ASSESSING FITNESS TO FLY

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INTRODUCTION

Air travel today is relatively convenient, expeditious, affordable and, barring any criminal activity or foul play, safe. The majority of health problems encountered in association with air travel stem from pre-existing, perhaps latent, illness in the individual which may be exacerbated by the rigours and hazards of air travel. It has been estimated that 5% of commercial airline passengers have some disease or illness including chronic obstructive pulmonary disease (COPD). The number of airline passengers (which is expected to reach 2 billion per year by the year 2005) and the prevalence of obstructive pulmonary disease are growing spectacularly. It is therefore essential for advising physicians to understand the hazards that are likely to be encountered during air travel, in order that they may develop informed decisions regarding fitness for flying and give appropriate advice. This review focuses on the acute responses of patients with cardiopulmonary disorders to altitude hypoxia and the methods for assessing adequate oxygenation during commercial flights, which temporarily induce a hypobaric, hypoxic stress in an isolated environment. This review also summarizes clinical information, practical guidelines, and procedures applicable to patients requiring supplemental oxygen during air travel.

Responses to altitude hypoxia

Commercial aircraft cruise between 9,150 to 12,200 m above sea level for optimal operating efficiency. At these cruising altitudes, most commercial aircraft are unable to maintain the internal cabin pressure at sea level as this ideal pressurization can significantly weaken the structural integrity of aircraft over time. Instead, the Federal Aviation Administration requires aircraft to maintain a pressure that is equivalent to an altitude of 2,438 m (8,000-ft) above sea level at the highest operating altitude. At this pressure, the inspired fraction of oxygen (FiO_2) is 0.15 (15%) instead of the usual 0.21 (21%) at sea level. This altitude hypoxia causes the arterial oxygen partial pressure (PaO_2) of a normal healthy passenger to drop to 65-68 mmHg, which still lies on the horizontal part of the oxyhaemoglobin dissociation curve, and oxygen saturation will drop 3-4%. In contrast, significant hypoxaemia and desaturation may develop in patients with chronic lung disease as they often start with an ambient PaO_2 near to the end of the horizontal part of the oxygen dissociation curve. Patients with cardiopulmonary and neurologic disorders are most susceptible to the effects of altitude hypoxia and it is not surprising that these disorders are the most frequently reported causes of in-flight morbidity and mortality. Hence pre-flight assessment of altitude tolerance is prudent and necessary in hypoxaemic patients who are suspected or known to require flight-related oxygen therapy.

Preflight evaluation for oxygen therapy

The most specific and effective treatment of significant altitude hypoxaemia is supplemental oxygen. The goal of oxygen therapy at altitude is to maintain adequate tissue oxygenation and to prevent hypoxaemic complications. Currently, no universally accepted criteria exist for recommending supplemental oxygen during flight. The following are general recommendations

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pertaining to pre-flight testing for oxygen therapy.

Traditional tests for air travel in patients with pulmonary disorders have included lung function tests such as the measurement of vital capacity and maximal voluntary ventilation. The presence of respiratory acidosis or a PaO_2 < 50 mmHg and inability to perform simple exercise tests e.g. walking 50 m or up the flight to the airplane have also been considered as contraindications for air travel. However, most of these abnormalities do not adequately predict acute altitude intolerance or the ability to correct it with supplemental oxygen.

The ground-level PaO_2 is superior to spirometric values or lung volumes in predicting altitude PaO_2. Equations and normograms are available for predicting acute PaO_2 and assessing the need for oxygen therapy at moderate altitudes. Nevertheless, these prediction formulae cannot precisely predict the altitude PaO_2 of a given patient since the ability to compensate for a reduction in FiO_2 varies among individuals (even in healthy persons) depending on the ability of the patient to increase ventilation and nature of the hypoxaemia.

To more accurately identify persons who are at risk of developing respiratory distress during air travel, the response to hypoxia in patients can be assessed by either exposing subjects to a low FiO_2 or by using hypobaric chambers. Owing to the relative inaccessibility of hypobaric chambers, the hypoxia inhalation test (HIT) is a more practical test that can be performed in a routine clinical laboratory. The basic premises of the HIT are that altitude hypoxia is the primary stress or threat to patients with cardiopulmonary disorders and that the FiO_2 at altitude can be replicated according to known pressure-altitude relationships. This test uses a hypoxic breathing mixture (15% oxygen) to simulate an anticipated altitude (usually 2450 m or 8000 ft as the typical "maximum" cabin altitude) and monitoring with an oximeter or arterial catheter and electrocardiogram. If oxygen saturation is less than 85% or PaO_2 < 50 mmHg, in-flight supplemental oxygen is usually required. HIT can also involve exercise (e.g. walking on a treadmill) and oxygen supplementation. In these ways, the data obtained from this test may then help the physician recommend fitness for flying and determine appropriate oxygen therapy for individual patients.

A practical approach to the assessment of the need for in-flight oxygen supplementation in patients with respiratory disorders will be provided by the British Thoracic Society, which will be publishing their recommendations shortly. Preliminary (not finalized) guidelines from this document are summarized in Table 1. These recommendations include the use of HIT only for sub-groups of patients. The use of pulse oximetry instead of arterial blood gas analysis in all but patients requiring HIT should improve patient acceptability of the assessment.

It must be noted, however, that the opinions of respiratory physicians regarding assessment methods and criteria for recommending in-flight oxygen seem to vary widely. In spite of the considerable arterial hypoxaemia at moderate altitudes in patients with respiratory disease, its clinical consequences are still uncertain. Some consider detailed preflight hypoxia testing as unnecessary as the incidence of significant in-flight respiratory problems seems to be extremely low, in the range of one respiratory incident resulting in flight diversion per 5-10 million passengers and that, in doubtful cases, in-flight oxygen is probably less expensive than preflight hypoxia testing.

Table 1: Preliminary British Thoracic Society recommendations on pre-flight assessment of patients with lung disease

Sea level SpO_2* > 95%	–	no oxygen supplementation necessary
Sea level SpO_2 92-95% with no risk factors‡	–	no oxygen supplementation necessary
Sea level SpO_2 92-95% with risk factors‡	–	in-flight oxygen according to HIT†
Sea level SpO_2 <92%	–	in-flight oxygen according to HIT†
Patients on long-term oxygen therapy	–	increase in-flight oxygen flow rate

* Oxygen saturation according to pulse oximetry
‡ Risk factors e.g. preexisting hypercapnia, concomitant neurologic and/or cardiovascular disorders
† PaO_2 during HIT: >55mmHg – no oxygen needed
50-55mmHg – borderline (consider walking test)
<50mmHg – prescribe oxygen

Practical aspects of prescribing in-flight oxygen

For the physician prescribing in-flight oxygen, the following points are note-worthy:

1. In-flight oxygen at 2 L/min is sufficient for most patients
2. For patients who are already on long-term oxygen therapy, increase the oxygen flow-rate by 2 L/min during flight
3. Patients with significant hypercapnia are best referred to a specialist for careful assessment of the amount of oxygen that is required during flight
4. In-flight oxygen is not indicated for patients with coronary artery disease with impaired left ventricular function as most generally tolerate altitude exposure very well. An exception may be the patient with pulmonary hypertension, which may potentially be aggravated with mild degrees of additional hypoxic pulmonary vasoconstriction.

Other practical considerations for patients requiring in-flight oxygen are:

1. Submit the request for in-flight oxygen early (at least 48 hours before departure) to the airline's medical department. This is important as commercial airlines are not legally obligated to accept all patients or to manage specific medical needs during. Patients with special needs or services must satisfy the individual airline's policy regarding medical clearance. A request for in-flight oxygen therapy must be submitted to the airline's medical department using standard forms for its consideration
2. Insist on a seat in a non-smoking section, preferably an aisle seat near the toilets
3. The patient must not use his own oxygen on board. If the tank is taken along, it must be empty. Airline companies usually supply oxygen cylinders that are strapped beneath the passenger's seat. These cylinders usually allow variable flow from 2 to 8 L/min. The airline companies usually supply facemasks instead of nasal prongs. Patients should bring along their own prongs as well as tubing and extra connectors, as facemasks may be rather uncomfortable if worn for several hours
4. Preparations must also be made for oxygen supply for ground use before boarding, after landing and at any stopovers
5. Direct flights instead of connecting flights are preferable
6. The patient must take on board all the

medication that is likely needed, especially metered dose inhalers and battery powered ultrasonic nebulisers
7. During the flight the patient should avoid overeating and drinking alcoholic beverages. It is important to keep well hydrated because of the relative dryness of the cabin air
8. When flying, it is prudent for an oxygen-dependent patient to be accompanied by a companion or spouse who is able to help when required.

Problems related to gas expansion at altitude

In addition to altitude hypoxia, gas expansion at altitude may present potential dangers to patients travelling in commercial airplanes. As gases expand by 30 per cent at an altitude of 2450 m, patients with unresolved pneumothoraces should not be allowed to fly. Likewise, following brain or chest surgery, patients should defer flying for at least 6 weeks. There are also theoretical risks for patients with resolved pneumothoraces and large non-communicating bullae.

CONCLUSION

Hypoxia, as a result of the hypobaric environment in commercial airplanes flying at high altitudes, presents potential risks to patients with limited physiological reserves. Much of preflight medical assessment is therefore focused on identifying the patient who is susceptible to excessive in-flight hypoxaemia and evaluating the need for oxygen supplementation. Currently, opinions regarding assessment methods and criteria for recommending in-flight oxygen seem to vary widely. The practical approach to assessment of fitness to fly in patients with lung disease described in this review provides a framework for physicians involved in the decision-making process.

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