In-flight Medical Emergencies — A Difficult Medical and Legal Environment

MARK LOVELL, MB, BS, FANZCA
The Children's Hospital at Westmead, Sydney, NSW

Mark Lovell is a Staff Specialist at Westmead Hospital and The Children's Hospital at Westmead, Sydney. His interests include paediatric and obstetric anaesthesia.

INTRODUCTION

There is an old joke about in-flight emergencies that goes something like this.

An announcement comes over an aircraft intercom, "Is there an anaesthetist on the plane?" After many requests, an anaesthetist reluctantly volunteers to a grateful flight attendant who thanks him and says breathlessly that there is a surgeon in first class who urgently needs his light adjusted! Despite widespread misconceptions about the role of the anaesthetist, we are actually well placed to provide help during in-flight emergencies. Anaesthetists are specifically trained in the care of critically-ill patients, with airway and resuscitation skills in advance of many other specialties. This article discusses the environmental and physiological factors peculiar to airline travel, the assessment and treatment of in-flight emergencies and the medico-legal issues relevant to your decision to volunteer assistance, especially when such emergencies are attracting the attention of the media, travellers and the medical profession.

Every year, commercial airlines transport hundreds of millions of passengers. Air transport is extremely safe with a very low death rate of about 0.31 deaths per 1 million passengers.[1] However, passengers with pre-existing disease are now travelling in increasing numbers and there is an expectation that commercial airlines will assist them with any in-flight emergencies. Medical practitioners from all specialities are frequently asked to volunteer during these events. How should they respond to in-flight emergencies, when they are passengers?

EPIDEMIOLOGY OF IN-FLIGHT EMERGENCIES

The incidence of in-flight medical events appears to be increasing.[2] There have been a number of studies of this, but currently there is no mandatory reporting of events aboard commercial aircraft and so accurately assessing the incidence of such emergencies has been difficult. In 1999, a British report found an incidence of one in-flight emergency for each 11,000 passengers,[3] while another study quoted an incidence of 1 in 39,000 in-bound passengers.[4] The death rate amongst passengers from a 1997 study was 1 in 6.4 million paying passengers.[5] Only about one in five deaths are amongst passengers with a documented severe illness.[1]

Most in-flight events on commercial flights are not serious. By far the most common are fainting episodes, or "syncope". After syncope, angina, cardiac events, gastro-intestinal conditions, asthma, anxiety and panic attacks were the next most common.[2]

Anxiety, alcohol abuse, sleeplessness, immobility and barotrauma contributed to the difficulties faced by passengers. [3]

DOCTOR PARTICIPATION

Despite the relatively low frequency with which in-flight emergencies occur, a recent survey showed that 62% of physicians had been called on at least once to care for a sick or injured passenger on a commercial airline.[6] The same study showed that medical personnel were generally happy to give assistance during in-flight emergencies, but fear of litigation made physicians reluctant to offer their help.[6] A study by the Federal Aviation Authority (FAA) in the US found that 69% of in-flight emergencies aboard US airlines were attended by some form of health care professional — medical doctors 40%, nurses 25% and paramedics 4%.[7]

AIRCRAFT DIVERSIONS

Diversions for in-flight emergencies are a time-consuming and costly exercise for all commercial airlines. Syncopal episodes, suspected heart attacks, neurological events and dyspnoea make up the majority of cases requiring unscheduled landings.[2] Other causes include seizure activity, abdominal pain and haemorrhage. A recent report of 201 in-flight medical emergencies on one commercial airline over a 4-year period reported eleven diversions and three in-flight deaths. The most common reasons for diversion in this study were cardiac disease (36.3%) and bleeding problems (27.2%).[8] Commercial airlines are increasingly looking for ways to decrease the cost imposed by these emergency diversions, which can range from $3000 to $100,000 because of the need to dump fuel prior to landing and provide accommodation for stranded passengers.[9]

ENVIRONMENTAL & PHYSIOLOGICAL FACTORS

Cabin Pressure

For reasons of passenger comfort and safety, it would be desirable in passenger aircraft to maintain a cabin pressure close to the atmospheric pressure at sea-level. However, this is not possible for structural design and operational efficiency reasons. Modern commercial aircraft fly at altitudes of between 9000 m and 12000 m, primarily to decrease fuel costs but also to avoid unfavourable weather systems.[5] At 12000 m, the atmospheric pressure outside the aircraft drops from 760 mmHg to 176 mmHg. Within the cabin, pressure is maintained by drawing in external air and limiting its outflow. Thus, a differential pressure is established between the outside and the inside of the plane. Most aircraft are able to increase the pressure within the cabin, but only to a pressure differential of about 430 mmHg. Thus, cabin pressure changes in parallel with altitude, but to a much lesser degree than the drop in external atmospheric pressure. For example, at 12000 m where atmospheric pressures outside the aircraft is 176 mmHg, the cabin pressure will be 176 mmHg+430 mmHg, or 606 mmHg. This is equivalent to the atmospheric pressure found at an altitude of 1600 m, therefore giving a "cabin altitude" of 1600 m.

Aboard the supersonic Concorde, the situation is somewhat different as it operates up to a cruising altitude of 18300 m (60,000 ft). By necessity, a greater pressure differential must be reached to provide a near normal cabin environment. This is achieved by drawing even more compressed air from its significantly more powerful engines into the cabin. A differential pressure of 530 mmHg can be maintained, ensuring reasonable cabin pressures at this extreme altitude, where the external atmospheric pressure is only 51 mmHg.[10]

The drop in cabin pressures generally has minimal effect for healthy passengers, but will result in a drop of arterial partial pressure of oxygen from about 95 mmHg to about 56 mmHg. This represents only a 4% reduction in the amount of oxygen carried by the blood as, even at a PaO_2, of 56 mmHg the passenger still lies on the flat part of the oxygen-haemoglobin dissociation curve. Difficulties occur in those patients with significant cardio-respiratory disease, who have lower PaO_2 at sea level. Any reduction in atmospheric pressure may see them move onto the steep portion of the dissociation curve, where oxygen saturations may fall quickly. These passengers are at risk of hypobaric hypoxia. Their vulnerability to hypoxaemia at altitude depends on their PaO_2 at sea level and their physiological ability to compensate for the decrease in PiO_2 as the plane ascends.[5]

Fortunately, depressurisation of commercial aircraft through equipment failure or accident is an extremely rare event. When there is a slow loss of cabin pressure, then an aircraft is able to descend to a level at which the outside atmospheric pressure is adequate for passenger oxygenation. For healthy passengers who are exposed to external atmospheric pressures, 100% oxygen given by face mask should still provide adequate protection against loss of consciousness, up to an altitude of about 12000 m (40,000 ft). However, Concorde operates at altitudes at which even 100% oxygen would be insufficient, should the passengers be exposed to external atmospheric pressures. Its design therefore includes features such as small windows, which aim to minimise the rate of accidental decompression and is also engineered to have a reserve capacity for cabin pressurisation. Special pressurised breathing apparatus ensures that the pilots and crew can function normally in the event of a rapid depressurisation.[10] This equipment is normally only used for pilots operating military aircraft at high altitudes.

Gas Expansion

In accordance with Boyle's Law, air and gas trapped in body cavities expands in direct proportion to the decrease in atmospheric pressure. A cabin pressure equivalent to the pressure at an altitude of 1600 m will result in expansion of gas volume by about 30%.[11] Symptoms such as abdominal cramping, ear and tooth ache occur in healthy passengers as a result of this gas expansion.[3,5] The case involving Dr Angus Wallace, a trauma surgeon from the UK, dramatically illustrates the potential for gas expansion. He was faced with a passenger who developed a tension pneumothorax aboard a commercial aircraft; he managed to relieve this with the aid of a coat hanger, urinary catheter and a brandy bottle![12]

More particularly, this effect must be considered in the circumstances of patient transport. For instance, patients who have had recent surgery are at increased risk of wound dehiscence. Care must be taken with medical equipment such as pneumatic splints, urinary catheters, cuffed endotracheal tubes and tracheostomy tubes in which gas containing closed spaces may expand during flight.[5] Instillation of water into the endotracheal cuff has been recommended to avoid this problem.

Cabin Air Quality

Most studies of the composition and quality of commercial aircraft cabin air have found that it is remarkably clean, even more so than in the home or workplace.[13] When compressed air has passed through the jet engines, its temperature is initially very hot (250°C); it is then cooled at high pressure. These harsh physical properties of aircraft intake systems provide essentially sterile cabin air.[13]

When passengers exhale potential respiratory pathogens, the infectious agents enter laminar sheets of air flowing vertically from top to bottom of the cabin and are then diluted by frequent air exchanges. (Commercial aircraft exchange cabin air every 3-4 minutes.) Studies have shown that the concentration of bacteria within cabins is less than that found on city buses, shopping malls or even in airline terminals[14] although there have been sporadic reports of the transmission of tuberculosis and other infectious diseases aboard commercial flights.[15, 16] However, the risk of cross-infection aboard commercial airlines seems to be primarily determined by the length of the flight (>8 hours) and the proximity to the index passenger (i.e. sitting within 2 rows indicating an increased risk).[17]

Because the air drawn in from the engines at altitude has very low water content and engineering constraints do not allow for cabin humidification systems, humidity is invariably low. Most aircraft cabins have a relative humidity of between 15-25%.[10] Passengers will often complain of dry skin and itchy eyes. Additionally, the low humidity will tend to exacerbate reactive airways disease in susceptible passengers.[13]

Air Rage and Other Disturbances

Aggressive or disruptive behaviour aboard aircraft is an increasing problem and presents great difficulties for the air crew, because of the disruption to other passengers, the potential for passenger and crew injury and the very real risk to the safe working of the aircraft. Sporadic reports of "Air Rage" appear in both medical journals and the lay media. The intoxicating effects of alcohol are enhanced at altitude and may contribute to the problem, along with frustration associated with the smoking ban for nicotine addicts. There have been instances requiring physical restraint of passengers, and some occasions requiring physicians to assist with sedating agitated or violent passengers. In one incident, a passenger became abusive and violent on a flight to Turkey and had to be restrained. When his agitation worsened, a doctor aboard the aircraft was asked to assist by sedating the passenger, which he did with 10 mg of intravenous diazepam. Approximately five minutes before landing, the patient stopped breathing and soon died. The aircraft made an emergency landing in Istanbul, where both the crew and the treating doctor were arrested. They were questioned overnight, but allowed to continue their travel the next day.[18] Such incidents highlight the difficulties associated with treating aggressive patients who may be under the influence of other drugs, who may not be fasted and who need to be treated within the close confines of a commercial aircraft.

FITNESS FOR AIR TRAVEL

Providing medical advice on flying to passengers with pre-existing disease is very difficult. It might be expected that those with prior significant illness would have greater morbidity and mortality during air travel. One approach to prevention of in-flight emergencies might be to increase travel restrictions for people who have a documented severe illness.[1, 5] Implementing these types of restrictions would be complex and possibly discriminatory. The Air Carrier Access Act of 1986 prohibits airlines from discriminating against passengers with disabilities; however, an airline would still be able to refuse passengers considered at risk for travel. None the less, a policy that excluded "at risk" passengers may only eliminate up to 20% of in-flight deaths; as noted earlier, only about 1 in 5 deaths aboard commercial aircraft occur in passengers with documented severe illness.[1]

Many guidelines on assessing fitness for air travel have been published but, in general, travel on commercial airline is contraindicated if a medical condition would be adversely affected by hypoxic or pressure changes.[1, 5, 13]. If a patient has a pre-flight arterial oxygen tension of less than 70 mmHg, supplementary oxygen should be recommended.[19] For individuals in whom excessive oxygen can worsen hypoventilation, there are centres where a simulation of altitude, by inhalation of hypoxic gas mixtures, can be done pre-flight. Supplemental oxygen for in-flight medical use can be arranged, but requires 48 hours notice and a prescription for the gas. Passengers cannot use their own equipment during flights, as oxygen is considered a hazardous material.

Specific medical contraindications to air travel include recent myocardial infarction, recent stroke, and decompensated cardiac disease. Others are pneumothorax, recent eye surgery, uncontrolled seizures, recent skull fractures, severe anaemia, sickle cell disease (especially above 7000 m) and pregnancy beyond 35 weeks gestation.[5, 20]

IN-FLIGHT MEDICAL KITS

The standard of in-flight medical resources varies greatly worldwide. The issue has recently been raised in both the US Congress and in a special report by the Chicago Tribune entitled "Code Blue-Survival in the sky".[21] As public expectation increases, a balance has had to be found between the competing needs of cost effectiveness, storage space, staff training, security concerns and the short shelf life of drugs. Currently, the FAA requires a compulsory medical kit which includes basic equipment such as stethoscope and sphygmomanometer, along with a range of emergency drugs including adrenaline, nitroglycerin, lignocaine, antihistamines and bronchodilator inhalers.[9] Of interest to anaesthetists is that the equipment available includes self-inflating bag, masks and oropharyngeal airways. However, there is no requirement for equipment such as laryngoscopes and endotracheal tubes.

In Australia, Qantas carries a more extensive medical kit that includes laryngoscopes, endotracheal tubes and suction equipment. Medications such as haloperidol, morphine, benztropine and naloxone are also included.

Automated External Defibrillators

Virgin Atlantic Airways was the first to carry automatic external defibrillators in 1990. Provision of defibrillators was controversial until findings showed that cardiac arrest aboard aircraft was most commonly due to ventricular fibrillation.[22] The previous policy of cardiopulmonary resuscitation and emergency diversion was found to be generally unsuccessful for the patient and expensive for airlines. Recent litigation has increased the availability of defibrillators, as well as the training of cabin staff in their use. A further benefit has been the use of defibrillators as portable ECG monitors for patients with cardiac ischaemia, allowing better decision making.[22] From April 2004, all US flights with at least one flight attendant must carry an automated external defibrillator.

There are also trials of advanced telemetry systems capable of transmitting 12 lead ECG, pulse oximetry, end-tidal capnography, pulse rate, blood pressure, together with a video and communications link direct to ground-based medical assistance teams. Virgin Atlantic is currently the only airline to use this system.[11] Recent studies have shown that long-term survival following the use of automated external defibrillators aboard commercial airlines is still only about 27%.[22]

Ground-based Medical Assistance

Recently airlines have been using the services of ground-based medical assistance companies to cover those instances when medical assistance is not available aboard a commercial aircraft. For instance, Medlink is a ground-based medical assistance company based in the emergency department of the Good Samaritan Regional Medical Centre in Phoenix, Arizona. It provides direct communication between flight crew, volunteering medical staff and ground-based doctors. Information can be provided about treatment of patients as well as lists of airports suitable for diversions and details of their medical facilities. Reassuringly, once the company has been contacted by an air crew, the airline and any assisting physician are relieved of liability in the treatment of a sick passenger.[11] It is hoped ground-based medical assistance will be cost effective, given the very high costs associated with emergency diversions.

MANAGEMENT OF IN-FLIGHT EMERGENCIES

A doctor travelling on board a commercial aircraft may encounter any type of medical emergency. The cramped conditions, difficult access to the patient, lack of privacy, cultural and language difficulties, noise and vibration make providing assistance very difficult. Simple monitoring procedures such as auscultation and blood pressure measurement are affected, even by low levels of ambient noise and vibration.

It is not within the scope of this discussion to recommend treatments for all the various medical emergencies that may be encountered. However, there are some overriding principles that can be employed. As a general rule, the flight crew is responsible for responding to a passenger who is ill. The role of any medical personnel who volunteer is to assist the crew with the management of this patient, but not to take over. Overall, the goal is to stabilise the patient until the aircraft has landed and more definitive treatment can be instituted. As anaesthetists, we have skills for effective treatment of the critically-ill but usually simple first-aid techniques will prove the most useful.

Firstly, the provision of oxygen may be life-saving. If cardiac or respiratory disease is the concern, it may be of benefit to ask for the plane to descend to below 7000 m (22,000 ft). In less serious circumstances, vaso-vagal episodes may be simply be treated by laying the patient down and raising the legs. Hypoglycaemic episodes are relatively common, as patients may inject insulin prior to the flight and then be delayed in eating their meals. Oral glucose preparations or intravenous 50% dextrose are present in most kits. Allergic reactions can often be improved with antihistamines, corticosteroids or adrenaline. Some airlines will carry adrenaline pens in their kits.

If available, consultation with ground-based medical staff will assist with management as well as providing some protection from medical litigation. When simple measures are inadequate, diversion of the aircraft should be suggested. The following conditions are examples:

- Cardiac arrest.
- Chest pain (unrelieved by nitrates, aspirin and oxygen).

- Shortness of breath (unrelieved with oxygen, lowering of altitude or bronchodilator therapy).
- Cerebrovascular accident.
- Uncontrolled seizure activity.
- Unresponsive patient (not improved with 50% Dextrose administration).

MEDICOLEGAL ISSUES

Despite recent advances in ground-based medical assistance, there is still the need for cabin staff to call on travelling doctors for medical assistance. A recent survey of 850 physicians showed that 62% had, been asked to provide medical assistance aboard a commercial airliner at one time or another.[6] The legal situation regarding liability and obligation to treat aboard commercial airlines varies worldwide. In the United States, the 1998 Aviation Medical Assistance Act contains wording designed to protect airlines and individual doctors from medical liability. It states that individuals "will not be liable for providing assistance unless the individual is guilty of gross negligence or wilful misconduct".[24] In addition to being medically qualified, the assisting passenger must be a volunteer, render care in good faith and receive no monetary compensation. Gifts in the form of travel voucher, alcohol or seat upgrades are generally not considered monetary compensation. However, there is a report of an Australian orthopaedic surgeon, who was given a travel voucher for providing medical assistance aboard a US airline. After redeeming the voucher he read the conditions of acceptance; these included absolving the airline of any liability in the treatment of the passenger.[25]

There are cases where volunteering medical personnel have attempted to obtain payment for providing medical assistance aboard an aircraft. In one case, the volunteering doctor was a specialist psychiatrist who billed the airline for the five hours he treated a passenger, who was suspected of having a pulmonary embolus.[26] The psychiatrist, who was initially reluctant to volunteer, only billed the company after feeling aggrieved that he had only been given a bottle of champagne and a travel voucher worth $50. The airline refused to pay the bill and the doctor took them to court!

At this time there is no record of a passenger bringing suit against a physician in a US court related to an in-flight medical event.[24] There have, however, been instances where airlines have successfully been sued for medical incidents. Lufthansa Airlines was forced to pay $2.7 million to a passenger who claimed to be having a heart attack during a 9-hour flight. The captain had refused to land, having been advised by a doctor aboard the aircraft that there was no necessity to do so.[27]

When does a doctor travelling as a passenger have an obligation to treat?

In the United States, Canada and the United Kingdom doctors do not have a legal duty to render assistance, unless there is a pre-existing physician-patient relationship. In fact, in the UK, the law seemingly discourages the "Good Samaritan". If a doctor comes to the aid of the sick person, he or she undertakes a duty of care and will be liable if skills fail. On the other hand, European Law does impose an obligation to treat. For example, under French law there is an obligation to render assistance where a person is in need of help; backed up by threat of fines or imprisonment.[27]

In Australia, there is case law to suggest that there is an obligation to treat. One case involved a general practitioner who declined to attend a patient having a grand mal seizure, a short distance from her practice. The patient subsequently developed cerebral ischaemia and severe neurological deficit. The court found a duty of care did in fact exist and found against the doctor, despite there being no previous patient-doctor relationship.[25]

Developing recommendations from all the various case law, international law and conflicting jurisdictions is extremely difficult. However, there are some general principles which may help to guide a doctor who is called on to assist with an in-flight emergency and is concerned about liability.

1. Always wait for the airline to ask for your assistance. In this way, the airline and the doctor are at least equally responsible for incidents related to the ill passenger.
2. Clearly identify yourself and state your qualifications.
3. Obtain as comprehensive medical history as is possible, with the aid of interpreters, if available. Tell the patient and their family of your clinical impression and obtain consent prior to any examination or treatment.
4. If you are unsure of diagnosis or management, ask if there are other medically qualified persons aboard the aircraft.
5. Quickly assess the equipment and drug kit.
6. Consider moving the passenger to a less populated or more spacious area within the aircraft, if this is possible.
7. Ask if the airline has the services of ground-based medical assistance and use them. When this is done, the service then takes overall liability and is responsible for any flight diversion necessary.
8. Ask the flight crew for an estimated time of arrival or, alternatively, the time to the nearest appropriate airport. If the patient's condition is serious, inform the captain of the need for urgent treatment and discuss diversion options.
9. Always make written notes during treatment or shortly after, including clinical impression, treatment and details of communication with flight crew and ground-based medical services.
10. Do not use any treatment you are uncomfortable with; basic first aid principles will often be sufficient until definitive treatment can be instituted on the ground.
11. Do not accept monetary compensation. (Upgrades or small gifts are probably acceptable.)

These points should be taken as a general guide to the difficult decisions that have to be made when volunteering assistance during in-flight medical emergencies.

We should remember that when we offer to assist someone in distress we perform an act of basic humanity. Let us hope that despite all the environmental and legal difficulties associated with in-flight emergencies we can still provide timely and skilful assistance.

REFERENCES

1. Cummins RO, Chapman PJC, Chamberlain DA et al. In-flight deaths during commercial air travel. *JAMA* 1988; 259:1983-1988.
2. Donaldson D, Pearn J. First aid in the air. *Aust NZJ Surg* 1996; 66:431-434.
3. Dowdall N. "Is there a doctor on the aircraft?" Top 10 in-flight medical emergencies. *Brit Med J* 2000; 321:1136-1137.
4. Cummins RO, Schubach JA. Frequency and types of medical emergencies among Commercial air travellers. *JAMA* 1989; 261:1295-1299.
5. AMA Commission on Emergency Medical Services. Medical aspects of transportation aboard commercial aircraft. *JAMA* 1982; 247:1007-1011.
6. Raymen RB. In-flight medical kits. *Aviat Space Environ Med* 1998; 69:1007-1010.

7. Dejohn CA, Veronneau SJ, Wolbrink AM et al. The evaluation of in-flight medical care aboard selected US carriers 1996-1997. FAA Administration, Office of Aviation Medicine. (Technical report no. DOT/ FAA/AM-0013).
8. Han HM, Chae DH, Kim JH. In-flight medical emergencies in civil airline. *Aviat Space Environ Med* 2000; 71:330.
9. Gendreau MA, DeJohn C. Responding to medical events aboard commercial airline flights. *N Engl J Med* 2002; 346:1067-1073.
10. Nunn. Nunn's Applied Respiratory Physiology.
11. Goodwin T. In-flight medical emergencies: an overview. *Brit Med J* 2000; 321:1338-1341.
12. Wallace WA. Managing in-flight emergencies. *Brit Med J* 1995; 311:1508.
13. Rayman RB. Passenger safety, health and comfort: A review. *Aviat Space Environ Med* 1997; 86:432-440.
14. Wick RL, Irvine LA. The microbiological composition of airline cabin air. *Aviat Space Environ Med* 1995; 66:220-224.
15. Wenzel RP. Editorial. Airline travel and infection. *New Engl J Med* 1996; 334:981-982.
16. Mcfarlane JW, Hickmann C, Osteholm M, McDonald KL. Exposure to mycobacterium tuberculosis during air travel. *Lancet* 1993; 342:112-113.
17. Kenyon TA, Valway SE, Ihle WW, Onorato IM, Castro KG. Transmission of multi-drug resistant mycobacterium tuberculosis during a long airplane flight. *New Engl J Med* 1996; 334:933-938.
18. Kovac C. Airline passenger dies after being sedated by doctor. *Brit Med J* 1999; 318:12.
19. Cottrell JJ. Altitude exposure during aircraft flight. *Chest* 1988; 92:81-84.
20. Barry M, Bia F. Pregnancy and travel. *JAMA* 1989; 261:728-731.
21. Code Blue: Survival in the sky. *Chicago Tribune* June 30, 1996.
22. O'Rourke MF, Donaldson E, Geddes JS. An airline cardiac arrest program. *Circulation* 1997; 96:2849-2853.
23. Page RL, Joglar JA, Kowal RC et al. Use of automated external defibrillators by a US airline. *New Engl J Med* 2000; 343:1210-1216.
24. Lyznicki JM, Dietchman SD, Howe JP. In-flight medical emergencies. *Aviat Space Environ Med* 2000; 71:832-838.
25. The Law Report, Part 2. Health law: radio national transcripts. Sydney Australia: Australian Broadcasting Corporation, August 3, 1999.
26. Dyer C. Doctor demands payment for helping airline passenger. *Brit Med J* 1998; 317:701.
27. Newson-Smith MS. Passenger doctor in civil airliners — Obligations, duties and standards of care. *Aviat Space Environ Med* 1997; 68:1134-1138.