WILEY **CLINICAL CARDIOLOGY**

Navigating air travel and cardiovascular concerns: Is the sky the limit?

Muhammad Hammadah[1] | Bryan R. Kindya[2] | Marc P. Allard-Ratick[2] |
Sammer Jazbeh[3] | Danny Eapen[1] | W.H. Wilson Tang[4] | Laurence Sperling[1]

[1]Department of Medicine, Division of Cardiology, Emory University School of Medicine, Atlanta, Georgia

[2]Department of Internal Medicine, Emory University School of Medicine, Atlanta, Georgia

[3]Department of Radiology, University of Oklahoma, Oklahoma City

[4]Cardiology Department, Cleveland Clinic, Cleveland, Ohio

Correspondence
Laurence Sperling, MD, FACC, Director of Emory Heart Disease Prevention Center, Emory University School of Medicine, 1365 Clifton Road, NE, Building A, Suite 2200, Atlanta, GA 30322
Email:lsperli@emory.edu.

As the population ages and our ability to care for patients with cardiac disease improves, an increasing number of passengers with cardiovascular conditions will be traveling long distances. Many have had cardiac symptoms, recent interventions, devices, or surgery. Air travel is safe for most individuals with stable cardiovascular disease. However, a thorough understanding of the physiologic changes during air travel is essential given the potential impact on cardiovascular health and the risk of complications in passengers with preexisting cardiac conditions. It is important for clinicians to be aware of the current recommendations and precautions that need to be taken before and during air travel for passengers with cardiovascular concerns.

KEYWORDS

Air Travel, Heart Disease, Coronary Artery Disease, Heart Failure, Left Ventricular Assist Device, LVAD, ICD, Pacemaker, Implantable Cardioverter-Defibrillator, Pulmonary Arterial Hypertension

1 | INTRODUCTION

More than 2.75 billion passengers travel globally by air each year. As the population ages and our ability to care for passengers with cardiac disease improves, an increasing number of people with cardiovascular disease will be utilizing air travel. Among these individuals, some have had pacemakers or automatic defibrillators implanted, recent revascularization, or surgery that might predispose to deep venous thrombosis (DVT).[1–3] Also, the use of air medical transport services provided by private and insurance-affiliated companies has risen significantly over the past 15 years.[4] In the largest observational study of medical emergencies during air travel, which analyzed data of 744 million airline passengers between 2008 and 2010, the medical incidence rate was reported to be 1.6 per 100 000 passengers, with medical deaths occurring in 36 passengers.[3] Cardiac causes represent 8% of the medical emergencies, whereas cardiac arrest was the most common cause of medical death (31/36) and flight diversion.[3,5] Myocardial ischemia is the most common cause of cardiac events during air travel.[6] DVT is another concern for people who fly long distances, with incidence reaching up to 5.4% in high-risk groups flying an average of 12.4 hours.[2] The risk of venous thromboembolism (VTE) is about 3 times higher in passengers on long distance flights than in the general population.[7]

Air travel is safe for most individuals. Importantly, a thorough understanding of the physiologic changes during air travel is essential for every physician, as special precautions are needed for higher-risk passengers.

2 | PHYSIOLOGICAL CHANGES DURING AIR TRAVEL

Multiple factors can affect cardiovascular health during air travel, including decreased atmospheric pressure, decreased humidity, gas expansion, prolonged immobility, and increased physical and emotional stress.

Most commercial aircraft fly at an elevation somewhere between 22 000 and 44 000 feet above sea level (cruising altitude), with a corresponding decline in partial pressure of inspired oxygen of approximately 4 mm Hg per 1000 feet above sea level.[8] This altitude is associated with an approximate 65% to 85% decrease in atmospheric air pressure and a 60% to 90% decrease in partial pressure of inspired oxygen in comparison with sea level. These values make pressurization of the aircraft essential for the survival of the passengers. Most aircraft use atmospheric air that is subsequently compressed and

routed to the cabin to pressurize the cabin to an atmospheric pressure, usually about 7500 feet (only 25% lower than sea level) but not to exceed 8000 feet (cabin altitude). This corresponds to only a 30% decrease in partial pressure of inspired oxygen, which—although close to the region of rapid decline in the oxyhemoglobin dissociation curve—should keep arterial blood oxygen saturation >90% in healthy individuals. These conditions are usually well compensated in healthy individuals by increasing tidal volume and heart rate.[4,8,9]

However, during turbulence or adverse weather, a higher cruising altitude may be required, which results in further decrease in the cabin pressure. Newer aircraft designs have improved to allow higher intra-cabin oxygen pressures. In all circumstances, cabin altitude >10 000 feet is effectively prohibited, because all flight crew and passengers must then use supplemental oxygen.[8] As such, passengers with underlying ischemic heart diseases and heart failure (especially with concomitant lung diseases) may be more vulnerable with increased hypoxia, as lower baseline oxygen levels may lead to further decline down the steep portion of the oxyhemoglobin dissociation curve with decreased atmospheric oxygen pressures.

Hypoxemia can have many effects on the circulation, including local vasodilatation of coronary and cerebral vascular beds, vasoconstriction in the pulmonary vascular beds, and increase in pulmonary artery pressure, in addition to increase in heart rate, systemic blood pressure, myocardial contractility, and cardiac output.[8,10,11] Most of these reported effects do not become apparent until marked hypoxemia occurs, so only mild changes are typically seen in healthy individuals during air travel.[10]

Aircraft use atmospheric air to pressurize the cabin, which, at flight altitude, has very low humidity (<1%). Although this decrease in cabin air humidity might be associated with increased insensible water loss, these changes have not been proven to result in significant intravascular depletion.[2,12] Nonetheless, relative humidity in the cabin environment usually ranges from 5% to 25%, with other sources of moisture including human respiration, food preparation, beverage consumption, and other in-flight water uses. In fact, one study has demonstrated that most air passengers actually gain weight because of increased fluid intake. Nevertheless, it is recommended that dehydrating beverages such as alcohol, coffee, and certain soft drinks be avoided.

Any gas trapped in a closed space will expand by approximately 35% when going from sea level to cabin altitude. This may be of particular concern in a patient recovering from chest surgery, as air expansion may cause desaturation or even hemodynamic compromise if it promotes a tension pneumothorax.[4] Considering air expansion is very important in patients being transported with a balloon pump. Intra-aortic balloons increase in volume by 25% to 63% (depending on the model) over a change in altitude from 0 to 10 500 feet. Balloon pressure should be equalized at every 1000 feet of ascent to maintain constant volume.[4] Chest tubes, urinary catheters, and cuffed endotracheal or tracheostomy tubes may be affected by the expansion of air or gas.[12]

Prolonged immobilization during air travel, with pressure from the aircraft seat at the back of the legs and subsequent venous stasis, predisposes passengers to DVT and thromboembolism.[1,2] This has long been known as a possible complication of air travel, particularly with prolonged flights, especially in those with additional risk factors including prior VTE, venous insufficiency, or a hypercoagulable state.

Fear and anxiety upon takeoff and landing, challenges related to security measures, concern about missing one's flight, uncertainties related to check-in and identifying the appropriate departure gate—in addition to carrying, pushing, or pulling bags—are potentially stressful events associated with air travel.[10] Fear of flying itself has been reported in about 10% to 40% of passengers.[10] It has been reported that myocardial ischemia occurs more often on the ground rather than in the air, with stress and exertion being precipitating factors.[6]

3 | MEDICAL EQUIPMENT ONBOARD AIRCRAFT

Since 2004, all passenger-carrying aircraft of >7500 pounds maximum payload capacity have been mandated to have ≥1 flight attendant trained in advanced cardiac life support, carry ≥1 automated external defibrillator, and have an emergency medical kit, according to Federal Aviation Administration (FAA) regulations.[12,13] Table 1 outlines the equipment required in an emergency medical kit.[12] Oxygen is typically available at flow rates of 2 L to 4 L. It can be provided for passengers in need, although advanced arrangement, a letter of medical need, and oxygen prescription from the passenger's physician ≥48 hours prior to the flight are required.[8]

Commercial aircraft are equipped with high-level telecommunication capabilities when needed to report medical events and consult with emergency physicians on the ground. Some airlines maintain physician consultative availability to the cockpit 24 hours a day to

TABLE 1 Medical equipment included in an in-flight medical kit

Devices
Sphygmomanometer
Stethoscope
Oropharyngeal airway (3 sizes)
Self-inflating manual resuscitation device with 3 masks
CPR mask (3 sizes)
IV administration set
Adhesive tape
AED
Medications
Saline solution: 500 mL
Non-narcotic analgesic: 325 mg, 4 tablets
Antihistamine tablets: 25 mg, 4 tablets
Antihistamine injectable: 50 mg, 2 doses
Atropine: 0.5 mg/5 mL, 4 doses
Aspirin tablets: 325 mg, 4 tablets
Bronchodilator, inhaled (MDI or equivalent)
Dextrose: 50% in 50 mL, 2 doses
Epinephrine 1:1000: 1 mL injectable, 2 doses
Epinephrine 1:10 000: 2 mL injectable, 2 doses
Lidocaine: 5 mL, 20 mg/mL, injectable, 2 doses
Nitroglycerin tablets: 0.4 mg, 10 tablets

Abbreviations: AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; IV, intravenous; MDI, metered dose inhaler.

TABLE 2 Clinical recommendations for passengers with cardiac conditions prior to air travel

Medical Condition	Recommendation
CAD	
Stable	Can safely travel
UA	Absolute contraindication
MI	
Previous MI	Can safely travel if clinically stable
Recent uncomplicated MI	Wait 2 weeks after the event
	Exercise stress test is recommended prior to air travel for passengers who survived STEMI if no catheterization was performed
Recent complicated MI	Should avoid flying until stable
HF	
NYHA class I/II	No further testing recommended
NYHA class III/IV	Likely will need supplemental oxygen
Unstable HF	Absolute contraindication
LVAD	Maintenance of adequate hydration and avoidance of caffeinated beverages
	Additional fully charged batteries should be accessible
	Medical records and LVAD card should be available
	Contact LVAD centers in travel destination
PAH	
NYHA class I/II	No further testing recommended
NYHA class III/IV	Likely will need supplemental oxygen
Cardiac arrhythmia	
ICD/pacemaker devices	Device ID cards should be carried at all times
	Handheld metal detectors should not be held over devices
	Copy of recent ECG should be carried at all times
	Hand search is preferable
Recent cardiac procedure	
PCI	Can travel after 2 days if procedure was uncomplicated; longer waiting time recommended for complicated cases
CABG	Can travel safely after 10 days of uncomplicated procedure
ICD insertion	Can fly safely within 1–2 days for uncomplicated cases
Prevention of VTE	Below-the-knee compression stockings (20–30 mm Hg) for patients at high risk

Abbreviations: CABG, coronary artery bypass grafting; CAD, coronary artery disease; ECG, electrocardiogram; HF, heart failure; ICD, implantable cardioverter-defibrillator; LVAD, left ventricular assist device; MI, myocardial infarction; NYHA, New York Heart Association; PAH, pulmonary arterial hypertension; PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction; UA, unstable angina; VTE, venous thromboembolism.

provide real-time advice; other airlines use a company that links aircraft to emergency room physicians. This "physician-on-call" program has reduced the need for medical diversion.[14]

4 | AIR TRAVEL AND HEART DISEASE

Air travel is safe for most passengers with stable heart disease. Clinical stability is a better predictor of how one will one will fare with air travel rather than the severity of the heart disease.[10] However, special precautions are strongly recommended for passengers with cardiovascular disease. Table 2 and Table 3 summarize recommendations related to air travel in those with cardiac disease.

4.1 | Coronary artery disease

Given the physiologic changes at high altitude, including increased ventilation, heart rate, systolic blood pressure, and decreased oxygen

saturation, passengers with coronary artery disease (CAD) may experience symptoms of angina at lower effort in comparison to ground level.[15] Cabin altitudes up to 8000 feet (which correspond to regular commercial flight altitude) do not typically pose a hazard for a patient with stable CAD and good exercise tolerance.[16]

Individuals with stable CAD and prior myocardial infarction (MI) can travel safely, with recommendations to carry their usual medications as well as short-acting nitrates.[17] Additional preflight evaluation is not necessary. They should be advised to arrive early and to seek assistance with personal transport at the airport, if needed, to decrease stress and anxiety.[6] Importantly, scheduled medication time adjustments are required for flights that cross time zones; therefore, these transitions should be planned in advance.

On the other hand, passengers with unstable or unclear cardiovascular symptoms should be prohibited from flying.[17] Treatment modification and additional evaluation are often needed before clearance to fly is provided.[18] There are limited data available for safety of air travel in passengers who survived recent acute MI. Previous

TABLE 3 General air-travel recommendations for passengers with cardiac conditions[1,2,25]

Assure adequate amount of medication is in carry-on luggage, including sublingual nitroglycerin.
Keep a list of medications, including doses and frequencies, in case medications are lost.
Adjust dosing intervals with time-zone crossing to maintain appropriate frequency.
Carry a copy of the most recent ECG.
Those with pacemakers should carry a pacemaker card (ECGs should be done with and without a magnet).
Contact the airline prior to travel concerning special needs (eg, diet, medical oxygen, wheelchair) and consider special seat requests, such as near the front of the plane or close to a restroom.
Limit unnecessary ambulation, particularly during flight. Consider curbside baggage check-in and arranging for a wheelchair or electric cart for transportation to terminals/gates within the airports. Assure adequate time between connections.
Consider in-flight medical oxygen if the patient has CCS class III/IV angina or baseline hypoxemia.
Prophylactic drugs for tropical infectious disease (especially antimalarials of the quinidine group) should be used with caution due to possible adverse interaction with medications used to treat heart disease.

Abbreviations: CCS, Canadian Cardiovascular Society; ECG, electrocardiogram.

studies were performed over 3 decades, a time period in which there was significant change in the management and treatment of acute MI, enrolled a heterogeneous population of patients who survived acute ST-segment elevation myocardial infarction (STEMI) and non–ST-segment elevation myocardial infarction with treatment varying between conservative (aspirin and nitroglycerin), to invasive reperfusion therapies (fibrinolysis and percutaneous coronary intervention [PCI]).[9,18–21] The heterogeneity of these studies was also reflected in the published guidelines.[10,22,23] In stable patients, establishing a safe waiting time after an acute coronary event prior to air travel is paramount to minimize in-flight risk. Among different published guidelines, the waiting times after MI range from 3 days to a few weeks, depending mainly on the passenger risk and adaptation of the published heterogeneous, limited studies. However, there is a consensus that air travel 2 weeks after MI is safe, without the need for medical escorting or supplemental oxygen, and the risk of adverse cardiac events is minimal.[9,18,20] A shorter post-event air travel may be associated with increased risk of complications.[10,24] In the current era of treatment of STEMI, a symptom-limited treadmill test prior to discharge or referral to cardiac rehabilitation is recommended for passengers who were treated with fibrinolysis who did not have a follow-up coronary angiogram to define their ischemic burden.[2,25] Similar passengers may also benefit from exercise stress testing prior to air travel.

Passengers with complicated MI or with limited functional capacity should wait >2 weeks, at least until they are medically stable on their recommended treatment regimen.[17]

4.2 | Heart failure

Passengers with stable heart failure without recent changes in symptoms and medication are usually able to tolerate air travel and the

associated mild hypoxia.[10,11,26] Decreased exercise capacity has been reported in heart failure passengers at high altitudes.[27] Oxygen supplementation is generally recommended in passengers with New York Heart Association (NYHA) class III/IV symptoms, passengers with baseline arterial oxygen saturation of <92%, and those who use oxygen at sea level.[1,2,10,17,28] Severe decompensated heart failure is an absolute contraindication to air travel.[17] Passengers with NYHA class IV severely limited by heart failure symptoms are advised not to fly without special consideration and the availability of in-flight oxygen.[10]

Such individuals are advised to use personal transport at the airport to decrease pre-travel exertion. Passengers with congestive heart failure should be advised to avoid consuming in-flight food, which is often quite high in sodium content. Furthermore, it is recommended they avoid alcohol and caffeinated beverages and drink adequate amounts of fluids during the flight.[1,2]

4.3 | Passengers with LVADs

Left ventricular assist devices (LVADs) are being implanted with increasing frequency as both destination therapy and a bridging strategy prior to heart transplantation. Although there is no published data about LVADs and air travel, passengers with LVADs and stable clinical status are usually considered safe to fly.[29,30] During flight, insensible fluid loss is often increased due to decreased humidity. Minor hemodynamic alteration and decrease in blood flow has been reported in several cases.[29–31] Because LVADs are sensitive to blood volume,[29] maintaining adequate hydration and avoidance of caffeinated beverages are important during air travel.[30] Additional fully charged batteries should be accessible during the trip.[32] Medical records and an LVAD card should be available during the security checks. Contacting the airline and airport security should be done prior to the trip. No interference between LVADs and security gates or airplane devices has been reported.[29] Locating and contacting an experienced medical LVAD center in the planned travel destination may be important for such individuals traveling long distance.

4.4 | Pulmonary arterial hypertension

Passengers traveling with pulmonary arterial hypertension (PAH) pose an interesting patient population due to the complex changes that occur in pulmonary vasculature and their potential effects on right ventricular function when exposed to cabin conditions. Pulmonary vasculature is known to constrict rapidly over the course of several minutes in response to hypoxia, which can increase pulmonary artery pressures.[33,34] One study of 8 healthy volunteers flew on commercial airline flight from London, United Kingdom, to Denver, Colorado, for 9 hours, showed an approximately 20% raise in pulmonary artery pressure during flight, and about a 10% elevation 12 hours after landing.[33,34] A similar rise was observed in patients with PAH exposed to simulated cabin altitude using hypobaric oxygen for 20 minutes, yet without worsening of the right ventricular function.[35] The latter was likely due to the short duration of the simulation (only 20 minutes). In a cohort of 34 patients with PAH, mainly with NYHA class II/III, who flew for a median of 3.6 hours on commercial flights, the arterial

oxygen saturation dropped by a median of ~5%, and about 26% of the patients developed significant desaturation, with arterial oxygen saturation <85%.[35-37] Flight duration and resting use of supplemental oxygen were the 2 most important factors to predict significant desaturation during air travel.[35-37] Thus, a careful assessment of this group of passengers must be made before clearing them for air travel. Unfortunately, the role of hypoxia altitude challenge test prior to air travel in this group of patients is still unclear, as one study showed that it failed to accurately predict which patients will require supplemental oxygen.[37,38] Furthermore, an analysis found that pretreatment with sildenafil did not impact pulmonary artery pressures in 62 healthy volunteers who were acutely exposed to high altitude conditions.[39]

The British Thoracic Society recommended that clearance for air travel for patients with PAH should be made based on the resting oxygen levels and NYHA classification.[38] Passengers who use oxygen at sea level are likely to require more oxygen during air travel. Patients with PAH with NYHA calls I/II can travel without additional oxygen, whereas those with class III/IV symptoms should receive in-flight oxygen.[38]

4.5 | Cardiac arrhythmia

Hypoxia and increased sympathetic activation may increase the risk of cardiac arrhythmias at high altitude[2]; however, the incidence of significant arrhythmias during air travel is rare. Over a period of 5 years in Australia (1997–2002), automated external defibrillators were used on board or at the terminal on 109 occasions: 63 times for monitoring of acutely ill passengers and 46 times for cardiac arrest. A majority of cardiac arrests (59%) occurred during flights, of which 22% were due to ventricular fibrillation.[40] Thus, it remains unknown whether hypoxia during air travel results in an increased predisposition to sustained ventricular arrhythmia and implantable cardioverter-defibrillator (ICD) activation in susceptible individuals.[10] Passengers with chronic cardiac arrhythmias, such as atrial fibrillation, should be stable with appropriate rate control and anticoagulation before flying.[10] Passengers with uncontrolled significant cardiac arrhythmia should avoid air travel.[10]

A concern for individuals who have ICDs/pacemakers is passing through security checkpoints. These devices may, in rare cases, set off airport metal detectors, so all passengers should carry an information card with device type, implantation details, and physician contact information, as well as manufacturer contact information.[1] Several studies have reported no significant interference between ICD/pacemakers and security devices, including handheld metal detectors and airplane devices.[17,41-43]

It has been suggested that hypoxia induced by high altitude could influence the stimulation threshold of pacemakers; however, a study consisting of 30 patients with implantable pacemakers exposed to an altitude of 4000 meters above sea level simulated by exposure to a hypobaric chamber demonstrated no change of the stimulation threshold.[44] Activity-sensing rate-adaptive pacemakers and ICDs could be also affected by the vibrations associated with air travel, particularly during takeoff and landing. Device reprogramming to attenuate or disable the rate-response function prior to flying or

applying a magnet to disable the rate-adaptive function of a pacemaker could address this concern if needed.[10]

4.6 | Traveling after undergoing cardiac procedures

Passengers post–uncomplicated elective angiography without stent placement are usually safe to travel the next day if clinically stable.[10] Access site and duration of flight should be taken into account and factored into clinical judgment when advising individuals. In the setting of uncomplicated coronary angioplasty and stent deployment, as hypoxia has been suggested to impair fibrinolysis and activate coagulation cascades that may increase the risk of intra-stent thrombosis,[2] waiting for ≥2 days after the procedure is recommended. On the other hand, those with complicated PCIs or with tenuous medical status pre-PCI should wait for 1 to 2 weeks and be reevaluated before flying.[22] Notably, airport security measures do not detect the alloys in intracoronary stents.[2]

Passengers who have recently undergone coronary artery bypass grafting (CABG) are at risk of trapped gas expansion. Three to 10 days are usually required for the gas to be absorbed.[10] Although no specific guidelines have been issued by the American Heart Association or American College of Cardiology for air travel after CABG, patients should not be allowed to travel within the first 10 days after uncomplicated CABG. Clinical evaluation prior to travel is important to ensure a stable postoperative course and to exclude congestive heart failure, serious arrhythmia, or residual ischemia.[17]

Most passengers can fly safely within 1 to 2 days following placement of an ICD/pacemaker. However, a small increased risk of pneumothorax has been reported.[4] In the case of pneumothorax complicating device insertion, travel should be deferred for 2 weeks with evidence of complete radiographic resolution.[10] Passengers should be advised to restrict arm movements on the side of the device placement, to avoid raising the elbow above the shoulder, and to avoid heavy lifting to minimize the risk of lead displacement.[10]

Cardiac ablation and electrophysiological studies are associated with an increased risk of thrombosis due to a prolonged time of catheter insertion.[10] Appropriate anticoagulation prophylaxis is required for these individuals before early air travel, as they are considered high risk for VTE.[10]

4.7 | Pulmonary embolism and DVT

Although air travel has been associated with risk of VTE, the actual risk in the healthy population remains small, and most cases of VTE occur in people with predisposing risk factors.[45] The risk of thrombosis is increased significantly in passengers with heart failure due to increased venous stasis with already underlying circulatory insufficiency.[1] VTE can develop up to 1 month after a long-distance flight, with most cases occurring within the first week.[14] Fortunately, pulmonary embolism has been reported in only a small proportion of patients with DVT, although it remains an important cause of sudden death among long-distance passengers.[46]

Aspirin or other anticoagulants prior to air travel are not recommended as routine VTE prophylaxis, according to American College of Chest Physicians (ACCP) guidelines.[47] Avoidance of constrictive

clothing and leg crossing, in addition to participation in minor physical activity such as calf muscle exercises during flights, are likely to have some efficacy in the prevention of VTE. Aisle seating and avoidance of tobacco and alcohol-containing beverages may be of benefit.[2] Below-knee gradual compression stockings are weakly recommended by the ACCP during long-distance travel, and only in those with very high risk for VTE (ie, previous VTE, active malignancy, recent surgery, advanced age, thromboembolic disorder, severe obesity, or pregnancy).[47]

5 | PILOT-SPECIFIC REGULATIONS

The FAA considers significant CAD, angina pectoris, and a past medical history of MI as potentially disqualifying medical conditions for pilots. Additional evaluation is required for this group of patients to determine their ability to fly an aircraft without endangering public safety. Before certification can be considered, a 6-month recovery period after open heart surgery or left main coronary artery PCI must elapse. For pilots who had uncomplicated MI or PCI to coronary arteries other than the left main, the recovery period can be shortened to ≥3 months. The typically recommended evaluation includes angiography, electrocardiogram (ECG), and treadmill stress test no sooner than the recovery period. Stress imaging modalities (eg, stress echocardiography, nuclear imaging) are reserved for those with an uninterpretable ECG stress test. A maximal ECG treadmill stress test should achieve 100% of the maximal predicted heart rate, complete ≥9 minutes, and should reveal no evidence of ischemia. Physician certification is necessary for clearance to resume flying. Further details and forms can be found on the FAA website (http://www.faa.gov).

6 | RESPONDING TO IN-FLIGHT EMERGENCIES

Medical emergencies may occur mid-flight and airline staff may request assistance from healthcare professionals during these situations. In these circumstances, a physician responds 48.1% of the time, and aircraft diversion is deemed necessary 7.3% of the time.[3] Fear of liability is a concern many physicians have when it comes to intervening during in-flight emergencies. In the United States, Canada, and the United Kingdom, physicians do not have a legal responsibility to intervene in these situations unless a prior doctor-patient relationship exists.[12,48] In other countries, however, there is a legal obligation to intervene. As of 2002, there had been no reported cases of litigation brought against physicians who intervened while aboard an aircraft.[12] The 1998 Aviation Medical Assistance Act provides limited protection to physicians who intervene during in-flight emergencies. This act requires that the intervening physician be medically qualified, a volunteer, render care in good faith, provide care similar to care that other providers with similar training would provide, and receive no monetary compensation.[48,49] Familiarity with the contents of an onboard medical kit may be helpful to physicians intervening in these situations (Table 1).

7 | CONCLUSION

Multiple physiologic changes occur during air travel as a consequence of the atmospheric changes encountered in the cabin, including increased heart rate, increased tidal volumes, and decreased partial pressure of arterial oxygen. These changes must be taken into account in passengers with cardiac conditions to risk-stratify and apply proper clinical judgment when determining whether air travel is safe. Air travel for those with stable cardiac disease is usually safe with no need for further evaluation. Importantly, when a potential passenger is unstable, high risk, or has had recent procedures, special precautions are recommended.

Conflicts of interest

The authors declare no potential conflicts of interest.

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