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REVIEW ARTICLE

Commercial aviation in-flight emergencies and the physician

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Abstract

Commercial aviation in-flight emergencies are relatively common, so it is likely that a doctor travelling frequently by air will receive a call for help at some stage in their career. These events are stressful, even for experienced physicians. The present paper reviews what is known about the incidence and types of in-flight emergencies that are likely to be encountered, the international regulations governing medical kits and drugs, and the liability, fitness and indemnity issues facing 'Good Samaritan' medical volunteers. The medical and aviation literature was searched, and information was collated from airlines and other sources regarding medical equipment available on board commercial aircraft. Figures for the incidence of significant in-flight emergencies are approximately 1 per 10–40 000 passengers, with one death occurring per 3–5 million passengers. Medically related diversion of an aircraft following an in-flight emergency may occur in up to 7–13% of cases, but passenger prescreening, online medical advice and on-board medical assistance from volunteers reduce this rate. Medical volunteers may find assisting with an in-flight emergency stressful, but should acknowledge that they play a vital role in successful outcomes. The medico-legal liability risk is extremely small, and various laws and industry indemnity practices offer additional protection to the volunteer. In addition, cabin crew receive training in a number of emergency skills, including automated defibrillation, and are one of several sources of help available to the medical volunteer, who is not expected to work alone.

Key words: *aviation*, *defibrillator*, *emergency*, *equipment and supplies*, *ethics*, *medical*.

Introduction

You are on your way to an international emergency medicine conference, flying long-haul. You have had your choice of food, enjoyed a couple of glasses of wine, and now you are settling down for a sleep to while away the long hours ahead. Then, a calm female voice announces, 'If there is a doctor or nurse on board, would you please make yourself known to a member of the cabin crew?' Should you pretend not to have heard this, especially in view of the couple of glasses of wine, or do you volunteer to help? Many of the factors involved in making this decision are rarely talked about, but some rehearsal of these may help more volunteers to come forward.

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The present review aims to reduce the 'unknown' elements in making the decision to help during an in-flight emergency, and will cover what emergency equipment doctors may expect to find on board most airliners, other sources of help available or whether the volunteer may have to face the emergency alone, and whether they will be protected legally when examining and treating a patient on board. Effectively, we hope to offer a rough outline of a 'job description for the potential Good Samaritan' that will allow him or her to diagnose and treat the patient without overly worrying about the logistics and other issues.[1]

Methods

The present paper reviews the medical and aviation literature on in-flight emergencies and what is known about the medical and legal aspects of the Good Samaritan volunteer response. Data from the published literature are supplemented with case discussions, original data from Cathay Pacific Airways and a survey of other airlines' views on the role of medical, nursing and paramedical volunteers.

Discussion

Incidence of in-flight emergencies

Flying is often said to be the safest form of transport.[2] This applies only to flying by commercial aircraft, however, as the accident rates for general aviation (private flying and nonscheduled air transport) are considerably higher, making travel by railway safest overall.

The International Air Transport Association (IATA) predicted that the number of airline passengers would rise from 1.4 billion in 1997 to 2 billion in 2003.[3] These predictions were affected by both the 11 September 2001 attacks and the severe acute respiratory syndrome outbreak of 2003, but the rate of growth of around 5% per year means that the original prediction of 2 billion passengers has probably now been surpassed. A survey by the UK Office for National Statistics found that almost half of adults in the UK had flown at least once during 2001, with the age group 45–54 years being the most likely to have travelled. According to the Australian Bureau of Statistics, more than 3 million Australians travel abroad each year.[4]

Flying has clearly become accessible to more people worldwide. Passengers who would not previously have travelled because of age or poor health will now consider taking a distant holiday overseas. This shift of passenger demographics has implications for the number of in-flight emergencies and deaths. There is no mechanism to accurately collect the annual number of such emergencies worldwide, or details of their nature, but a number of studies provide a snapshot of their likelihood.

In-flight deaths

One of the first large-scale studies of the more serious emergencies was published in 1988 by Cummins *et al.* concerning in-flight deaths.[5] This study collected data from 42 airline members of IATA for the 8 years from 1977 to 1984. Five hundred and seventy-seven deaths were recorded, for a mean of 72 per year and a rate of 0.31 per million passengers. This translated to a rate of 125 deaths per billion passenger-kilometres and 25 per million flight departures. More than half the deaths appeared related to cardiac problems, although confirmatory autopsy data were not available in most cases. The data were also considered to be limited by the under-reporting of deaths.

A US Federal Aviation Administration (FAA) study for the years 1986–1988 included 33 in-flight deaths, 48% of which were caused by cardiac problems.[6] The number of in-flight deaths from Cathay Pacific Airways has increased during the last 5 years. In 2005, there were 9 deaths among a total of 15.34 million passengers carried over 65 billion route kilometres. This rate of 0.58 deaths per million passengers had more than doubled from 0.24 in 2002. Final causes of death were difficult to obtain in every case, but the majority of deaths were related to cardiac disorders and stroke. Notably, none of these passengers had asked the airline for pretravel medical clearance for known health problems.

In-flight emergencies

Studies of deaths, and in particular cardiac deaths, may assist in the planning of what medical equipment should be carried on airliners, but these events still represent a minority of in-flight medical incidents. The Flight Safety Foundation studied in-flight medical care aboard selected US air carriers in 1996–1997 and recorded 1132 medical incidents. Of these incidents, 22.4% were caused by vasovagal syncope, 19.5% by cardiac events and 11.8% by neurological events.[7] Affected passengers were then tracked through the health-care system, which found that the in-flight diagnoses agreed closely with the postflight diagnoses. Dowdall studied 910 in-flight emergencies on British Airways for the months January–September 2000 and found a different pattern of diag-

noses, of which more than 25% were gastrointestinal problems, with just less than 10% each of cardiac, neurological and vasovagal problems.[8]

A Mayo Clinic–Airline Collaborative Study between 1995 and 2000 found that neurological problems, predominantly dizziness and vertigo followed by seizures, were the most common diagnostic category (31% of 2042 incidents) and the third commonest cause of diversions.[9,10]

There is some evidence that incidents are becoming more common, although it is unclear whether this could be accounted for by external factors such as increased publicity and differing reporting procedures.[11] Cabin crew are encouraged to make a report on all incidents, whereas few of these result in hospital admission after landing and thus do not come to the attention of the health-care system.

The incidence of significant emergencies appears to be one per 10–40 000 passengers.[12] A total of 2503 cases of illness were reported by Cathay Pacific Airways cabin crew in 2005, among a total of 15.34 million passengers, giving a rate of 1 in 6250 (0.16 per thousand) passengers. The automated external defibrillator (AED) was used 10 times, and there were 9 medically related diversions of aircraft to airports other than the planned destination.[8]

Medically related diversions

Airlines try to avoid diversion of aircraft from their planned flight path, as diversions are expensive, with an estimated cost of US$100 000 to divert a fully laden Boeing 747 to an alternative airport if the aircraft is not able to take off again and complete its journey within the flight time hours limitations of the pilots. This does not take into account costs incurred by the other passengers in missing connecting flights, or the resulting knock-on effects of aircraft being incorrectly positioned for the next service. Gardelof estimated that 13% of medical incidents resulted in a diversion, and DeLaune calculated a rate at 1 in 12.6 incidents (7.9%).[13,14] The rate experienced by Cathay Pacific in 2005 was considerably lower at 0.35%. Airlines attempt to reduce the need for diversions by preflight screening of ill passengers, training cabin crew and securing both planned online assistance and unplanned in-flight volunteer assistance (*vide infra*).

Passenger prescreening

Any passenger requesting special assistance for a medical condition at the booking stage is normally asked to provide further details from their doctor on a structured form. These details are assessed by airline medical or nursing staff in order for them to decide whether the passenger is fit to travel and, if so, what special arrangements (e.g. the provision of oxygen or a medical escort) might be necessary to achieve a safe journey. The effectiveness of this process is reflected by the fact that, although passengers with serious illnesses are frequently accepted for travel, few of these cleared cases lead to an in-flight emergency. Some airlines, including Cathay Pacific, will even accept passengers who are in the final stage of a terminal illness, provided that an agreement is made that should death occur in-flight, the aircraft will not be diverted. Airlines have procedures for dealing with a death in-flight, given that laws in force at the port of destination must be followed.[6]

Medical training for cabin crew

The risk of aircraft diversion may be reduced if cabin crew are trained to make an informed assessment of the emergency case. Dowdall's study showed that, on one airline, almost three-quarters of emergencies were handled by cabin crew alone.[8] Most airlines now ensure that their cabin crew at induction are fully trained in first-aid, cardiopulmonary resuscitation (CPR) and in the use of the AED, when carried. This training is updated annually, usually including CPR drills.

Many airlines in the early days of commercial aviation initially recruited cabin crew who were trained as nurses. More recently, there have been calls to reintroduce this practice, notably by Dr Hirofumi Okoshi of Japan Airlines.[15] The aviation analyst Farrol Khan has even suggested that every airline should employ and carry in-flight doctors in response to the planned introduction of much larger aircraft such as the Airbus A380.[16] As the management of medical emergencies is not a primary function of cabin crew, and the frequency of emergencies is insufficient to maintain a high level of skills, these suggestions appear illogical at present. Moreover, the capabilities of cabin crew may be enhanced with access to online advice from an emergency physician.

Online medical advice

A number of worldwide providers offer on-line medical advice to airlines. Other airlines appoint their own medical staff to perform this task. One of the longest-established providers in this field is MedAire, with a system known as MedLink (Tempe, AZ, USA). The MedLink call centre is based within the emergency department of the Level 1 Trauma Center at Banner Hospital in Phoenix, Arizona, USA. This provides

access to advice for contracting airlines' flight crew from nurses and an American Board of Emergency Medicine-certified emergency physician around the clock, through satellite phone link or aircraft VHF radio.

MedLink began operating in 1986 and now serves 88 commercial airlines worldwide (Heidi Giles, MedAire, pers. comm.). The organization also provides emergency-response training courses for cabin crew, and emergency medical equipment to some carriers. MedLink handled more than 23 000 in-flight medical incidents in 2005 (more than 60 per day), with the most common diagnostic categories being neurological (35%), cardiac (27%), respiratory (11%) and gastrointestinal (8%).

In-flight volunteer medical staff

Studies have shown that at least one doctor is present on approximately 85% of long-haul flights.[13] When a physician is involved in the decision to divert an aircraft, 49% of the emergency cases are admitted to hospital, compared with only 15% where there is no medical input, indicating that physician triage may be effective in potentially selecting the more serious cases.[14] The IATA study in 1988 estimated that a physician helped in 43% of the emergencies studied.[5] The actual role of volunteers is discussed next.

Considerations when volunteering medical assistance in-flight

The environment

Practising emergency medicine at 39 000 ft is no easy task. It will not be possible to lie the passenger down, particularly in economy class, unless the person is moved from his or her seat. The airflow in the cabin is noisy, making the use of a stethoscope difficult, if not unworkable, and the ambient light does not allow an accurate impression of skin colour. At cruising altitude, the cabin pressure is set to 5–8000 ft a.s.l., rendering all passengers a degree of hypoxia, which can have serious effects on an already sick person.[17] Gas trapped in body cavities at sea level will expand by 25–30% at cruising altitude, predisposing to tensioning of an existing pneumothorax or pneumocranium, and common problems such as middle ear pain. Access to a fully equipped hospital could be hours of flying time away, possibly a worse situation than in many rural areas.

Responsibilities

Lord Justice Stuart-Smith in 1997 famously summed up the duty of a doctor volunteering assistance in an emergency as '*His only duty as a matter of law is not to make the victim's condition worse*.'[18] Newson-Smith explored the various codes of medical ethics governing doctors' actions in these situations and drew attention to discrepancies between the law and the ethical aspects. Although no obligation in law exists in most countries, the author cites the International Code of Medical Ethics advice that 'A doctor must give emergency care as a humanitarian duty unless he is assured that others are willing and able to give such care.'[19]

Although there is no legal duty for a doctor to offer assistance, a duty of care exists once help is offered and accepted, and technically the doctor is potentially liable for any negligence that results. However, the realistic expectations of the volunteer are limited in view of the difficult circumstances involved in dealing with an in-flight emergency. Public policy in most countries limits liability for an imperfect outcome.

The airline's expectations

The authors polled a number of sister airlines concerning their expectations of volunteer doctors. It was clear that all airlines were grateful for this essential service offered by such volunteers, with each airline having a set of standard emergency operating procedures. Most considered that volunteers should complement and add to the skills possessed by cabin crew, rather than override them. Thus, doctors are not expected to perform procedures that cabin staff were trained to carry out. In addition, airlines hoped that volunteers would normally follow the advice offered by MedLink (or another dedicated online medical provider), particularly in view of the varying levels of expertise of volunteers. It is also expected that MedLink would be consulted whenever the in-flight medical kit is opened, although in a life-threatening case the priority would be to deliver care first.

European Joint Aviation Authorities (JAA) regulations (JAR-OPS 1.775) require that the aircraft commander (captain) 'shall ensure that drugs are not administered other than by qualified doctors, nurses or similarly qualified personnel'. Thus, medical professionals should not be offended if the crew ask for a business card or other form of identification of basic credentials, although in most cases these are taken on trust, particularly when the doctor sensibly discusses the case with the online medical provider.

Indemnity

Doctors often worry whether they will be indemnified if they offer assistance and something goes

wrong, or there is an unsuccessful or suboptimal outcome. Litigation against Good Samaritans is excessively rare, and many jurisdictions protect volunteers against such liability. The reluctance of doctors in the USA to offer help led to the passage of the Aviation Medical Assistance Act in 1988, which includes provisions limiting the liability of airlines and volunteer physicians. Many airlines indemnify doctors who volunteer, and will offer written confirmation from the aircraft captain of this, if the doctor requests it.

Fitness to practise

The skills of an emergency physician should be readily able to cope with most emergencies, with some adaptation. But what about those few drinks you had? A relevant debate which tackled this issue head-on was aired in the *British Medical Journal* in 1998.[20–23] This debate, entitled 'Too drunk to care?', makes useful reading for all. In the index article, an anaesthetist posed questions to peers, ethicists and lawyers concerning a case in which he volunteered help at a sports event, after he had taken an alcoholic drink.[20] The doctor was not overtly drunk but reflected carefully on his fitness to practise. Respondents to this debate were largely pragmatic, agreeing that guidelines would be impossible to develop and that individual doctors would have to judge for themselves, however impaired that judgement might be. It was argued that a doctor in this position should not withhold care in a life-threatening case and that doctors should therefore never have a 'moral holiday', but must balance the risks as best they can.[21–23] In addition, it was noted that other sources of help might also be available, for instance from other volunteers.

The law governing any event happening on board an aircraft is usually the law of the country in which the aircraft is registered, except when the aircraft is on the ground. This is of particular interest for volunteers from Australia, as protection offered by Good Samaritan law differs between states.[19] Some states (New South Wales, Southern Australia, Western Australia) take the view that a Samaritan is not protected by the law if he/she is significantly impaired by recreational drugs or alcohol, whereas others (Northern Territory, Queensland, Tasmania, Victoria) apply no similar riders. What would constitute significant impairment? Perhaps the legal blood alcohol limit for driving a motor vehicle might provide a useful reference, which in Australia is 50–80 mg% or 0.05–0.08 g/L, and in Britain is 0.08 g/L. This equates to drinking more than 300 mL of wine containing 12% alcohol, which would put the average person at risk.

It is also notable that, to be afforded protection in law, doctors must not expect payment for their services.[24] One doctor who took an airline to court demanding payment received criticism for his actions in the letters column of the *British Medical Journal* in 1998 from fellow doctors.[25,26]

What equipment can the doctor expect to find on board?

The equipment carried by different airlines varies and partly depends on which countries the airline flies into. Both the FAA and the JAA mandate minimum levels of provision in aircraft medical kits.[27–30] All aircraft carry first-aid kits and survival equipment that are required by law to cover eventualities such as ditching of the aircraft in water, or an emergency landing. These kits are considered 'no-go' items, and if they are opened, the aircraft cannot take off if stocks are reduced below a minimum provision. Medical kits intended for use by volunteers are separate and are usually more comprehensive. In a few countries such as the USA, these kits are also considered 'no-go' items and so may be duplicated on each aircraft. In others, they are not considered mandatory for aircraft departure, as long as the used contents are replaced within a reasonable time, with only one kit carried on each aircraft.

The skills that these kits are designed to service are not tailored to the emergency physician or anaesthetist wanting advanced airway management tools and a wide range of drugs. They must also be appropriate for a general practitioner or a psychiatrist. Some equipment would be hazardous in the wrong hands, and following the doctrine of '*Primum-non-nocere*', many airlines limit the sophistication of the equipment carried to that which will be useful to a doctor with only rudimentary emergency training.[31]

There have been several studies in the USA that evaluated the use and suitability of the mandatory kits introduced on US airlines in 1996.[32–34] These data assisted the FAA in ruling that all carriers operating through the USA must carry such kits, operative from April 2001 onwards.

Equipment

The standard contents of medical kits mandated by the JAA and the FAA are listed in Tables 1 and 2. The additional items carried by airlines vary widely, but advanced airway equipment is not always available,

Table 1. Kit Specification – US Federal Aviation Administration (FAA) Final Rule FAA-2000-7119 from April 2001 – Emergency Medical Kits

All aircraft operating with one or more flight attendants must carry:
A defibrillator
An i.v. kit with connectors and i.v. normal saline
Bag–valve–mask resuscitator and masks
Emergency drugs: antihistamine (oral), aspirin, atropine, bronchodilator inhaler, lidocaine (lignocaine), non-narcotic analgesic.
Basic instructions for equipment and drugs

Applies to US domestic and international Airlines, for completion by April 2004.

Table 2. Kit Specification – European Joint Aviation Authorities (JAA) Regulation: JAR-OPS 1.755 – Emergency Medical Kit

All aircraft with more than 30 seats must carry an emergency medical kit, if any point on the planned route is more than 60 min flying time from an aerodrome where qualified medical assistance could be expected to be available.
The commander shall ensure that drugs are not administered other than by qualified doctors, nurses or similarly qualified personnel.
Contents:
Sphygmomanometer
Syringes and needles
Oropharyngeal airways (two sizes)
Tourniquet
Disposable gloves
Needle disposal box
Urinary catheter
A list of contents in at least two languages (English and one other)
Drugs: Adrenocortical steroid, antiemetic, antihistamine, antispasmodic, atropine, bronchial dilator (inhalation and injectable forms), coronary vasodilator, digoxin, diuretic, adrenaline (epinephrine) 1:1000, major analgesic, medication for hypoglycaemia, sedative/anticonvulsant, uterine contractant.

No requirement for an i.v. kit.

and relatively small quantities of intravenous fluids are carried because of space constraints in the kit. Of interest to Australian emergency physicians, Qantas long-haul aircraft do carry intubation kits and 1 L of intravenous fluid, and every aircraft in the fleet carries a Laerdal Heartstart FR2 AED (Toronto, Canada). In addition, the airline subscribes to the MedLink service (Dr I. Morrison, Qantas, pers. comm.).

Drugs

Medical kits contain a range of drugs to manage convulsions, cardiac arrest, nausea and vomiting, and allergic reactions. Morphine is also frequently included. The relative hypoxia of the cabin environment, and the fact that the sick passenger may have taken sleeping medication or alcohol makes the effect of some drugs unpredictable. Thus, opiates and benzodiazepines should be administered with caution if given by intravenous injection. In 1999, an unfortunate incident occurred when an agitated airline passenger died after being given intravenous sedation by a doctor, leading to the arrest of the doctor and flight crew by Turkish authorities on landing.[35] As alternatives to pharmacological sedation, handcuffs are available on aircraft and cabin crew also receive training in physical restraint of unruly passengers.

Automated external defibrillator

Most airlines now carry at least one AED unit on their long-haul and regional aircraft. The results of AED programme use are rarely reported in the medical literature, although some have shown results comparable to ground-based prehospital programmes.[36]

O'Rourke *et al.* studied cardiac arrests on Qantas aircraft and in airport terminals over a 64-month period.[37] AED were used on 46 cardiac arrests, 27 of which occurred on board aircraft. Of these cases, 41% were unwitnessed, and 78% were associated with asystole or pulseless idioventricular rhythm. Long-term survival from ventricular fibrillation was achieved in 26% (2 of 6 in aircraft and 4 of 17 in airport terminals). In addition, the ability to monitor cardiac rhythm aided decisions on diversion, which could be avoided in clearly futile situations, enhancing the cost-effectiveness of the programme.

Bertrand *et al.* reported on medical emergency cases occurring on Air France for 1 year between November 2002 and November 2003.[38] Among 4194 cases of emergency care delivered to passengers, the AED was used in 12 cases. Shock treatment was advised initially in 5 of 12 cases, with a survival rate after in-flight defibrillation of 3 of 12 (25%), and survival to discharge from hospital of 20% following in-flight DC shock. Many airlines insist that only their own trained cabin crew operate the AED, to ensure continuity of protocols. Although irritating for some medical volunteers who are well-trained in this type of emergency, it is best to offer help within the overall spirit of teamwork.

Conclusion

It is likely that a doctor who travels on even just one long-haul flight each year will encounter an in-flight emergency sooner or later, and be expected to respond to a request for help. The most likely case will be one of vasovagal syncope, followed by a cardiac or respiratory emergency. The doctor will receive assistance from cabin crew fully trained in CPR and in the use of an AED. Cardiac drugs or strong analgesia will usually be available on board. Support and reassurance may also be given by satellite phone speaking to a fellow emergency physician, who will have encountered all this before on a daily basis. In the event of critical illness, the responsibility for recommending to divert a plane in the rare case this proves necessary may also be shared and corroborated.

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This work has not been previously published in any format.

Competing interests

The authors declare no competing or conflicting interests in writing this work.

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