and resilience the multinational set-up provided, the PNs quickly approached EATC during the COVID-19 pandemic and entrusted it with the management of the majority of the COVID-19 related Strat AE missions. Recently, the realignment of the geographical areas of interest, the new geopolitical power-balances, as well as the emergence and re-emergence of infectious diseases, have underlined and increased the global need for an effective, efficient and sustainable Strat AE system. The coordination of a Strat AE by the AECC offers many advantages and increased organizational resilience, which allows AECC to take on almost any type of AE-mission , both in relation to the patient's condition and to the patient's current location. Not only are there dedicated AE assets within the EATC fleet that are on a permanent 12h / 24h notice to move (NTM) alert, but AECC can also take advantage of a multitude of EATC missions, already planned for cargo or passenger transport, in order to perform a Strat AE mission on the same aircraft. This last possibility will always depend on the clinical condition of the patient and the classification and categorization according to the NATO-system this clinical condition entails. The NATO STANAG 3204[vi] gives medical personnel responsible for coordinating the patient evacuation an easy yet concise way to assess the urgency of medical treatment (priority), medical support needs during transport (dependency), and transport modality (classification) of each patient. As depicted in fig. 3, the vast majority of EATC's Strat AE patients are low dependency (D3) and very low dependency (D4) patients. This categorization often allows to manage the patients on routine missions and thus to optimize aircraft an personnel. Frequently with the appropriate planning, many dedicated

missions can be avoided by using scheduled EATC flights to perform the AE. In order to achieve the safest and at the same time most effective and efficient performance, the following requirements have to be met at all times: 1) standardization of operational procedures (SOPs) in the management of patients across the different PNs, 2) extensive aeromedical knowledge of all personnel involved in the planning and execution of the mission, which allows to anticipate and prevent the deterioration of a patient's clinical condition and ultimately 3) an appropriate communication system for exchange of medical information.

Figure 3. Patient classification according the STANAG 3204



Another important advantage of the partnership is to find PNs willing to carry out a Strat AE mission at the request of another PNs, satisfying national needs and carrying out cross-national Strat AE missions in an economical way. Cross-national AE is defined as a mission, where a patient of one nation is evacuated by an aircraft and medical crew provided by another nation[vii]. This type of mission is the manifestation of an operational cooperation where trust, synergy and interoperability among its PNs strengthens the situational awareness of the EATC and its ability to address the future needs of air transport.

Cross-national StratAE flights during COVID-19

The emergence of COVID-19

Since the 1970s, approximately 40 emerging infectious diseases have been identified, including SARS, MERS, Ebola, Zika, Avian influenza, and Swine influenza. The urban demographic expansion, the increased travel on a global and regional scale for commercial and tourism interest or in support of a national interest, has the potential for the rapid spreading of emerging infectious diseases and pandemics[viii]. Among the various pathogens, Coronaviruses (CoV) are a large family of respiratory viruses that can cause mild to moderate illnesses, ranging from the common cold to respiratory syndromes such as MERS (Middle East Respiratory Syndrome) and SARS (Severe Acute Respiratory Syndrome). They are named for the crown-like spikes on their surface, "corona" being the Latin for crown. Coronaviruses are common in several animal species (including camels and bats), but in rare cases can infect humans and then spread between people[ix] [x]. A novel coronavirus is a new strain of coronavirus, that has not been previously identified in humans. The virus is known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease it causes is called coronavirus disease 2019 (COVID-19). In March 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a pandemic[xi]. The pandemic immediately had a significant impact on the military operational sustainability of deployed contingents, as it limited the maneuverability of the forces in the field, restricted day to day operations within military installations and caused numerous medical evacuations. Reasons for this were the need to adequately treat infected personnel, and also the logistical difficulties in managing adequate isolation for contact cases or positive but asymptomatic or with mildly symptomatic personnel. However, the pandemic has posed another challenge to national health systems; in fact the surge in cases of severe respiratory failure COVID-19 has exceeded the availability of intensive care resources (intensive care beds, respirators, ICU physicians and nurses) triggering numerous inter-hospital medical transports to ensure continuity of care.

METHODS

Aeromedical; Evacuation Highly Infectious Patient(S) Potentially Infectious Samples

Historically, infectious diseases have posed a significant health risk to military personnel, especially during overseas deployments. Usually, patients in the infective stage of serious communicable diseases are not accepted for Strat AE [xii]. There are exceptions to this general principle, but only under specific conditions, which must be assessed carefully in a risk-benefit analysis. When an aeromedical transport of an infectious or potentially infectious patient is to be carried out, several conditions must be considered: 1) risk of infection of the flight crew including the aeromedical evacuation (AE) team and other passengers 2) ability to isolate the patient during the flight, 3) treatment capacity of the receiving country 4) risk assessment of transporting a biological hazard to another medical treatment facility and another resident population; 5) international rules, governing flights under these conditions 6) the national rules of the transit and receiving countries and 7) a set of regulations and different from those of a medical prospective[xiii] [xiv].The 2014 Ebola virus disease (EVD) outbreak in West Africa and the 2020 COVID-19 pandemic demonstrated the need to repatriate highly infectious patients (suspected or confirmed), but also to transport potentially infectious samples[xv] [xvi]. This is due to the impossibility of isolation and adequate treatment of patients at the place of infection, or in

the case of domestic transfers, due to overcrowded health facilities and the need to transport patients between hospitals within the same nation or in neighboring nations. The latter is a good example of how vital and beneficial such a synergistic relationship between civil and military health services is when facing current and future challenges and emergencies. Following this principle, strategic military AE capabilities were made available to the civilian health services and many strategic missions were carried out. Typically, once a decision has been made to initiate aeromedical evacuation of highly infectious patients, various different options regarding patient management have to be decided and the respective individual and collective prevention procedures must be undertaken. AE of patients with infectious diseases can be carried out using a closed or open system[xvii] [xviii]. Using a closed system, the patient is placed inside an isolator or isolation chamber with high-efficiency particulate air (HEPA) filters and the medical staff supports the patient either through the PVC barrier in the case of single isolator, or directly inside the isolation chamber while airborne. In both cases the patient is separated from the flight deck and cabin environment, using a layered system of protection. The first level of protection is guaranteed by the negative pressure level inside the isolator, followed by the air filtration, provided by the HEPA filters and, as last and final layer, the PVC barrier of the isolator or the isolation chamber. Using an isolator keeps the patient in complete isolation once placed inside the device; this way, the chance of accidental contamination of the flight deck and crew members is greatly reduced and, in all but a few very special cases, the aircraft does not need to be disinfected after transport[xix]. Disadvantages of using an isolator are limited space inside the isolator, as well as limited treatment options during the isolation. Also, the medical team has to be specially trained, not only in barrier nursing, but also in the use of the isolator. The weight and dimensions of a system like this requires a larger crew and cannot be transported in all aircraft and ambulance cars. Using an open system, there is no other protective barrier between the patient and the medical crew than the individual protection measures, the relative distance between the individuals and clever engineering of the air flows inside the passenger compartment and optimal positioning of the patient. These measures will reduce the risk of contamination and infection of personnel participating in the mission. However, since medical crew needs to wear personal protective equipment (PPE) at all times, the physiological stress is greatly enhanced, making repeated crew rotation necessary for direct patient car during flight. Lastly, a thorough and time-consuming decontamination of the aircraft will always be necessary after mission completion, sometimes resulting in subsequent downtime of the asset[xx]. During the COVID-19 pandemic several other procedures were tested in order to facilitate the necessary mass transport of COVID-19 patients. One such procedure was to use plastic sheeting (Fig. 4) to isolate an area of the cabin in order to segregate a larger group of passengers. This was mostly done in the rear of the plane to allow for separate exits and to avoid further exposure to other passengers, as well as cabin crew and medical personnel. For long flights, an additional area inside the aircraft had been created, whenever possible, to allow the medical crew to remove their PPE for rehydration, unfiltered respiration and toilet use.

Figure 4. Mass transport of COVID-19 patients. Isolation zone in Italian KC767

With the exception of an isolation chamber, all modules and methods of transport mentioned above were used by EATC PNs. Belgium, France, Germany, the Netherlands and Spain have opted for the open transport variant (fig. 5&6), while Italy has used a closed biocontainment isolator transport system, the Air Transport Isolator (ATI) systems which consists of a stretcher, placed inside a metal frame with transparent plastic coating, and the possibility to create negative pressure inside the system (fig. 7&8).

Figure 5. Open system medical management of a COVID patient in German A310.

Figure 6. Open system medical management of a COVID patient in a German A400

Figure 7. Air Transport Isolator (ATI) systems in Italian C130J

Figure 8. Air Transport Isolator (ATI) systems in Italian KC767

Isolation Tents (fig. 9) and rigid shell isolators (fig. 10) were also used. The EpiShuttle, used by the Luxembourg Air Ambulance Service, is one such example.

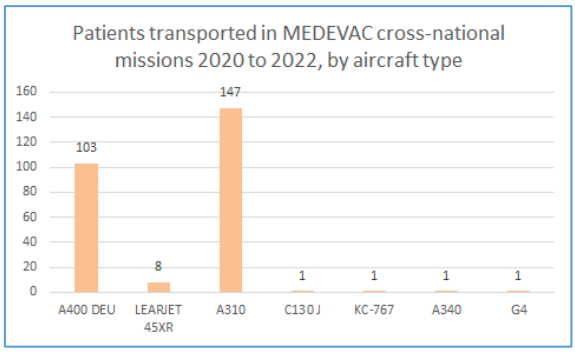
Figure 9. Isolation Tents in :Luxembourg Air Ambulance jet

Figure 10. Rigid isolators (EpiShuttle) in :Luxembourg Air Ambulance jet

RESULTS

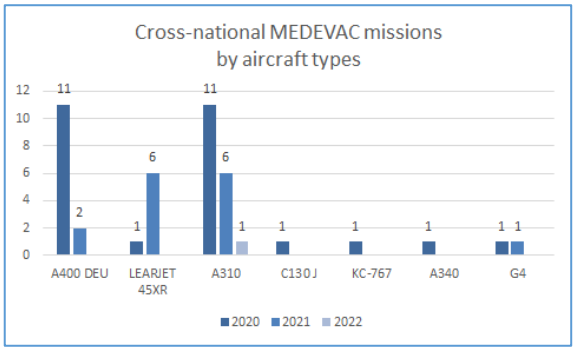
During the pandemic, 1158 COVID-19 positive patients were transported in 192 missions. 186 missions were performed with dedicated assets, while 6 missions were performed on routine aircraft. There were a total of 43 cross-national missions with a total of 262 patients (fig. 11). The data presented shows the rapid and effective response of EATC to PNs requests, with 99% of the requested, planned and coordinated missions carried out using dedicated assets. At the same time, the cross-national missions highlight the trust in the multinational EATC system and the confidence, that a nations' patient can be placed under the care of another PNs' medical crew and get excellent transport and treatment results.

Figure 11. Cross-national patients 2020-2022



The cross-national missions were accomplished with 14 different types of aircraft, strategic ones (A310, A321, A340, LEARJET 45XR, A332), as well as tactical ones (C130 A400 and tC27). The aircraft used during cross-national missions are depicted in fig. 12.

Figure 12. Cross-national missions 2020-2022



The diversity of this multinational fleet of aircraft has given EATC enough flexibility to reach almost any airport. There is hardly a place on the planet, nor even under certain threat levels, where the coordinated EATC effort is unable to ensure patient transport as requested. Diversity of patient transport modules, and air assets has ensured resilience, efficiency and effectiveness of EATCs' missions in support of military and civilian patients who needed aeromedical evacuation. The various open and closed isolation patient management procedures have proven to be opportunities, not limits, in order to meet the different needs during different stages of the pandemic. The PNs have remained united in following standardized procedures, tested by more than 10 years of cooperation within the realm of aeromedical evacuation in EATC. The Standard Operating Procedures (SOP), created by AECC, provides validated procedures, guidelines and reference data to be used by both EATC and the PNs during all AE missions under EATC OPCON. For each Strat AE mission requested, the EATC acts as the single point of contact and is responsible for the control and coordination from patient takeover by the AE crew at the Airport of Embarkation (APOE) to patient handover at the Airport of Debarkation (APOD). EATC structures and processes have been able to cope with pandemic challenges, showing resilience and the ability to adequately plan and task missions during such situations. Flexibility, standardization and the growing interoperability among the EATC PNs compensated for multiple obstacles EATC was confronted with during the pandemic. In order to transport COVID-19-infected patients, EATC quickly developed new guidelines and procedures[xxi], which, due to their practical value and effectiveness, were also adopted by non-EATC nations. Moreover the drastic increase in patients with acute respiratory distress syndrome related to the COVID-19 pandemic had caused a regional overload of intensive care units in various countries during certain periods of the pandemic. Situations like these can be remedied by dispersing patients to hospitals in other regions or even countries willing and capable to receive ICU patients Therefore, with the consent of the respective ministries of defense of the EATC PNs, AECC has been involved in the organization of the intra-European AE of civilian patients. For this occasion, AECC has produced a document, aimed at dealing with serious COVID-19 patients intended to undergo AE, providing (contra-)indications and recommendations for transport. This AECC guideline was a valuable contribution to the decision-making process and aeromedical risk assessment. A total of 74 civilians were transported in 17 missions; 81,1 % of those patients were categorized as urgent (P1). No patient deaths or disease transmission occurred during those Strat AE flights.

Cross-national StratAE flights during Ukraine crisis

Following the same approach and applying the same methods and EATC guidelines, 251 patients have been transported during the Ukrainian crisis, 112 of which were military and 139 were civilians (including 30 children). Among the recorded injuries were cerebro-cranial, abdominal and chest injuries, as well fractures (180) and amputations (48) of extremities .

DISCUSSION

Today, AECC is recognized as a center of expertise for Aeromedical Evacuation. EATC is looking back at more than ten years of operational experience, demonstrating on a daily basis, that interoperability and harmonization of concepts are keys to success and safety in the AE domain. EATC manages time-critical Strat AE missions from anywhere in the world to the patients' home country, or to a safe place where the necessary medical treatment facilities are available. Successful and effective AE requires a combination of in-depth medical expertise and know-how in aeromedical transportation. This is why EATC relies on a special team of flight surgeons and flight nurses within its operational division: the Aeromedical Evacuation Control Centre or AECC. The overall aim is to offer efficient and effective AE missions to EATCs' PNs. AECC evaluates the AE requests from PNs, selects the most suitable transportation asset for the patient, plans the mission and supervises every step until its successful completion. This is done in close cooperation with the national authorities. When COVID-19 hit the world, AECC quickly developed procedures, published in point papers, for safe transport of infected patients, responding to the crisis and the PNs' new challenges. Cross-national missions, where a patient is evacuated by an aircraft provided by another PN, offers maximum flexibility for the benefit of the patient. This is only possible due to the trust and confidence between the medical personnel, the military commands and the political authorities. Crisis situations, such as the COVID-19 pandemic, have shown, that multinational cooperation is not only achievable but also provide robust, effective and reliable solutions, in particular for AE. In the next years, EATC intends to transform AE related challenges into multinational opportunities and benefits. The COVID-19 pandemic, with the subsequent time pressure and operational

urgency, strengthened the trust, cooperation and communication between EATC and the PNs. EATC is thus looking forward to seizing this momentum and paving the way towards further standardization of regulations, procedures and trainings, as well as common procurement of equipment.

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