

Clinical aviation medicine: safe travel by air

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ABSTRACT – Commercial air travel has increased dramatically in the last 25 years, which has resulted in an increased number of passengers travelling. In 1995, approximately 1.4 billion passengers flew. There are very few contra-indications to flying in commercial jet aircraft and even passengers with medical conditions travel regularly without incident. To avoid in-flight emergencies which potentially have implications for the patient's medical condition and the operation of the flight it is essential to assess significant medical conditions prior to travel. With appropriate assessment by a physician who has an understanding of the aviation environment and its potential interaction with the patient's medical condition, the majority of passengers may be carried. If a medical emergency occurs in flight the medical practitioner may have a role to play when asked by the crew, whose training has recently been augmented by many airlines to include the use of self diagnosing defibrillators. This team approach is important and is of benefit to the patient; it may avoid disruption to the flight.

Commercial air travel is an extremely safe, convenient and relatively inexpensive mode of transport. The relative decrease in cost in recent years has resulted in an annual growth in air travel of approximately 4% per annum¹. In 1995 approximately 1.4 billion passengers flew, which was a three-fold increase on the numbers from 1975. It is estimated that by the year 2015 the number may again treble².

Background

There are few contra-indications to flying in a commercial jet aircraft and many passengers who have medical conditions travel regularly without incident. However, there are some passengers whose fitness may be borderline or who may be severely ill and are travelling to obtain treatment in a centre of expertise or, indeed, who are terminally ill and are returning home for humanitarian reasons. The main concerns in assessing passengers' fitness to fly are: (a) will the in-flight environment have an adverse effect on the medical condition; and (b) will this result in delay or diversion of the aircraft?

The reported incidence of medical emergencies varies considerably. One major British airline reported 2002 incidents in over 34 million passengers carried in one year³. The average figure reported in 1991 was 5 per 10,000 passengers⁴. The frequency of medical conditions causing such incidents has been documented in literature. Respiratory disorders were reported as the cause in 10% in 1992⁵ and this was unchanged at 10.2% in the more recent figures published in 1996³. In that study the commonest causes of incidents were gastrointestinal (22.3%) and cardiovascular (21.8%). Deaths in flight are rare, Cummins⁵ in 1998 reported 0.31 per million passengers, a figure remarkably similar to that of Bagshaw³ in 1996 of 0.29 per million.

Medical practitioners may have input into passengers' health at two points:

- in assessing fitness to travel by air
- assisting, on the request from the airline, when a passenger becomes unwell during a flight.

An understanding of the environment in the aircraft cabin is important in both these roles.

The cabin environment

Modern subsonic jet aircraft fly at cruising altitudes selected for the safe and efficient operation of the flight. Normal cruising altitudes vary from 35,000 feet (10688m) to 43,000 feet (13107m) depending on the aircraft and operational considerations. At 35,000 feet, atmospheric pressure is approximately 23% and at 43,000 feet is 16% of that at sea level⁶.

In this physiologically hostile environment the aircraft cabin is pressurised to a maximum cabin altitude of 8,000 feet (2438m). The first consequence of this is that the alveolar oxygen tension falls from 103 mmHg (13.7 kPa) at sea level to approximately 70 mmHg (9.3 kPa) at this cabin altitude. However, because oxygen-haemoglobin dissociation has a sigmoid curve, this restricts the fall of arterial oxygen saturation to only 6% from 3% at 6,000 feet and approximately 9% at 8,000 feet cabin altitude (Fig 1). This is of no consequence for a fit individual but may well be for passengers with significant medical conditions.

The second consequence of the reduction in cabin pressure, determined by the Gas Laws, is an expansion of gas in body cavities of some 30–40%⁷. The

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rise in pressure during descent is a common cause of pain in the ears and sinuses of passengers with upper respiratory tract infections. This effect during the climb has obvious implications for gas introduced into body cavities during surgical procedures.

The quality of air in the cabin has been the subject of debate in the literature⁸ and the popular press. In modern jet aircraft it is normal practice for 50% of the cabin air to be recirculated. This recirculated air is usually passed through high efficiency particulate (HEPA) filters which remove micro-organisms. The flow rates of fresh air in the passenger cabin are designed to exceed the minima laid down for indoor rooms by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). This rate is 5 cubic feet per minute per passenger, which ensures that carbon dioxide levels remain below 5,000 parts per million by volume. Most modern airliners achieve flow rates of approximately double this value. The air entering the cabin has a relative humidity of less than 1%; however, exhaled moisture from passengers and crew, in addition to moisture from the galleys and toilets, increases the humidity to average levels of 15–21%. These values are below the levels for maximum comfort and may cause symptoms of nasal dryness which can be alleviated by drinking more non-alcoholic liquids to avoid dehydration. The relatively dry atmosphere may have implications for passengers with respiratory problems.

Assessing fitness for travel by air

Having reviewed the aircraft cabin environment it is evident that this mode of travel should not present any problems for fit and healthy passengers. The aim in assessing fitness to fly is to allow the passenger to complete travel safely without any deterioration in their medical condition which may also result in delay and/or diversion to the aircraft. For this process to work efficiently it

requires the passenger to declare to their treating physician that they intend to travel and for the physician to be familiar with the aviation environment and any potential interaction with the patients' medical condition. Most airlines have a medical adviser who will assist in the assessment¹⁰. Although each airline has its own particular guidelines, they tend to base them on those of the Aerospace Medical Association¹¹.

Specific medical conditions

Specific advice for individual passengers should be sought from the airline carrying the passenger, using the Medical Information Form (MEDIF) recommended by the International Air Transport Association (IATA).

Respiratory diseases

The main conditions include asthma, chronic obstructive airways disease (COAD), emphysema and pneumothorax. In general, it is accepted that if an individual can walk 50 metres on the level or climb 10 steps without dyspnoea they will be able to tolerate the relative hypoxia of the aircraft cabin without incident. It has been suggested that if the traveller's PaO₂ is less than 70 mmHg additional oxygen should be requested¹² and those with a PaO₂ of less than 50 mmHg should preferably use surface transport. Most airlines will provide supplementary oxygen at a charge which varies from airline to airline. It is not permissible for the passenger to use their own oxygen system in flight as all equipment used on board the aircraft must meet a higher regulatory standard than for normal medical oxygen in terms of permissible water content (to prevent freezing of valves and regulators at high altitude). Most patients with asthma travel without problems but it is important that all medication is carried in hand baggage. Spacers are preferable to nebulizers and some airlines do not permit the use of powered nebulizers.

An individual with a spontaneous pneumothorax should postpone flying for 10–14 days after full inflation. It is generally advised that a patient should not fly for 21 days after thoracic surgery but individual assessment may be carried out between 11 and 21 days.

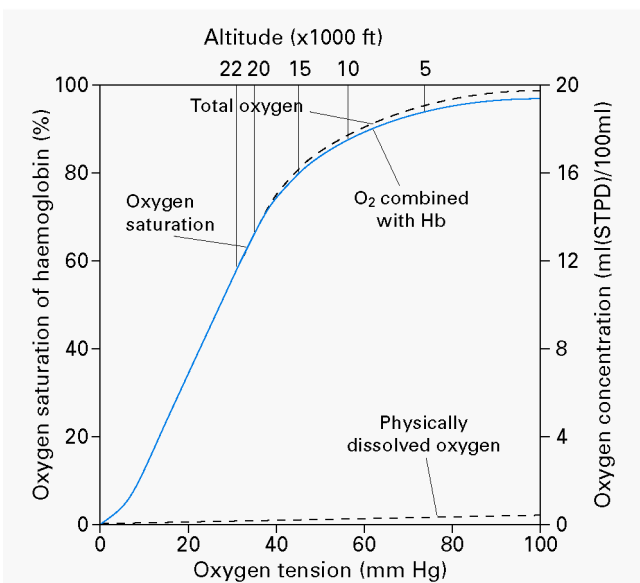
Cardiovascular diseases

Relative hypoxia may cause problems to patients with myocardial ischaemia and cardiac failure. Most patients with uncomplicated myocardial infarction should be fit to fly within 10 days. If complications exist an individual risk assessment should be carried out. After an angioplasty with or without stenting, patients should be fit to fly within 3–5 days, but after open cardiac surgery the thoracic surgery guidelines should be followed.

Other medical conditions

Anaemia: Haemoglobin of less than 7.5g/dl usually precludes travel and a haemoglobin between 7.5 and 10 g/dl needs

Fig 1. Haemoglobin dissociation curve.



individual assessment. A history of red cell sickling in the 10 days prior to travel is another contraindication to flying.

Neurology

Patients recovering from a stroke should not travel within 10 days and similar guidelines are usually applied to neurosurgery where the cranium should be free of air. Passengers who suffer from epilepsy should ensure their medication is in their hand baggage and should not travel within 24 hours of a grand mal seizure.

Orthopaedic conditions

Patients in plaster should not fly within 48 hours unless the splint is bivalved. Limited space in the cabin may be a problem on some flights and passengers with mobility problems should not be seated at emergency exit rows.

Pregnancy

Women with uncomplicated single pregnancies may continue to fly with most airlines up to week 36 of pregnancy; multiple pregnancies are usually safe to carry up to week 32. Healthy neonates are normally fit to fly some 48 hours after birth when the majority of alveoli have inflated.

Psychiatric disorders

The main problem is the potential effect on other passengers and the safety of the aircraft. If the patient is well controlled medically and accompanied by an escort capable of administering the appropriate medication, they are usually fit to fly.

Surgical procedures

Most cases will require individual assessment depending on the nature of the surgical procedure, but at 10–14 days after general surgery most patients are fit to fly. Laparoscopic surgery or investigation usually precludes air travel for 48 hours to ensure all gas is absorbed. After eye surgery, air travel is possible by the seventh day but if there is gas in the globe total absorption, which may take six weeks, is necessary.

Miscellaneous conditions

Recreational diving: Divers who have been deeper than 30ft should delay their flying for 24–48 hours.

Deep vein thrombosis

Often called 'economy class syndrome', this is a misnomer as the condition can occur in any cabin in the aircraft and, indeed, has also been associated with travel by car, bus and sea. Although there has been considerable interest in the popular press, it is

Key Points

There are very few contraindications to flying in modern aircraft even for passengers with medical conditions

Significant medical problems should be assessed prior to travel to avoid in-flight emergencies

An understanding of the aviation environment and its potential interaction with the patient's condition enhances the quality of the assessment

important to emphasise that it is a relatively rare condition, bearing in mind the number of passengers who travel. In order to counteract the effects of prolonged sitting mobility it is reasonable to carry out lower limb exercises and encourage mobility within the aircraft cabin. For those with multiple risk factors, anti embolism stockings, aspirin or low molecular weight heparin should be considered in discussion with the individual's treating physician¹³.

In-flight medical emergencies

*'But a Samaritan who was making the journey came upon him, and when he saw him he was moved to pity.'*¹⁴

The incidence of in-flight emergencies is low^{3,4}. However, any such emergency can be disturbing for both passengers and crew and may have operational implications for the flight. Air France has estimated that for three out of four life threatening medical emergencies during a flight, there is a medical practitioner travelling as a passenger¹⁵; Air Canada's data suggest the figure is even higher, at approximately 90%¹⁶. The cabin crew are trained to handle common medical conditions but in more serious circumstances they will request the assistance of a 'medical practitioner on board'. This approach uses the 'Good Samaritan' concept. It has been estimated¹⁷ that medical help will be sought on one in 50 international flights on wide bodied aircraft. The commonest causes of in-flight emergencies were fainting (14.9%) and diarrhoea (11.5%)³.

Legal implications

There are a number of variables in international travel which may have implications for the doctor who assists at the request of the cabin crew. A British registered aircraft is subject to United Kingdom law but not when it is not moving under its own power. Thus, if it should be on stand in the United States of America it is subject to local law. Under French law it is a legal requirement for a medical professional to offer assistance to a sick or injured individual. Some countries (eg USA) have passed a 'Good Samaritan Law', whereby a professional who assists in delivering emergency medical care within the bounds of their competence is not liable for prosecution for negligence. In the UK both the Scottish and English defence insurance companies provide indemnity for their members who give 'Good

Samaritan' assistance. As yet there have been no cases brought against any medical practitioner for malpractice following a Good Samaritan incident on a commercial aircraft. Airlines do recognise the assistance of medical practitioners and the expression of that recognition varies from airline to airline. It would be inappropriate to pay full professional fees as the indemnity implications would be self evident. Many medical practitioners have been critical of the emergency medical facilities available on aircraft^{18,19} but it is important to bear in mind the constraints of space and weight on a commercial flight. For aircraft registered in North America the Federal Aviation Administration (FAA) lays down the minimum standards of equipment carried in part 21 of the Federal Aviation Regulations. The equivalent regulations for aircraft registered in Europe are laid down in the European Joint Aviation Requirements: JAR-OPS 1, subpart L. Most airlines do carry more than the legal minimum and the final choice will depend on a number of operational and legal considerations. In addition, the standard of training of the cabin crew will influence the kit contents. Many airlines have a two part kit, one to be used by the cabin crew and the other part to be used only by a medical practitioner²⁰. In addition to the basic medical kit, airlines carry equipment for cardiopulmonary resuscitation. Increasingly, airlines now carry an automatic advisory defibrillator, with cabin crew trained in its use. Despite this change, it is important for all physicians to remember that a commercial aircraft is not an intensive care unit. In order to improve the support given to those assisting in in-flight emergencies, many airlines are now using 'telemedicine'. This provides a link from the aircraft to a central ground station where medical advice may be given, often based on information, eg ECG data and pulse oximetry, transmitted from the aircraft. This may assist in managing the condition of the patient and any decision to divert the aircraft.

Conclusion

Commercial air travel is a safe and effective mode of transport. For some passengers with medical problems, however, flying means exposure to potential risk. If this risk is to be managed effectively, it is essential that pre-planning is carried out together with a physician who has an understanding of the aviation environment and its interaction with the patient's medical condition. If, despite this precaution, a medical emergency occurs in flight, the medical practitioner has a role to play when asked by the crew. It is important to utilise the knowledge of the crew so that the physician may augment their skills for the ultimate benefit of the passenger and the safe conduct of the flight.

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