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Prevention of Medical Events During Air Travel: A Narrative Review

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ABSTRACT

Prior to traveling, and when seeking medical pretravel advice, patients consult their personal physicians. Inflight medical issues are estimated to occur up to 350 times per day worldwide (1/14,000-40,000 passengers). Specific characteristics of the air cabin environment are associated with hypoxia and the expansion of trapped gases into body cavities, which can lead to harm. The most frequent medical events during air travel include abdominal pain; ear, nose, and throat pathologies; psychiatric disorders; and life-threatening events such as acute respiratory failure or cardiac arrest. Physicians need to be aware of the management of these conditions in this unusual setting. Chronic respiratory and cardiovascular diseases are common and are at increased risk of acute exacerbation. Physicians must be trained in these conditions and inform their patients about their prevention.
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International tourism is one of the leading points of the world economy.[1] In 2009, more than 59% of travel was by air,[1] and according to the World Tourism Organization, tourism represents up to 50% of air travel, before business travel (15%) and travel to visit friends and relatives (27%). Since the establishment in 1919 of the first airline company, air traffic continues to increase, with an estimated average annual growth of 4%.[1] In 2008, almost 2 billion people traveled by commercial airlines.[2] With the increased number of passengers per year, the number of miles flown and passengers boarding is also increasing. In 2013, the maximum number of passengers authorized to board the airbus A380 was 853 per flight.[3]

Medical issues during air travel are estimated at about 350 per day worldwide, corresponding to 1/14,000-40,000 passengers.[4] Because of the specific characteristics of air cabin environment, air travel can exacerbate passengers' underlying conditions, for increased risk of medical emergencies. However, unlike ground travel, air travel raises the question of the availability of advanced care in case of medical issues and their management.

Health care providers and travelers need to be aware of the potential medical issues associated with air travel and their prevention. Among all medical problems on board, some might be life threatening, such as cardiac issues.[5] Some others are predictable and therefore preventable, such as pulmonary issues,[6,7] which suggests that prevention of medical issues related to air travel is highly important in primary and secondary care.

General practitioners often provide pretravel medical advice, most commonly for immunizations and malaria

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chemoprophylaxis.[8] They also frequently advise certain patient groups such as cardiovascular patients and pregnant women.[8] General practitioners are often the first physicians consulted prior to departure.[9-11] However, other sources for travel health advice include travel clinics, travel agents, pharmacists, family and friends, the Internet, books, brochures, and newspapers.[9,10] This clearly illustrates the variety of sources consulted, and the fact that travelers are aware of the need to obtain information and be prepared prior to traveling.

Several studies have investigated the determinants of consulting a general practitioner prior to departure. Male sex,[12,13] age <50 years,[12-14] travel to a nonmalarial region,[13] foreign nationality, and previous travel experience[12,14-16] are negatively associated with the likelihood to consult. Frequency of pretravel consultations with specialized physicians other than general practitioners remains poorly documented.

In this context, 3 issues are currently debated: in-flight emergencies and their management, common underlying conditions at risk of exacerbation during the flight and their prevention, and the main situations justifying a priori specific care. In this paper, we review these 3 issues.

PATHOPHYSIOLOGY

The earth's atmosphere is defined by its pressure, composition, and temperature. Air pressure and temperature depend on the altitude. When the altitude increases, barometric pressure and temperature decrease according to an exponential curve (**Figure**). At cruising altitude (10,000 to 13,000 m above sea level), temperature outside the aircraft is about −54°C and the atmospheric pressure is about 240 hPa. With decreasing barometric pressure, oxygen partial pressure also decreases (according to Dalton's law), and gases trapped within body cavities expand (according to the Boyle-Mariotte law). Thus, aviation regulation requires that all aircraft carrying passengers must be pressurized and maintain a cabin altitude of about 2438 m. Moreover, cabin air is first drawn from outside the aircraft and then heated, filtered, and recirculated, which results in very low humidity, about 10% to 20%.

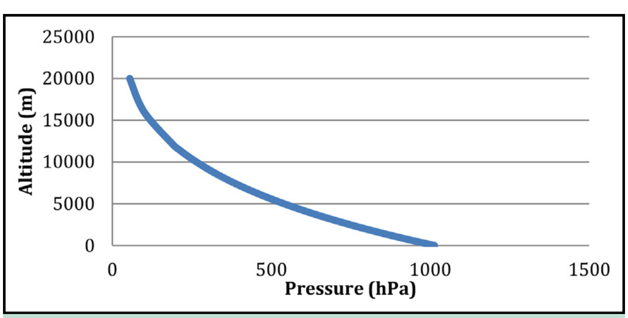

Figure Change in air pressure with altitude.

CLINICAL SIGNIFICANCE

- The most common in-flight medical issues are gastrointestinal pathologies (mainly abdominal pain), psychiatric disorders, and ear, nose, and throat pathologies (mainly barotitis). Most could be prevented with appropriate pretravel advice or medical treatment.
- Some underlying conditions are at higher exacerbation risk during air travel and require an assessment of ability to fly. Respiratory and cardiovascular exacerbations are predictable in most cases, and can be avoided with appropriate prevention.

MEDICAL EVENTS IN AIRCRAFT

In 1998, the US Aviation Medical Assistance Act was passed. Its goal was to protect physicians who respond to medical emergencies on board against liability, except in cases of gross negligence or willful misconduct.[17] In emergency cases, the care provided and treatments delivered should be documented. Because of probable underreporting, the exact number of medical issues during air travel is difficult to assess. Most in-flight medical events may be minor, because diversions may occur in 7% to 13% of cases,[18] and deaths are estimated at about 0.3 to 1 per million passengers per year.[19]

Medical advice is obtained on board in 69% of cases from physicians (40%), nurses (25%), or paramedics (4%).[4] The most common causes of medical events on board are gastrointestinal diseases or troubles (25%).[4,5] Among all medical events, cardiac arrest is rare, about 1000 cases per year, but is responsible for 86% of deaths on board.[20] Here, we focus on cardiac arrest and the most common causes of medical events on board.

Cardiac Arrest

It is no longer debated that early defibrillation is related to survival after cardiac arrest[21]; therefore, the presence on board of automated external defibrillators appears necessary. Qantas (Mascot, NSW, Australia) was the first airline to equip their aircraft with automated external defibrillators, in 1992.[22] During a 65-month period, 27 cardiac arrests were reported, with 2 cases of long-term survival.[22] A study estimated that deploying automated external defibrillators on all aircraft would save approximately 33 lives per year, and automated external defibrillator deployment on large- and medium-capacity aircraft would cost <$50,000 per quality-adjusted life-year gained.[23] Since then, most airlines have equipped their aircraft with automated external defibrillators and trained staff in basic cardiopulmonary resuscitation.

Gastrointestinal Pathologies

Gastrointestinal pathologies are mainly due to the expansion of bowel gas. In most cases, this situation is responsible for isolated abdominal pain. To prevent this event, current guidelines recommend avoiding the consumption of soft drinks and foods at risk of fermentation during and prior to the flight. Gas expansion can be a contraindication for travel, for example, in case of sub-occlusion, diverticulitis, and ulcerated colitis.[24] Patients who have undergone recent surgery or colonoscopy should not fly for 24 hours after colonoscopy, and 5 to 10 days for coelioscopic and non-coelioscopic surgery.[24]

Psychiatric Pathologies

Psychiatric issues constitute 3.5% of in-flight medical emergencies, many (90%) presenting primarily as acute anxiety. The fear of flying is estimated to concern 10% to 40% of passengers and increases with enhanced security measures, delayed flights, cramped cabins, and alcohol consumption.[25,26] Incidents of in-flight passenger misconduct represent a serious threat to passenger safety. This situation corresponds to 1% per 2 million passengers, on average.[27] Excessive alcohol use and illegally smoking on board aircraft are implicated in more than 80% of incidents.[27] The typical passenger at risk of misconduct is a male 30 to 49 years old.[27]

Ear, Nose, and Throat Pathologies

One of the most common causes of premature incapacitation for work among aircrew is barotrauma induced by pressure changes during air travel.[28] Equilibration is normally achieved by swallowing, jaw movements, yawning, or chewing, but with upper respiratory infection, the equilibration process might fail and cause barotitis or aerosinusitis. The incidence of barotitis has been estimated at 10% among adults and 22% among children.[29] For people regularly exposed, the use of an oral decongestant prior to flying decreases the incidence of middle-ear barotrauma.[30,31] An autoinflation device (Otovent; ABIGO Medical AB, Askim, Sweden) is also recommended for passengers with problems clearing the ears during flights.[32]

UNDERLYING CONDITIONS AT RISK OF EXACERBATION

As seen above, air travel is associated with decreased partial pressure of oxygen. In healthy subjects, the condition is asymptomatic. However, with underlying conditions, hypoxia can exacerbate previous diseases, especially respiratory and cardiac pathologies.

Respiratory Exacerbation

The effect of decreased barometric pressure and partial pressure of oxygen with air flight is generally limited by the shape of the hemoglobin dissociation curve and thus, is usually asymptomatic. In healthy subjects, the mean SpO_2 decreases from 97% at sea level to 93% at 2438 m.[33,34] However, this exposure may affect people with lung disease, especially if they are hypoxemic prior to travel, because flying involves the steeper part of the dissociation curve. In addition, air travel is associated with an expansion of gases trapped and lowered air humidity. All these conditions can lead to acute exacerbation of chronic obstructive pulmonary disease, asthma, and other lung diseases.[35-37]

Several measures are available for evaluating supplemental oxygen needs during flight. The pulse oxymeter[38] and the 50-m walk test[39] are simple tests achievable in ambulatory care even if they have some limitations.[38,40,41] They allow for screening patients for whom specialized evaluation is needed, particularly by the hypoxia test.[38] For safety reasons, the US Federal Aviation Administration does not allow travelers to carry their own liquid oxygen aboard aircrafts. Airlines can provide oxygen during the travel at the request of a doctor (2 or 4 L/min), but they do not provide oxygen for ground use. Instead, most patients can use a portable oxygen concentrator. Airline authorization is recommended to allow use of these devices throughout the flight.

Cardiovascular Exacerbation

Cardiac diseases represent 10% of medical incidents on board, are the first cause of diversion,[5] and represent 56% of deaths on flights.[42] The most common cause of cardiac events on flights is a vasovagal episode.[19] However, with less oxygen available for cardiac cellular metabolism (secondary to hypoxemia), ischemic events can occur, particularly in the days following a previous myocardial infarction.[43,44] Many guidelines concerning myocardial infarction related to air travel are available. The expert panels recommend waiting from 3 days to 8 weeks prior to air travel after uncomplicated myocardial infarction (defined as confirmed myocardial infarction without recurrent angina, dysrhythmia, and pump failure).[34,45-47] Limited data are available on air travel after complicated myocardial infarction, defined as myocardial infarction with any of the following events occurring in the peri- or postinfarction period: recurrent ischemia, compromising dysrhythmia, and pump failure (congestive heart failure or significant hypotension). Experts recommend delaying air travel from 2 to 6 weeks.[34,45,46]

Only a few studies are available regarding congestive heart failure and air travel.[48,49] In 2010, Smith et al[34] produced a report on fitness to fly for passengers with cardiovascular disease. With congestive heart failure, short-term (up to 1 hour) hypoxia at rest was associated with no significant adverse effects (including patients with New York Heart Association class III/IV symptoms). Longer-term hypoxia (up to 7 hours) was tolerated in patients with mild-to-moderate stable congestive heart failure. Following an episode of acute heart failure, the authors recommended waiting 6 weeks after stabilization prior to flying.[34] Patients with stable congestive heart failure have no restrictions on flying, but for those with severe limitations (New York Heart Association class III/IV), airport assistance and oxygen supplementation should be considered.[34]

Finally, hypoxia and the associated increase in alpha- and beta-adrenergic stimulation may increase the susceptibility to arrhythmia, but few data are available. According to Smith et al,[34] hypoxia is not associated with increased susceptibility to arrhythmia or any adverse effect on pacing threshold at cabin altitudes encountered during air travel. However, atrial fibrillation or ventricular arrhythmias should be controlled prior to flying. For people with pacemakers or implantable cardioverter defibrillators, the risk of electromagnetic interferences due to metal detector gates is minimal.[50,51] However, the security staff should be alerted to the presence of the device because the metal casing of the device may activate the alarm.

SITUATIONS REQUIRING SPECIFIC CARE AND PREVENTION

Venous Thromboembolism

Prolonged air travel increases the risk of venous thromboembolism (pooled relative risk 2.8; 95% confidence interval, 2.2-3.7) and a dose-response effect: each 2 hours of travel is associated with an 18% increased risk of venous thromboembolism.[52-54] The association between air travel and venous thromboembolism is the strongest with travel for 8 to 10 hours[26-28] and the presence of venous thromboembolism risk factors, including previous venous thromboembolism, recent surgery, active malignancy, pregnancy, estrogen use, advanced age, limited mobility, severe obesity, or thrombophilic disorders.[55-58] However, the global risk of (severe) pulmonary embolism is about 0.4 cases/million passengers.[59] The risk reaches 5 cases/million for travel >10,000 km, with an excess risk among women.[60] Thus, long-distance travelers (ie, >6 hours) with one venous thromboembolism risk factor should perform frequent ambulation and calf muscle exercise, sit in an aisle seat if feasible, and use graduated compression stockings (Grade 2C).[58] Recommendations are also against the use of aspirin or anticoagulants (Grade 2C) due to lack of data on this subject.[58] More studies are needed to assess the value of such treatments in venous thromboembolism prevention.

Infectious Diseases

Cabin air quality depends on a ventilation system, air filtration, and humidity. Because the aircraft cabin is a confined space, airborne, food-borne, vector-borne, and zoonotic infectious diseases transmitted during commercial air travel are an important public health issue. The severe acute respiratory syndrome outbreak of 2002 showed the potential role of air travel in the rapid spread of emerging infections.[61]

The risk of disease transmission within the confined space of the aircraft cabin is difficult to determine. It depends on cabin ventilation,[61-63] with the flow rate the most important element. Airflow in aircraft is described as laminar, but air emerging above one row is considered to be shared mainly with that row and the 2 adjacent rows in front and behind.[62] Despite limitations related to reporting bias caused by incomplete passenger manifests, data from several studies suggest that risk of air transmission of infection to other passengers in the aircraft is associated with sitting within 2 rows of a contagious passenger for a flight time of more than 8 hours.[61,64,65]

CONCLUSION

Medical issues related to air travel are relatively frequent. In most cases, they are related to underlying conditions and could have been easily avoided through appropriate prevention. Health care providers need to be aware of the potential medical issues associated with air travel and their prevention.

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