EDITORIAL

Cardiovascular disease and airline travel

Michael Joy

Heart 2007;**93**:1507–1509. doi: 10.1136/hrt.2007.134247

See article on page 1599

One of the frequently asked questions of the doctor is about fitness to travel. Fitness to travel by road or rail as a passenger is largely common sense and relates to comfort and locomotor ability. It may not be advisable immediately after an acute illness or surgical intervention. Certain limitations are placed both on both private and vocational drivers in the event of illness or disability which are covered by section 92 of the Road Traffic Act 1988. These are published by the Driver and Vehicle Licensing Agency in its "At a Glance" booklet.[1]

It is beyond the scope of this editorial to review the (international) standards required for aircrew certification[2] or those relating to Europe[3] and the UK,[4] but it is helpful to examine some of the unique aspects of the aviation operational environment which are relevant to the carriage of passengers. Travel by air most people find stressful to some extent: access to the airport, inconvenient parking, carrying luggage long distances, long delays at check in, security and boarding, jet lag. To this now is added the terrorist threat (it has always been present) and the confiscation of deodorant and nail scissors. And about one-third of travellers also admit to apprehension or fear before and during a flight. Finally, the cabin of a crowded aircraft is not a good environment in which to be taken ill, or render treatment, as anyone who has been asked if they are "a proper doctor" will attest.

THE AIRLINE OPERATIONAL ENVIRONMENT

Extent of air travel

In 2006 the world's airlines saw an increase of 4.1% in the total number of passengers carried to 2.1 billion[5] in some 26 300, mainly turbojet, airliners which flew over 21 million hours. This was achieved for the loss of 863 lives in 27 fatal accidents,[6] comparing favourably with the 3172 road deaths in the United Kingdom[7] in the same year, underlining the remarkable safely levels that have been achieved world wide. The average sector length (taking into account both long and short haul operations), which was about 1 hour 30 years ago, is now just over 2 hours and reflects the growth in intercontinental travel. Ultra-long haul, sometimes transpolar, flights may last up to 18 hours. As would be expected, the exposure of such large numbers of people over such a time frame will be associated with illness and death while travelling which is unrelated to the fact of the travel itself.

Airline medical facilities

The major airlines have medical departments whose advice should be sought when contemplating the transfer of a sick passenger. The smaller ones may contract out guidance. British Airways[8] in common with the other larger airlines has a passenger medical clearance unit and requires the submission of the standard International Air Transport Association (IATA) medical information form (MEDIF), which can be downloaded from the web.[9] Most of the large carriers also subscribe to organisations such as MedAire Inc of Phoenix, Arizona, USA, which can give immediate advice to an aircraft in the air through a radio link (MedLink). British Airways, which carried some 33 million passengers in 2006, made 2561 contacts with MedLink (about 210/month). The same airline diverted 47 flights at an average cost of £50 000, 25% of the diversions being for a suspected cardiological reason. There were 12 on-board deaths. A defibrillator was called for on 33 occasions, there being 12 cardiac arrests, eight demonstrating ventricular fibrillation, of whom four were successfully resuscitated Wilkinson E and Dowdall N, unpublished data). Experience elsewhere has been similar.[10] Comprehensive published data are scant but a report some years ago indicated that there were 0.31 deaths/million passengers carried.[11]

THE CABIN ENVIRONMENT

The cabin environment is not a normal one. It is temperature controlled, but the humidity is low—commonly 10–20%—which can give rise to drying of the air passages. It is also cramped, restricting movement. Cabin pressure varies, although it is maintained on all but the smallest aircraft at the equivalent of between 1525 and 2438 metres (5000 and 8000 feet). As the aircraft climbs there is a corresponding fall in cabin pressure, and in the partial pressure of inspired oxygen (Pa_{O_2}). Standard barometric pressure at sea level is 760 mm Hg, which gives an arterial Pa_{O_2} of about 103 mm Hg (13.7 kPa) when breathing air. This falls at 1525 metres (5000 feet) to 565 mm Hg and the Pa_{O_2}, on air, to 75 mmHg (10.0 kPa). At 2438 metres (8000 feet) the Pa_{O_2} (air) falls again to 65 mmHg (8.7 kPa). Fortunately, the dissociation curve of normal haemoglobin allows for 90% saturation of arterial blood at the cabin pressures normally encountered. There are implications, though, if the haemoglobin is abnormal (ie, haemoglobin S), is unsaturated at sea level, or if there is gas (air) entrapped in a closed cavity following surgery.

Abbreviations: DVT, deep venous thrombosis; MEL, minimum equipment list; VTE, venous thromboembolism

Correspondence to:
Dr M Joy, Nuffield Hospital, Shores Road, Woking GU 21 4BY, UK; mj@aviationcardiology.com

The minimum equipment list (MEL)

The MEL carried on every aircraft is included in its certificate of airworthiness. An aircraft may not be permitted to take to the air if not in compliance with the MEL specifications. It requires one to four (basic) first aid kits and may also include an enhanced emergency kit which contains items required for cardiopulmonary resuscitation. The content of these kits is detailed elsewhere.[12] The Federal Aviation Administration (FAA) in the USA requires that aircraft above 3400 kg (7500 pounds) shall carry at least one automatic external defibrillator and at least one flight attendant regularly trained in its use. Many other international airlines also carry an automatic external defibrillator. Likewise, if there is a requirement for supplemental oxygen this has to be prebooked (and paid for) as the emergency supply cannot be used throughout the flight. Airliners carry a small amount of portable oxygen for use in an emergency.

Role of the cabin crew

The foremost role of the cabin crew is to ensure the safety of the passengers. The cabin crew are commonly trained in advanced first aid and intermediate life support. They undergo annual refresher training, but this does not equip them for, nor is it their responsibility to offer, nursing support, which has to be provided (with agreement of the airline) by others if a seriously ill patient is carried.

ASSESSMENT OF FITNESS TO FLY

An assessment of fitness to fly should include some knowledge of the purpose of the travel. Fitness for task is relative and a different level of assessment may be appropriate to the repatriation of a severely ill or dying patient (suitably accompanied) to one bound for Sangria on a Costa. Patients receiving medication should carry it with them in their hand luggage and take it at the time intervals prescribed. It should be pharmacy labelled and be accompanied by a doctor's covering note for the benefit of the customs officers at the destination. Additional personal equipment may be carried at the discretion of the airline. The duration of the flight needs to be taken into taken into account and the need for assistance.

The normal person responds to hypobaric hypoxia with a mild tachycardia which increases myocardial oxygen demand. In patients with significant impairment of myocardial function, or of coronary flow reserve, this may give rise to symptoms.[13] Likewise, patients with a diffusion abnormality due to incipient pulmonary oedema may also become breathless. Notwithstanding the stress of flying, patients with stable heart disease who are symptom free at rest and who can mount a flight of stairs are likely to be fit enough to fly (and undergo an operation).

SPECIFIC PROBLEMS IN CARDIOVASCULAR MEDICINE

Coronary artery disease

There is no contraindication to flying with chronic stable angina pectoris provided that it is not severe (two to three attacks/week) and medication is available and being taken. Those with unstable angina should not fly. After an uncomplicated myocardial infarction, repatriation may be undertaken (with the agreement of the airline) after 1 week, but it is better to wait 3–4 weeks. There should be no evidence of decompensation. Patients who have undergone uncomplicated percutaneous coronary intervention may fly after 5 days, although this should be delayed if the patient has continuing symptoms or is otherwise unstable.

In the case of coronary artery bypass grafting, there are two additional limitations—the time taken for air to resorb from the pleural cavity (10 days to 2 weeks) and the stability of the sternal wound. Flying is not advisable in much less than 2 weeks and is best deferred for 4–6 weeks. A clinical review should be undertaken to exclude a significant arrhythmia (ie, atrial fibrillation) or heart failure, or both. If the post-surgical interval is short a chest *x* ray examination may be advisable.

Heart failure and other problems

Right, left or biventricular failure should be treated and stable. Patients with New York Heart Association grade IV symptoms should not fly, if possible, and those with significantly reduced functional status or ejection fraction may require supplementary oxygen. The same applies to symptomatic valvar heart disease, whether stenotic or regurgitant. Systemic hypertension is acceptable if controlled but significant pulmonary hypertension (>60 mm Hg systolic) may require supplementary oxygen in view of hypoxia-induced pulmonary vasoconstriction (***see article on page 1599***).[14] Patients with cyanotic congenital heart disease, however, may tolerate cabin hypoxia well.[15] Supraventricular (ie, uncontrolled atrial fibrillation) or ventricular tachyarrhythmias require management. Modern normally functioning implantable devices do not experience interference from aircraft systems.

Deep venous thrombosis (DVT)/venous thromboembolism (VTE)

The problem of DVT has received wide coverage. Wrongly tagged "economy class syndrome", it is also seen in travellers at the front of the aircraft and in those undertaking long journeys by rail or road.[16] In 2001 the World Health Organisation commissioned an expert report[17] to be based on prospective epidemiological and pathophysiological studies. It confirmed that the risk of VTE doubles after a flight of 4 hours and is increased further with longer and multiple flights. This risk also applies to travel by car, bus and train. Obesity, extremes of height, oral contraceptive use and prothrombotic disorders all increase the absolute risk, which is 1 in 6000 in healthy people over a 4-hour flight. The previously reported impact of hypobaric hypoxia on thrombosis could not be substantiated in healthy subjects, although there may be a problem, not attributable to immobility, in people "at risk", yet to be identified.[18]

There will be travellers at enhanced risk of DVT/VTE. These include those with previous DVT/VTE, congestive cardiac failure, inherited or acquired thrombophilia, polycythaemia (primary or secondary), recent surgery or lower limb/abdominal trauma, pregnancy and oestrogen therapy. Immobility and dehydration will increase this risk and the general advice, applicable to all, to move about and avoid alcohol should be headed. Support stockings may be helpful, but the use of aspirin is controversial. Low molecular weight heparin (ie, Clexane 40 mg S/C) may be given in patients at high risk the day before surgery, on the day itself, and the day after surgery if the patient is not already receiving warfarin.

CONCLUSION

The modern aircraft is a safe and well-regulated environment. There is a duty of care on the part of travellers towards fellow passengers and the airlines to minimise the risk of illness while in the air with its attendant problems to themselves and others. This responsibility also devolves to their medical advisors.

Recommended sources for passengers and crew:

- UK Department of Health (http://www.dh.gov.uk)
- WHO (http://www.who.int/ith).
- UK Civil Aviation Authority. Aviation Health Unit (http://www.caa.co.uk/default.aspx?catid=923).

Conflict of interest: None declared.

REFERENCES

1 **DVLA**. *At a glance guide to the current medical standards of fitness to drive.* Swansea: DVLA, 2007, Available at http://www.dvla.gov.uk/medical/ataglance.aspx (accessed 24 September 2007).
2 **Air Navigation Bureau**. *Aviation medicine (med) section*, Available at http://www.icao.int/icao/en/med (accessed 24 September 2007).
3 **Joint Aviation Authorities**. *JARs licensing*, http://www.jaat.eu/licensing/licensing_jars.html (accessed 24 September 2007).
4 **Civil Aviation Authority**. *JAR class 1 and 2 medicals: requirements for professional and private pilots.* http://www.caa.co.uk/default.aspx?catid=49&pagetype=68&gid=211 (accessed 24 September 2007).
5 **IATA**. *IATA Economic Briefing World Air Transport Statistics.* 51st ed. Available at http://www.iata.org/ps/publications/watt51 (accessed 24 September 2007).
6 **Learmount D**. Deadly lessons - Flight International airline safety review. *Flight International* 2007;**171**:14–8.
7 **Department of Transport**. *Road casualties in Great Britain: main results: 2006*, http://www.dft.gov.uk/pgr/statistics/datatablespublications/accidents/casualtiesmr/rcgbmainresults2006 (accessed 24 September 2007).
8 **British Airways**. *Health and medical informations*, http://www.britishairways.com/travel/healthmedcond/public/en_gb.
9 **IARA**. *Resolution 700*, http://www.iata.org/WHIP/_Files/WgId_0263/IATAReso700.pdf (accessed 24 September 2007).
10 **O'Rourke**, Donaldson E, Geddes JS. An airline arrest programme. *Circulation* 1997;**96**:2849–53.
11 **Cummins RO**, Chapman PJ, Chamberlain DA, *et al.* In flight deaths during commercial air travel. How big a problem? *JAMA* 1988;**259**:1983–8.
12 **Aerospace Medical Association**. *Medical guidelines for airline travel*, 2nd ed.*Aviation, Space Environ Med* 2003;**74**(section II), A1–18.
13 **Gong H Jr**. Air travel and oxygen therapy in cardiopulmonary disease. *Chest* 1992;**101**:1104–13.
14 **Broberg CS**, Uebing A, Cuomo L, *et al.* Adult patients with Eisenmenger syndrome report flying safely on commercial airlines. *Heart* 2007;**93**:1599–603.
15 **Harinck E**, Hutter PA, Hoorntje TM, *et al.* Air travel and patients with cyanotic congenital heart disease. *Circulation* 1996;**93**:272–7.
16 **Carter D**, Nathanson V, Seddon C, *et al. The impact of flying on passenger health: a guide for health care professionals.* London: BMA Publications, 2004, Also available at http://www.bma.org.uk/ap.nsf/Content/Flying (accessed 24 September 2007).
17 **WHO**. *Research into global hazards of travel (WRIGHT) project. Final report of phase 1.* Geneva: WHO Press, 2007, Also available at http://www.who.int/cardiovascular_diseases/wright_project/phase1_report/en/index.html (accessed 24 September 2007).
18 **Toff WD**, Jones CI, Ford I, *et al.* Effect of hypobaric hypoxia, simulating conditions during long haul air travel, on coagulation, fibrinolysis, platelet function and endothelial activation. *JAMA* 2006;**295**:251–61. [Erratum in: *JAMA* 2006;**296**:296–46.

IMAGES IN CARDIOLOGY

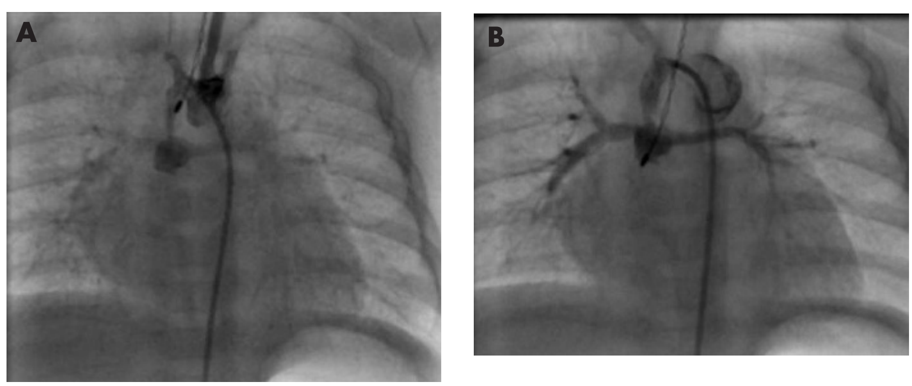
doi: 10.1136/hrt.2006.105296

Stenting of a stenosed modified Blalock–Taussig shunt after Norwood-I palliation for hypoplastic left heart

A male baby underwent stage I of the Norwood palliation on the third day of life. A month later he presented with clinical signs of bronchiolitis and recurrent episodes of desaturations. The modified Blalock–Taussig (BT) shunt was patent on echocardiography. The patient remained on the ward for 2 weeks with saturations varying between 60% and 80%.

On the 47th postoperative day saturations dropped to 40%. The shunt murmur was quieter and echocardiography showed shunt stenosis.

Emergency cardiac catheterisation via the femoral artery confirmed a long stenosis of the shunt, which was more severe at the distal end (panel A). The shunt ostium was entered with a 4F GL catheter, a 0.035 guidewire was forwarded into the left pulmonary artery, then exchanged to a 0.014 Luge wire. The shunt was ballooned with a 5×20 mm Tyshak miniballoon. After initial improvement, saturations dropped back to 40%. Repeat angiogram still showed distal stenosis. A 4×8 mm Liberte stent was placed into the BT shunt, which moved slightly proximally on withdrawing the balloon. A milder degree of distal stenosis remained (panel B). Saturations improved. Heparin infusion was started.



He remained stable with saturations between 70% and 80% for the next 5 weeks with no further episodes of desaturation. Medication consisted of low molecular heparin, aspirin, diuretics and ACE inhibitors. He gained weight from 3.96 kg to 4.98 kg. Six weeks after stent implantation, a stage II Norwood procedure was carried out uneventfully.

Stenting of modified BT shunts in hypoplastic left hearts is an option to treat shunt stenosis.

Thomas Krasemann, Shakeel Qureshi
Thomas.Krasemann@gstt.nhs.uk