Assessing fitness to fly

Guidelines for medical professionals from the Aviation Health Unit, UK Civil Aviation Authority

Civil Aviation Authority

Introduction

Every year, over one billion people travel by air and that figure is predicted to double in the next two decades. Air travel is a comfortable and safe means of transport and is accessible to all sectors of the population. The global increase in travel, as well as an increasingly aged population, means that there will be a significant increase in older passengers and those with illness who will wish to travel.

Physiology of flight

An understanding of the physics and physiology of flying and how this may interact with pathology is useful in coming to an objective conclusion about a passenger's fitness to fly. Contrary to popular belief, modern aircraft are not pressurised to sea level equivalent, and fly with a cabin altitude between 5,000 and 8,000 feet. This results in reduced barometric pressure and a concomitant decrease in the partial pressure of alveolar oxygen (P_aO_2). Few aircraft fly for any significant period of time at the upper limit of cabin altitude of 8,000 feet, where the barometric pressure is approximately 565 mm Hg with an alveolar partial pressure of O_2 of approximately 75mm Hg. However, due to the shape of the oxy-haemoglobin dissociation curve (Figure 1), this only results in a fall of oxygen

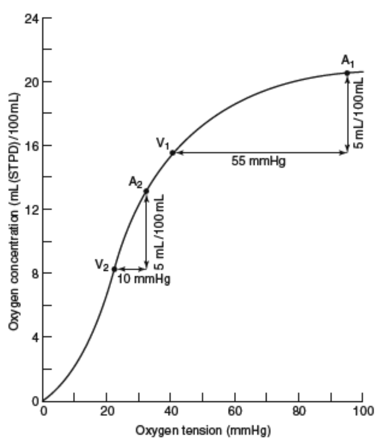

Figure 1: oxygen dissociation curve of whole blood

saturation to around 90%. This fall is well tolerated by most healthy travellers and is compensated by the normal physiological response. However, this decrease in saturation needs to be taken into consideration for those with cardiac, pulmonary conditions or anaemia.

The decrease in ambient pressure in the cabin, compared to ground level, will cause any gas to expand and increase in volume by approximately 30%, which may cause problems if trapped in any body cavity, e.g. the ear, giving rise to pain and possible perforation of the ear drum. Similar issues may occur following surgery, if gas is introduced to the abdominal cavity or the eye.

Contrary to what is believed by many, the aircraft cabin environment does not result in dehydration, as there is no evidence of any change in osmolality. However, the cabin has a low humidity, usually in the range of 10% to 20% compared to that in buildings, which is in the order of 40% to 50%. This is particularly noticeable in the mucous membranes, especially if wearing contact lenses and also in the skin.

Jet lag, or circadian dysrhythmia, in addition to being an annoyance for healthy travellers may complicate the timing of medication, e.g. in diabetic passengers who are treated with insulin (see below).

On commercial flights, regardless of aircraft type, many passengers sit in smaller spaces than in the home environment and may have reduced opportunity to get up and walk about. The potential for the development of travellers' thrombosis (see below), particularly on long haul flights, should be borne in mind and the use of lower limb exercises may be of value in improving the venous return.

Table 1
Cardiovascular indications for medical oxygen during commercial airline flights

- Use of oxygen at baseline altitude
- CHF NYHA class III - IV or baseline P_aO_2 less than 70 mm Hg
- Angina CCS class III-IV
- Cyanotic congenital heart disease
- Primary pulmonary hypertension
- Other cardiovascular diseases associated with known baseline hypoxaemia

CHF - Congestive Heart Failure
NYHA - New York Heart Association
CCS - Canadian Cardiovascular Society

Cardiovascular disease

Hypobaric hypoxia, i.e. that due to a lowered oxygen pressure at altitude, is an area of concern for travellers with cardiovascular disease. The decrease in oxygen saturation may have implications for passengers with cardiac disease who wish to travel. Patients compensate to an extent for this relative hypoxia by increasing their ventilation and by developing a mild tachycardia, which may result in increased myocardial oxygen demand. In patients with limited cardiac reserve, the use of supplemental oxygen (Table 1) may be required and most commercial airlines will supply this when requested in advance although a charge may be levied. There is currently ongoing work, with the Department for Transport, looking at the carriage of oxygen. This may permit passengers to carry their own oxygen, but the results of this work are not yet complete.

Despite the physiological changes that occur at altitude, the majority of patients with cardiac conditions can travel safely as long as they are cautioned to carry their medications in their hand baggage.

Angina Pectoris, if stable, is usually not a problem in flight. Patients with a recent **myocardial infarction** may travel after 7 to 10 days if there are no complications. If the patient has undergone an exercise test which shows no residual ischaemia or symptoms, this may be helpful, but is not a mandatory requirement.

Coronary artery bypass grafting and other chest or thoracic surgery should prove no intrinsic risk in the aviation environment as long as the patient has fully recovered without complications. However, as air is transiently introduced into the thoracic cavity, there is a potential risk for barotrauma due to the gaseous expansion which occurs at altitude. It is therefore prudent that patients should wait until the air is reabsorbed, approximately 10 to 14 days before travelling by air.

Patients with **uncomplicated percutaneous coronary interventions** such as angioplasty with stent placement may be fit to travel after 5 days, but should be medically stable, and individual assessment is essential.

Symptomatic valvular heart disease is a relative contraindication to airline travel. Individual assessment by the treating physician is essential, paying particular attention to the functional status, severity of symptoms and left ventricular function, in addition to the presence or absence of pulmonary hypertension. There is no contraindication to air travel for patients with treated hypertension, as long as it is under satisfactory control and the patient is reminded to carry their medication with them on the flight.

Those with pacemakers and implantable cardioverter defibrillators may travel without problems by air once they are medically stable. Interaction with airline electronics or aviation security devices is highly unlikely for the most common bi-polar configuration.

Following a **cerebrovascular accident**, patients are advised to wait 10 days following an event, although if stable, may be carried after 3 days. For those with **cerebral arterial insufficiency**, supplementary oxygen may be advisable to prevent hypoxia.

Clinical judgement has an important role in the individual assessment of fitness to fly. However, some **cardiovascular contraindications** to flight are shown in Table 2.

Table 2
Cardiovascular contraindications to commercial airline flight

- Uncomplicated myocardial infarction within 7 days
- Complicated myocardial infarction within 4-6 weeks
- Unstable angina
- Decompensated congestive heart failure
- Uncontrolled hypertension
- Coronary artery bypass graft within 10 days
- Cerebrovascular accident within 3 days
- Uncontrolled cardiac arrhythmia
- Severe symptomatic valvular heart disease

Respiratory disease

Medical advice to those with respiratory disease on fitness to fly depends primarily on:

a) the type, reversibility and functional severity of the underlying respiratory disease

b) an assessment of the likely tolerance to the cabin altitude and ambient oxygen concentration.

In patients with significant disease, the relative hypoxia encountered in the aircraft cabin may be easily correctable by therapeutic oxygen. The partial pressure of oxygen in the cabin at normal cruising altitude is considered to be equivalent to an oxygen concentration of approximately 17% at sea level. Some respiratory physicians can carry out assessments in a laboratory using oxygen-nitrogen mixes to simulate this cabin environment. This is termed a 'hypoxic challenge'. If it results in a P_aO_2 less than 55 mm of mercury, medical oxygen is indicated.

Guidelines on this approach to assessment can be found at the British Thoracic Society website at www.brit-thoracic.org.uk.

However, the single and most practical fitness to fly test, is to assess whether the patient can walk 50 yards/metres at a normal pace or climb one flight of stairs without severe dyspnoea. If this can be accomplished, it is likely that the patient will tolerate the normal aircraft environment.

Asthma
The normal aircraft cabin environment does not represent a specific challenge to those suffering from asthma that is stable. The key issue is to ensure that all medication is carried in hand baggage. It may be prudent that patients with asthma, other than the mildest cases, should take a course of oral steroids with them, in order that they could intervene early if there is any deterioration in their condition.

Chronic Obstructive Pulmonary Disease (COPD)
Patients with chronic bronchitis and emphysema are susceptible to in-flight hypoxaemia, depending on their baseline P_aO_2. The walking test and/or hypoxic challenge may be appropriate and medical oxygen can be provided by the airline with prior notification. A fee may be levied for this. Flow rates of 2 or 4 litres per minute are usually available, but generally it is not permissible for passengers to carry their own oxygen on board, as the equipment must meet specific aviation regulatory standards. Particularly, there are issues concerning the permissible water content to prevent freezing and the type of valve, which must be able to cope with varying cabin pressures.

Bronchiectasis and Cystic Fibrosis
Control of lung infection and measures designed to loosen and clear secretions are important aspects of medical care, both on the ground and during travel. Appropriate antibiotic therapy,

adequate hydration and medical oxygen may be required for both conditions. Medication to decrease sputum viscosity is helpful e.g. deoxyribonuclease in the low humidity of the aircraft cabin.

Respiratory infection
Patients with active or contagious infection are unsuitable for travel until there is documented control of the infection and they are no longer infectious. Those recovering from acute bacterial infection e.g. pneumonia should be clinically improved with no residual infection and satisfactory exercise tolerance before flying. Patients with respiratory viral infections e.g. influenza, may infect those sitting adjacent to them and they should postpone air travel until the infection has resolved.

Pneumothorax
The presence of a pneumothorax is an absolute contraindication to air travel as trapped air may expand and result in a tension pneumothorax. In general, it should be safe to travel approximately 2 weeks after successful drainage of a pneumothorax with full expansion of the lung. If there is a need to travel earlier, safe travel is possible using a one-way Heimlich valve attached to the chest drain.

Pregnancy
The advisability of flying whilst pregnant is a frequently asked question. The commercial aircraft environment is not generally considered hazardous to a normal pregnancy. At a normal cabin altitude the maternal haemoglobin remains 90% saturated and because of the favourable properties of foetal haemoglobin (HbF) including increased oxygen carrying potential together with a high foetal haematocrit and the Bohr effect, foetal P_aO_2 changes very little. The key focus in assessment of fitness to fly is the health and wellbeing of the mother and the baby. Delivery in flight, or diversion in flight to a location that may not have high quality obstetric services, is undesirable. For this reason, most airlines do not allow travel after 36 weeks for a single pregnancy and after 32 weeks for a multiple pregnancy. Most airlines require a certificate after 28 weeks confirming that the pregnancy is progressing normally, that there are no complications and the expected date of delivery. In specific individual circumstances, an airline may allow some discretion.

Surgical conditions
The issue of air travel following surgical intervention is becoming an increasingly important issue with the wider use of day surgery. It should be borne in mind that post-operative patients are in a state of increased oxygen consumption due to the trauma of surgery, the increased adrenergic outflow and the possible presence of sepsis. Concurrently, oxygen levels may be decreased or fixed in patients who are elderly, volume depleted, anaemic or who have cardiopulmonary disease. Consequently, for such patients it would be wise to delay air travel for several days or request oxygen to be provided. With the decreased use of blood transfusion, many post-operative patients are more anaemic than they have been in the past. It is not uncommon to see young patients with haemoglobins of the order of 7 g/dl and elderly patients with haemoglobins of approximately 8 g/dl (see Haematological Disorders).

It is important to remember that intestinal gas will expand by approximately 30% by volume at a cabin altitude of 8,000 feet. Many post-abdominal surgery patients have a relative ileus for some days, thereby putting them at risk of tearing suture lines, bleeding or indeed, in extreme circumstances perforation. Stretching intestinal or gastric mucosa may also result in haemorrhage. To avoid such complications, travel should be avoided for 10 days following abdominal surgery. Following other procedures, such as colonoscopy where a large amount of gas has been introduced into the colon, it is advisable to avoid travel by air for 24 hours. Similarly, it is advisable to avoid flying for approximately 24 hours after laparoscopic intervention, due to the residual CO_2 gas, which may be in the intra-abdominal cavity.

Neurosurgical intervention may leave gas trapped within the skull, which again may expand at altitude. It is therefore advisable to avoid air travel for approximately 7 days following this type of procedure.

Ophthalmological procedures for retinal detachment also involve the introduction of gas by intra-ocular injections, which temporarily increase intra-ocular pressure. Depending on the gas, it may be necessary to delay travel for approximately 2 weeks if sulphur hexafluoride is used and for 6 weeks with the use of perfluoropropane. For other intra-ocular procedures and penetrating eye injuries, 1 week should elapse before flying.

Diabetes
Air travel should not pose significant problems for patients with well-controlled diabetes. Pre-planning is important and discussion of the itinerary with the diabetic management team plays an important part in preparation for travel. It is essential that the diabetic passenger carries adequate equipment and medication in their hand baggage. It is important that insulin is not packed in the hold baggage even if it is not being used during the flight as insulin in the hold may be exposed to temperatures that could degrade it and there is the potential risk of loss of baggage en-route. Insulin may be satisfactorily carried in a cool bag for even the longest sector. Individual regimes should be discussed with the diabetic management team, but some general guidelines may be helpful.

When travelling east, the day will be shortened and if more than two hours are lost, it may be necessary to take fewer units with intermediate or long-acting insulin. When travelling west, the travel day will be extended and if this is more than 2 hours it may be necessary to supplement this with additional injections of short-acting insulin or an increased dose of intermediate-acting insulin. Type 2 diabetes is not a problem on diet or oral medication, nor indeed on insulin as the endogenous insulin, which remains in Type 2 diabetes will provide a suitable buffer and assist control. Further information on diabetes and travel is available from the Diabetes UK website (www.diabetes.org.uk).

Haematological disorders

Patients with a haemoglobin of greater than 8 g/dl may travel without problems assuming there is no coexisting condition such as cardiovascular or respiratory disease. If the haemoglobin is less than 7.5 g/dl, special assessment should be made and the use of supplemental oxygen should be considered.

Individuals with chronic renal insufficiency or other medical condition predisposing to anaemia, which is chronic in nature, will usually tolerate a lower haemoglobin level than if the anaemia is of acute onset. Sickle cell trait does not present a particular problem at normal cruising altitude. However, patients with sickle cell anaemia should travel with supplemental oxygen and should defer travel for approximately 10 days following a sickling crisis.

Trauma/orthopaedics

Following the application of a plaster cast, the majority of airlines restrict flying for 24 hours on flights of less than 2 hours or 48 hours for longer flights. This is due to the fact that air may be trapped beneath the cast. If there is an urgent need for travel before these limits, the plaster cast may be bi-valved. If a pneumatic splint is used, some air should be released to allow for gaseous expansion at altitude, which could cause discomfort as well as potential circulatory compromise or neuropraxia.

DVT

Deep vein thrombosis is not intrinsically dangerous but the complications of pulmonary embolism can be life threatening. It has been shown that DVT can occur in many other forms of travel, as described by Homans in 1954. The World Health Organisation Research Into Global Hazards of Travel (WRIGHT) Project recently reported that the key determinant for deep venous thrombosis is immobilisation and the risk of thrombosis is increased by travel of greater than 4 hours. Thus "travellers' thrombosis" is the most appropriate term to use, rather than "economy class syndrome". There is no evidence that the cabin environment activates the coagulation system of normal individuals. The absolute risk, as shown in the WRIGHT Study, was 1 in 4656 flights of more than 4 hours duration. The risk factors for thrombosis are well known and are listed in Table 3.

Prophylactic measures should be undertaken according to the degree of risk. Simple, effective measures are to move about the aircraft cabin and to carry out the lower limb exercises shown in airline videos and in-flight magazines. Any specialised prophylaxis should be targeted at those at highest risk and include properly fitted anti-embolism stockings giving graduated compression to the limb, subcutaneous low molecular weight heparin, which is highly effective and has a low risk of bleeding and in extremely high risk cases, oral anticoagulation. It is important to emphasise that the risk of side effects from the use of aspirin outweigh any potential anti-thrombotic effect and its use is not recommended.

Table 3
Risk factors for DVT

- Thrombophilia enhancing clotting activity
- Recent major surgery
- Trauma or surgery of the lower limbs
- Family history of deep vein thrombosis
- Age > 40 years
- The oral contraceptive pill

General issues

It is important to note that although cabin crew are trained to render advanced first aid, they are not trained to administer medication. In addition, most airlines will assist passengers to reach the toilet accommodation on the aircraft but cannot render more personal hygiene or nursing care.

The majority of in-flight emergencies occur to individuals whose medical condition is unknown to the airline and it is therefore essential that the passenger's physician sends adequate details well in advance of the flight to the carrier. Most airlines have medical advisors who provide advice and 'clear' passengers as fit to fly. The key information that they require is the nature of the individual's condition, its severity/stability, medication being taken and any pertinent information about mobility. The clearance can be done by telephone or by formal communication using the Med IF form available through travel agents or from the Internet which allows the medical information to be structured in a manner that can be processed by the majority of airlines.

The final decision whether or not to carry a passenger is that of the airline, but the more information that is provided in advance, the more likely it is that a fair, evidence-based decision can be made.

Useful sources of information

Aviation Health Unit
www.caa.co.uk/aviationhealthunit

Aerospace Medical Association
www.asma.org/pdf/publications/medguid.pdf

British Airways
www.britishairways.com/health/docs/before/airtravel_guide.pdf

MEDIF Form
http://www.britishairways.com/travel/healthmedcond/public/en_gb

British Medical Association
www.bma.org.uk/ap.nsf/AttachmentsByTitle/PDFFlying/$FILE/Impactofflying.pdf

Aviation Health Unit

The UK Civil Aviation Authority's Aviation Health Unit (AHU) was formed on 1 December 2003 to advise Government on passenger and aircrew health issues. In March 2007 the AHU was given an additional statutory function in safeguarding the health of all persons on board aircraft. The recent House of Lords Inquiry (Air Travel and Health: an Update) emphasised the pivotal role of the Unit as a focus for those interested in aviation health matters. The AHU can be contacted on 01293 573674 or by email: aviationhealthunit@caa.co.uk