Review Article

Impact of air travel on patients with heart disease

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INTRODUCTION

The International Air Transport Association (IATA) released an industry traffic forecast showing that airlines expect to welcome some 3.6 billion passengers in 2016. That is about 800 million more than the 2.8 billion passengers carried by airlines in 2011.[1] As the population ages and our ability to care for patients with cardiac disease improve, an increasing number of people with cardiovascular disease will be traveling long distances. Many travelers have had pacemakers or automatic defibrillators implanted, have had recent revascularization, or surgery which might predispose to deep venous thrombosis (DVT). Qureshi et al reported that most of the inflight events are due to exacerbation of pre-existing problems accounting for 65%, While 28% are due to new medical problems.[2]

Unscheduled landings for medical purposes are a serious problem for commercial air carriers. The cost of a medical diversion typically ranges from $3,000 to $100,000, depending on whether fuel needs to be dumped before landing and whether overnight accommodations for passengers are arranged.[3] According to the 2000 report by the Federal Aviation Administration

(FAA), 13% of all in-flight medical incidents aboard domestic aircraft resulted in an emergency diversion Cardiac incidents accounted for the greatest percent- age of the diversions (46 %), followed in frequency by neurologic incidents (18 %) and respiratory incidents (6).[4] More recently Valani et al reported that the four most common categories resulting in diversions were cardiac (26.4%), neurological (19.5%), gastrointestinal (11.4%), and syncope (10.0%). Only 6.8% of all diversions were due to cardiac arrest.[5]

Commercial aircraft cruise between 22,000 ft. (6,706 m) and 44,000 ft. (13,411 m) above sea level to improve operating efficiency.[6] The intolerable and lethal hypobaric effects at these high elevations are ameliorated by partial environmental modification of the aircraft cabin, i.e. pressurization to a safer and more comfortable lower altitude.[7,8]

The FAA requires aircraft to maintain an 8,000-ft cabin altitude at the highest operating altitude.[9] However, the regulations for actual flight operations are more complicated and flexible, allowing for temporarily higher flight and cabin altitudes such as during turbulence or adverse weather.[10] Cabin altitudes greater than 10,000 ft. are effectively prohibited since all flight crew and passengers must then use supplemental oxygen.

The effects of hypoxia in individuals with preexisting cardiopulmonary conditions are less understood. Briefly, acute hypoxia in normal individuals initiates reflex responses that reduce the PaO_2 (Partial Pressure of Oxygen) gradient between the atmosphere and body tissues and prevent a large fall in PaO2.[11,12,13] The normal person responds to hypobaric hypoxia with a mild tachycardia which increases myocardial oxygen demand. In patients with significant impairment of myocardial function, or coronary flow reserve, this may give rise to symptoms.[14] Cardiac output characteristically increases initially with hypoxia in a dose-dependent fashion, primarily due to tachycardia.[15,16]

The cardiac response slowly decreases over time despite continued hypoxia for unclear reasons[14].

Physicians who travel may be asked to render care to a passenger who is having a medical emergency during a commercial flight. A considerable proportion of passengers in whom medical issues develop during travel require hospitalization. Health care providers should understand which in-flight medical emergencies occur commonly as well as the roles the providers can play and the liabilities they may incur when offering assistance.[17] Federal legislation contained in the Aviation Medical Assistance Act of 1998 has provided limited protection and guidance for physicians and other medical professionals who volunteer their services during flight. Volunteers must be "medically qualified" and receive no monetary compensation in order to receive protection.[18]

The legislation states that "an individual shall not be liable for damages in any action brought in federal or state court arising out of the acts or omissions of the individual in providing or attempting to provide assistance in the case of an in-flight medical emergency unless the individual, while rendering such assistance, is guilty of gross negligence or willful misconduct." To date there are no documented cases of a physician being sued for providing assistance during an in-flight incident.[5,19,20]

While physicians have no obligation under U.S. law to volunteer, one can argue that they have an ethical obligation to do so, especially if they are specifically trained to respond to undifferentiated medical emergencies.

Volunteer physicians should document their assessment and interventions administered, using a standard airline medical incident form if available, or on a blank sheet of paper if a form is not available. If possible, the volunteer physician should request a copy of the medical document or form for their personal records. If a patient requires ongoing monitoring and therapy, the volunteer may need to stay by their side for the duration of the flight. Once the plane lands, the volunteer can hand over care to on-the-ground medical staff who can transfer the patient to an appropriate facility.[21]

This article examines the impact of air travel on persons with heart disease and defines the effect of cabin altitude and barometric pressure on specific heart conditions. It also discusses the role of the voluntary physician in the diagnosis, management, suggestion of flight diversion and the legal ramifications that may ensue as a result of his involvement.

PRE-TRAVEL ASSESSMENT

A frequently asked question both by travelers and airline personnel is whether a person is fit to travel by air. The answer entails the proper assessment of a person history, previous medical reports, coronary interventions, devices and current treatment. An assessment of fitness to fly should include some knowledge of the purpose of the travel. Patients receiving medication should carry it with them in their hand luggage and take it at the time intervals prescribed. It should be pharmacy labeled and be accompanied by a doctor's covering note for the benefit of the customs officers at the destination. Additional personal equipment may be carried at the discretion of the airline. The duration of the flight needs to be taken into account and the need for assistance.[22]

AIRLINE MEDICAL FACILITY

The major airlines have medical departments whose advice should be sought when contemplating the transfer of a sick passenger. The smaller ones may contract

out guidance. British Airways[23] in common with the other larger airlines has a passenger medical clearance unit and requires the submission of the standard International Air Transport Association (IATA) medical information form (MEDIF), which can be downloaded from the web.[24] Most of the large carriers also subscribe to organizations such as MedAire Inc of Phoenix, Arizona, USA, which can give immediate advice to an aircraft in the air through a radio link (MedLink).

MINIMAL EQUIPMENT LIST (MEL)

The content of the list can be downloaded from "Medical Guidelines for Airline Travel". [25]An aircraft may not be permitted to take to the air if not in compliance with the MEL specifications. It requires one to four (basic) first aid kits and may also include an enhanced emergency kit (Figure 1) which contains items required for cardiopulmonary resuscitation.

Figure 1: Enhanced emergency kit

The Federal Aviation Administration (FAA) in USA requires that aircraft above 3400 kg (7500 pounds) shall carry at least one automatic external defibrillator (AED) and at least one flight attendant regularly trained in its use[22] (Figure 2).

ROLE OF THE CABIN CREW

The foremost role of the cabin crew is to ensure the safety of the passengers. The cabin crew are commonly trained in advanced first aid and intermediate life support. They undergo annual refresher training, but this does not equip them for, nor is it their responsibility to offer, nursing support, which has to be provided (with agreement of the airline) by others if a seriously ill patient is carried.[22] In large aircrafts at least one flight attendant should be regularly trained in the use of AED and the Tempus IC health Telemedicine System (more details on Tempus IC is provided below**).** In addition to cabin crew **o**nboard assistance was provided by physicians in (48.1%), nurses (20.1%), EMS providers (4.4%) and other health care professionals in (3.7%).[26]

Figure 2: Automatic External Defibrillator (AED)

MEDICAL CONDITIONS THAT MAY IMPACT AIR TRAVEL

With the increasing prevalence of coronary heart disease in most of the third world countries a large number of patients with heart disease travel by air for business, pleasure or seeking medical and surgical treatment. They are stable at ground level but are vulnerable to changes in barometric pressure and the resulting hypoxia. The incidence of inflight cardiac emergencies in

this group of patients is more than in those without preexisting heart disease.[2] Some of the common events that may occur in air include syncope-presyncope (37% of in-flight medical emergencies), respiratory symptoms (12%), and cardiac arrest (0.3%).[26]

Coronary heart disease

Patients with stable angina with no recent change in symptoms or medication may travel without restriction. Patients with symptoms on minimal exertion Canadian Cardiovascular Society (CCS) Functional Status III usually need airport assistance and should carry all the medication with them. They should declare their symptoms and diagnosis to airline authority and submit a standard International Air Transport Association (IATA) medical information form (MEDIF). People with unstable angina CCS IV should not travel by air until their condition stabilizes. While non ST elevation myocardial infarction (NSTEMI) and ST elevation myocardial infarction with uncomplicated course, successful revascularization and ejection fraction of more than 40 may travel after one week, the general rule is to recommend air travel after 3-4 weeks. High risk post myocardial infarction (MI) patients with symptoms and signs of heart failure (HF) and ejection fraction (EF) <40 should defer air travel until they become in stable condition. Patients who had elective percutaneous coronary angiography (PCI) with no complications may travel after 2 days.[27] Patients who had undergone coronary artery bypass graft (CABG) and those who had open heart valve surgery should allow enough time for intrathoracic fluid to resorb before travel by air. This may take 2-3 weeks.

Patients with acute heart failure should only be allowed to travel after six weeks of stable condition and no change of symptoms or medication. The same applies to patient with chronic HF classified as NYHA I, II who have minimal dyspnea and no change of symptoms or medications during the previous six weeks. Those in NYHA Class III IV should not not be allowed except in the presence of a trained escort and the necessary supplies.

Regardless of etiology, acute or decompensated HF is one of the contraindication to air travel.

It is recommended that if air travel cannot be avoided the right aircraft, on-board equipment, including oxygen supply, and appropriately qualified and experienced escort personnel should be provided. [28] In this case an air ambulance should be the right choice and not a commercial airline.

PATIENTS WITH PACEMAKERS AND ICD DEVICE

The following instructions are quoted from Boston Scientific; Information for the Traveling Pacemaker or Defibrillator Patient preparing for travel. June 18, 2013.[29]

At the Airport

When traveling through airport security, have your Medical Device ID Card available. This card identifies you as a patient with an implanted pacemaker or defibrillator.

Handheld security wands

Some wands contain strong magnets that may temporarily affect the function of your implanted device. If a handheld wand must be used, it should be passed over the device quickly. In general, a hand-search is preferred to wand use.

Security archways

Walk through security archways at a normal pace (do not linger). Pacemakers and defibrillators may trigger airport security metal detector alarms. However, this will not harm you or your device.

Airport Body Scanners

The Transportation Security Administration (TSA) currently uses two types of full-body "people scanners": X-ray scans and millimeter wave scans. Neither type of scanner should affect your implanted pacemaker or defibrillator system. Step away from the scanner if you feel poorly.

ARRHYTHMIAS

Flight itself does not appear to induce paroxysmal supraventricular tachycardia, atrial fibrillation or atrial flutter, and providing the passengers are symptomatically stable with a low frequency of events, there should be no restriction to flying.

Passengers with permanent or persistent atrial fibrillation should be stable with appropriate rate control and anticoagulation. Passengers with a history of ventricular arrhythmias should have these controlled before flying. Ventricular arrhythmias may be treated by implantable defibrillators (see Pacemakers and ICD above) Patients with uncontrolled hemodynamically significant ventricular arrhythmias should not travel on commercial aircraft.[28]

PHYSICIANS'S ROLE DURING FLIGHT EMERGENCY

When a passenger experiences a health problem that requires the assistance of a physician, the flight attendant will request that any physician on board identify him/herself to a member of the flight crew. The crew will usually request that the responding physician verify his medical licensure through such means as the wallet-sized certificate of licensure. The physician is then accompanied to the passenger and the medical kit made available.[30]

The goal of in-flight medical assistance is to stabilize the condition of the ill passenger until the aircraft has landed. The health care professional who volunteers to assist has several options for basic management: he or she may provide oxygen; use medications and supplies in the emergency medical kit; ask the flight crew to lower the altitude of the aircraft to increase cabin pressure; consult with and obtain advice from ground-based medical support personnel; and suggest diversion of the aircraft.[31,32]

Unresponsiveness in a patient warrants application of the automated external defibrillator (if available on board), use of oxygen and establishment of intravenous access, and administration of 50 percent dextrose. Angina should be treated with aspirin and nitrates. A bronchodilator should be considered for shortness of breath in a passenger with asthma or chronic obstructive pulmonary disease. Vasovagal syncope can usually be managed simply by raising the legs and applying cold compresses to the forehead. Acute allergic reactions can be managed with diphenhydramine and (in severe cases) subcutaneous epinephrine. Increasing the cabin pressure, if possible, may alleviate altitude-related chest pain, shortness of breath, and abdominal pain by resolving relative hypoxia and decreasing the expansion of gas. An acutely agitated, psychotic, or violent passenger may be sedated with a benzodiazepine if it is available in the on-board medical kit.

Following the initial examination and treatment of the patient, usually in their seat, the physician will be asked to speak to the Captain of the plane to discuss options with respect to disposition of the patient. This usually involves consideration for continuation of the flight with the physician's ongoing medical management of the patient or the less favored option of the prohibitively expensive and inconvenient diversion of the aircraft. However, a recommendation to divert the aircraft should be considered if a passenger has chest pain, shortness of breath, or severe abdominal

pain that does not improve with use of the recommended initial interventions. A recommendation to divert should also be considered if a passenger is persistently unresponsive or has cardiac arrest, an acute coronary syndrome, severe dyspnea, stroke, refractory seizure, or severe agitation.[19]

It is important for the physician to realize that, with respect to the ultimate disposition of the patient, the Captain is in complete charge and bears ultimate responsibility for the safety and welfare of the passengers and crew. The physician, like a ship's doctor, acts solely in a consultative capacity. It is expected that the physician will respect the Captain's decision and continue to treat the patient to the best of his or her ability for the duration of the flight. Some airlines will occasionally acknowledge a physician who provides emergency medical assistance, through the presentation of an "honorary flight surgeon" plaque.[30,33]

NEW APPROACHES TO IN FLIGHT EMERGENCY

Tempus IC health Telemedicine System (Figure 3)

With more people travelling on larger aircraft for longer distances, the risk of a medical diversion has increased significantly.

Major international airlines have equipped with the Tempus on board telemedicine system because it enables fast, informed decisions and treatment advice avoiding costly, stressful and unnecessary medical diversions and significantly reduces the risk of aircraft downtime and disruption to fleet schedules. In the event a passenger develops a medical problem in flight, the Remote Diagnostic Technologies (RDT) system enables crewmembers to gather vital diagnostic information about the individual, such as blood pressure, glucose readings and electrocardiograms, as well as to take photographs. The data, in turn, is transmitted to medical experts on the ground who could advise the crew how best to treat the passenger until the aircraft lands and the passenger can be transported to a medical facility.

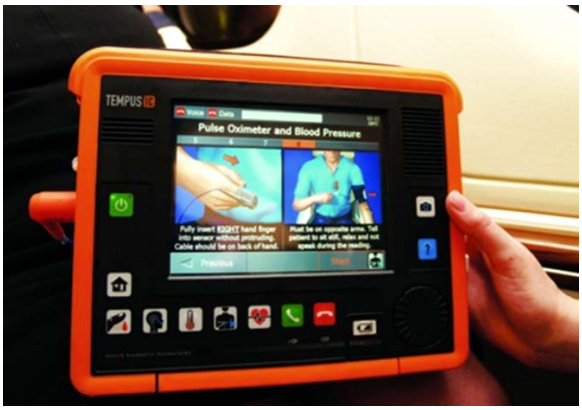

Figure 3: Tempus IC Health Telemedicine System

SEQUELIES OF AIR TRAVEL

Deep Venous Thrombosis

The problem of DVT has received wide coverage. Wrongly tagged ''economy class syndrome'', it is also seen in travelers at the front of the aircraft and in those undertaking long journeys by rail or road. [34] In 2001 the World Health Organization commissioned an expert report[35] to be based on prospective epidemiological and pathophysiological studies. It confirmed that the risk of VTE doubles after a flight of 4 hours and is increased further with longer and multiple flights. This risk also applies to travel by car, bus and train. Obesity, extremes of height, oral contraceptive use and prothrombotic disorders all increase the absolute risk, which is 1 in 6000 in healthy people over a 4-hour flight but the previously reported impact of hypobaric hypoxia on thrombosis could not be substantiated in healthy subjects.[36]

Travelers may be risk stratified into low, medium and high risk groups. The low risk group are essentially those persons without previous venous thromboembolism episodes

and had no recent surgery and no other risk factors. They are encouraged to keep mobile as much as possible, avoid alcohol, smoking and caffeine. The medium risk groups include persons who had surgery lasting more than 30 minutes within their previous two months but not the last four weeks or known to have thrombophilia, obesity (BMI > 30 kg/m^2) or pregnant females. They should follow the same guidance given to low risk group in addition to applying compression stocking. High risk group apply to those with previous history of venous thromboembolism, recent (within 4 weeks) surgery under general anesthesia and other risk factors e.g. cancer. It is advisable that person with high risk status follow all guidance given above in addition to subcutaneous Enoxoparin 40 mg on the morning of the flight and on the following day.[37]

CONCLUSION

Present aircrafts are designed to produce comfort and safety to the air travellers. The FAA requires aircraft to maintain an 8,000-ft cabin altitude at the highest operating altitude to make cabin environment endurable to all passengers and optimum for those with pre-existing heart disease. Medical facilities aboard aircrafts, though modest, are appropriate for initial handling of air medical emergencies.

Onboard physician are ethically bound to render help whenever requested. A volunteering physician shall not be liable for damages in any action brought in federal or state court arising out of the acts or omissions of the individual in providing or attempting to provide assistance in the case of an in-flight medical emergency unless the individual, while rendering such assistance, is guilty of gross negligence or willful misconduct.

Unscheduled landings for medical purposes are a serious problem for commercial air carriers. A recommendation to divert should only be considered if a passenger is persistently unresponsive or has cardiac arrest, acute coronary syndrome, severe dyspnea, stroke, refractory seizure, or severe agitation.

Deep venous thrombosis is a known complication of long haul flights and in flight measures should be followed to prevent it. High risk patients for DVT should receive subcutaneous Enoxoparin to safeguard against it.

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