

CARE IN THE AIR:

The Highs and Realities of Air Medical Transport

Text and photos by Dr Charles Johnson

Medical evacuation (medevac) is the long-distance transfer of patients between medical facilities or from non-medical facilities, such as homes, to hospitals and vice versa. In Singapore's context, all medevacs (other than local military helicopter casualty evacuations) are international. Medevacs can be grouped into evacuation (ie, the emergency or urgent transfer of a patient to a higher level or more appropriate medical facility), or repatriation, which is the planned (less time-sensitive) return of a patient to his/her home country (with medical support provided en route).

A short history of the air ambulance

The use of air as a means of casualty evacuation is a story that grew out of war and misery. In the late 1800s, hot air balloons were used to evacuate injured soldiers from the battlefields of the Crimean War and the Siege of Paris. In World War I, stretchers were strapped to the fuselage or wing bases of biplanes as the world's first air ambulances. Patients were exposed to the elements in what could only be described as the ride of their lives. No patient access or medical care could be provided during flight.

World War II saw the use of air ambulances on a larger scale as combatants with previously non-survivable war injuries were evacuated to field hospitals and away from the front lines for life- and

limb-saving surgery. It is from here that air ambulance growth truly took off.

The Korean and Vietnam Wars of the 1950s and 1960s cemented the use of helicopters as a means of rapid casualty extrication from the field to definitive care. In the late 1970s, civilian helicopter emergency medical services (EMS) and flying doctor-type services started, giving reality to the concept of the golden hour in major trauma and hope in medical emergencies even in remote or difficult-to-access communities.

Singapore's air ambulance operations

Singapore has established itself as a leading tertiary medical hub and thus is a frequent destination for critically ill patients or those with complex medical issues within the region. As such, Singapore is a base for fixed wing international air ambulance operations. As the distances covered are great and flight times long, only jets are utilised for air ambulance operations in Singapore.

In the context of our small country, helicopter search and rescue operations and EMS are only operated by the military. Our air force accepts civilian requests for assistance for medical emergencies on ships on a case-by-case basis.

An air ambulance also means multiple transfers, involving a ground transfer to airport, aircraft loading, the flight itself and

another road trip to the receiving hospital. All this needs to be coordinated well.

What is a jet air ambulance?

This is a small private jet that has been extensively modified to fit the role of a flying ambulance and critical care facility. The range of such an aircraft is about 3,000 km. This translates to about five hours flying time. The air ambulance flies at the same speed as a commercial airliner. All ASEAN countries are thus within reach of non-stop air ambulance. Anything further afield will require refuelling stops. The furthest I have personally flown in an air ambulance is from South America to Singapore – a total of five refuelling stops and 32 hours in a small aircraft. Quite an adventure...

Who and what is inside an air ambulance?

The air ambulance is usually crewed by four people, comprising a pilot, co-pilot and medical team (a flight physician and nurse or paramedic). The crew work closely together, with pilots aiding in stretcher loading and the medical team helping to make coffee or serve meals to weary pilots. Camaraderie and teamwork are a must.

The aircraft will usually have the following equipment:

- One or two stretcher bays (ie, up to two patients)



- A stretcher loading system
- Oxygen (sufficient for the entire case and buffer)
- Multi-parameter monitoring
- All manner of intravenous fluids with the exception of blood products (due to international health regulations)
- Advanced cardiac life support and intensive care unit (ICU) drugs with syringes/infusion pumps
- Airway management supplies and ventilator
- Trauma supplies
- Defibrillator and pacing
- Extended point of care diagnostics like ultrasound and 12-lead ECG

There will also be two additional seats for accompanying family members (they will be watching all that goes on), additional equipment or crew. Space on an air ambulance is treasured, so all nooks and crannies tend to be filled with equipment, stores, food and more. There is a small lavatory at the aircraft rear, especially important for the longer flights.

When is an air ambulance activated?

1. When the country or present medical facility cannot support with the expertise or level of care required for a critically ill patient.
2. When a critically ill patient in a foreign country has to return to his/her home country (generally as a repatriation for continued, supportive or palliative care).
3. Patient or family requests for second opinion care (usually private cases).
4. In special circumstances such as political instability, natural or manmade disasters, and recently, pandemics.

Physiology (and physics) when flying

The pressure in the atmosphere decreases with altitude. Most aircraft cabins are pressurised to about 5,000 to 10,000 feet altitude, with a corresponding drop in oxygen partial pressure. The percentage of oxygen is actually the same (21%) at all altitudes; however, it is 21% of a smaller number as one goes higher. The barometric pressure at sea level is 760 mmHg, while at 10,000 feet, it is 534

mmHg. Breathing cabin air may thus be equivalent to breathing air with only 15% oxygen at sea level, instead of 21%. The net result is that there is 29% less oxygen in the cabin air compared with at sea level. On a pulse oximeter, this can mean about a 5% drop in oxygen saturation (sats), not significant for normal lungs but critical for patients with baseline low sats, where the drop pushes values into the steep part of the oxygen dissociation curve. This translates into decreased oxygen carriage and tissue hypoxia. This is one of the main reasons one tends to feel fatigue after a long flight. Supplemental oxygen or even assisted ventilation may thus be essential to prevent patients tipping into hypoxemic respiratory failure.

In addition, Boyle's Law (*remember physics back in school?*) applies such that as you ascend in altitude (or to the surface if diving), gas expands to a greater volume due to decreased pressure exerted on it. This is clinically important for patients to consider as gas in the chest (pneumothorax), skull (pneumocephalus due to a fracture in the base of the skull), middle ear, gastrointestinal tract (closed loop intestinal obstruction) or other places can expand and result in decompensation or tissue injury.

Aircraft cabins have low humidity, so adequate hydration for patients (and crew) is required. This, together with the limited mobility of patients result in true increased risks for deep vein thrombosis (DVT) and the dreaded pulmonary embolism. Pre-flight DVT prophylaxis with low molecular weight heparin may be required for at-risk patients.

In cases of patients with recent dive history, decompression illness or closed air spaces within the body, we may request for the air ambulance to fly at sea-level pressurisation. This however, means flying at a lower altitude, slower speeds and with a greater fuel burn, resulting in a shortened range.

Costs of an air ambulance

The cost of jet air ambulance operations can range between S\$5,000 and S\$7,000 per hour, not including airport fees and other miscellaneous expenses. As flights are calculated two ways, you can see how the costs quickly add up. So,

it is important to have adequate travel insurance when you travel.

Also, do remember that most travel insurance policies do not cover pre-existing illnesses or complications related to it. Neither do they cover self-fully (like falling when drunk) or certain higher risk activities (eg, diving or rock climbing). Read the fine print when buying a travel policy and if unsure, seek clarification.

Additionally, do not expect that just because you have travel insurance, there would be a team waiting to rescue you in times of need. Insurance companies will require detailed medical information (which may be difficult to obtain due to language and other barriers) and even upon activation, aircraft operations require landing permits, country authorisations and more. It can take days to rescue a patient from a remote medical facility. The pandemic, with its border closures and quarantine restrictions, has made this process even more challenging.

Finally, every private jet flight emits significant greenhouse gases way up in the atmosphere, where they do the most harm. As such, I always review the clinical or operational indications for an air ambulance, and where alternatives such as commercial flights are safe and viable, these should be offered. Expenses are not just in dollars.

What information is needed to activate a medevac?

In order to start the process of planning an evacuation, we require:

- Medical details and clinical information (in the form of a report or through communication with the treating physician, etc). The more detailed the better, but realistically we often work with scant or inaccurate information so as not to delay evacuation and compromise care.



- Location of patient and contact details to communicate with the patient or companion at the scene.
- Passport details of the patient and companion (if any).
- Details of receiving medical facility/ accepting physician (we can assist if requested).
- How medevac will be financed (ie, private, insurance or corporate payment).

Other modes of international medevac

In addition to air ambulance, patients can also be transferred on commercial flights (subject to airline and local authority approvals) on a stretcher or seated (with wheelchair assistance). Infusions, oxygen and even ventilators can be used in such transfers. The main advantages of commercial flight medevacs are the significantly lower costs (no private jets involved) and ability to fly further (eg, Singapore to Europe) without refuelling stops. However, commercial flight transfers require about a week to plan and approve and are usually reserved for clinically stable patients.

We also do medevacs by road (advanced life support or ICU ambulance) up north to Malaysia (and even Thailand) and occasionally do sea ambulance responses. Sea ambulance will generally be from Indonesian or Malaysian islands or even from ships at sea.

Special medevac operations

Infectious disease medevacs

We developed the capacity and capability to transfer infectious disease patients after SARS about 18 years ago. Patient containment and isolation systems were acquired after the Ebola epidemic, but it was only with COVID-19 that we finally operationalised what we had long prepared for. I have since transferred several dozen COVID-19 patients to and from various countries in Asia, and our team has evacuated them by air, land and sea ambulance.

Incidentally, the air inside an air ambulance and commercial aircraft is completely expelled and fresh air taken in every few minutes during flight. It is

not recirculated like in an enclosed room. As such, the real risks of picking up an airborne infectious disease is probably significantly higher at the airport than in the actual aircraft.

Complicated cases

We have also done medevacs for patients on extracorporeal membrane oxygenation and intra-aortic balloon pumps, and multiple casualty medevacs. This is usually for situations like post-natural disasters or terrorist incidents. I leave neonatal and infant transfers to my esteemed paediatric colleagues from KK Women's and Children's Hospital and the National University Hospital.

The complexity of a medevac case may not depend on just the clinical condition. Other challenges we have faced include:

- Patients losing or having their travel documents stolen
- Officials demanding bribes
- The clinical status of the patient deteriorating before help arrives
- Cultural, religious or family disputes or differences arising
- Rough weather, technical issues delaying flights or requiring unscheduled stops
- Language and communication barriers
- Flight or medical crew falling ill (and still having to get the job done)

The challenges, highs and lows of doing medevacs

As a medevac physician, no two cases or days are the same. I like waking up not knowing how the day may end. Medevac is not just about the actual delivery of care in the air – there is a lot that goes on in the back end in terms of operational planning, coordination and logistics support. Everyone works in a closely knit team – almost a family I would say.

I have been doing medevacs as an escort physician for the past 20-odd years, initially as a young locum doing flights on my off days while working in a hospital and now running our own private medevac operations. Over the years, I have learnt the ins and outs of clinical care in challenging



environments while dealing with the nuances and realities of working with different healthcare systems, practices and boundaries. The fast-paced work and uncertainty is an adrenaline rush. Travelling to off-the-beaten-track locations lends a twinkle to my eye, and the chance to help heal with compassion warms my heart.

In summary, medevacs are about the start of a journey to heal. We cannot always cure but we always offer hope. Kindness counts. ♦

Legend

1. Air ambulance (Learjet 45) at Hanoi airport, awaiting patient loading
2. Sea ambulances can travel at 30 knots and access international waters
3. Inside an air ambulance with two COVID-19 patients on their way back to Singapore for continued care

Dr Johnson is an emergency physician and medical director of Hope Medical Services. In 2005, he helped establish Hope Medical Services, delivering private pre-hospital services in basic and advanced life support care on land, air and sea. Since the onset of COVID-19, his focus has been on the challenges of transferring pandemic patients internationally.

