Cardiac arrest in the skies

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ABSTRACT

Cardiac arrest occurring on board aeroplanes is rare, but remains a common cause of inflight incidents. This review examines some of the management problems unique to inflight cardiac arrests, and emphasises the use of cardiopulmonary resuscitation and automated external defibrillators.

Keywords: automated external defibrillation, aviation medicine, cardiac arrest, cardiopulmonary resuscitation

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INTRODUCTION

Cardiac arrest during commercial flights is a rare event. Of the approximately two billion people travelling on commercial airlines annually, it is estimated that about 1,000 die from sudden cardiac death.[1-3] This figure exceeds deaths from airline crashes (e.g. 863 deaths from 27 commercial airline accidents in the year 2006).[4] With increasing air travel, it is very likely that we will see more fatalities from inflight sudden cardiac death, especially with the increasing number of elderly travellers and passengers with various cardiac comorbidities taking to the skies.

SUDDEN CARDIAC DEATH AND THE CHAIN OF SURVIVAL

Sudden cardiac death accounts for 50% of the mortality from cardiovascular damage and is often the initial presenting feature of coronary artery disease.[5] Ventricular fibrillation (VF) is the initial arrhythmia recorded in up to 70% of patients with cardiac arrest[6] and can be treated successfully with electrical defibrillation, with long-term survival rates of up to 30%.[7] Time to defibrillation is the most important factor for survival from cardiac arrest, and therefore, immediate defibrillation as soon as a defibrillator is available is advocated in the guidelines for cardiopulmonary resuscitation (CPR).[8] For every minute of delay between collapse and defibrillation, survival rates from witnessed VF sudden cardiac arrest decrease by 7%–10% if no CPR is provided.[9] CPR in itself helps to improve the situation in myocardium with depleted high energy phosphates and severe acidosis so that it will respond more favourably to defibrillation.[10] Bystander CPR enables the survival rate to drop to a more acceptable 3%–4% per minute.[11] However, it is important to note that CPR alone is unlikely to eliminate VF and restore a perfusing rhythm. Early recognition of cardiac arrest is the first link in the chain of survival.[12]

Problems unique to cardiac arrest on board aeroplanes include:

Delayed time to defibrillation

Prior to 1990, it was a standard airline practice to divert aeroplanes to the nearest major airport if there was a cardiac arrest on board. Taking into account that it requires 10–15 minutes for even a taxiing aeroplane to return to its bay (after being given the requisite approval of the controllers) and more than 20 minutes for an emergency landing from cruising altitude,[1] it is not surprising that with VF being the most likely initial arrest rhythm and its successful reversion dependent on time-sensitive defibrillation, most, if not all these patients, did not survive. With the advent of the automated external defibrillator (AED), airline crew now have the capacity to initiate early CPR and early defibrillation with improved survival rates.

Failure to recognise cardiac arrest early

Collapsed passengers may be mistaken for being asleep, leading to a delay in resuscitation attempts, which results in poor survival outcomes.[13] Training aircrew to recognise cardiac arrest (unresponsive passenger who is not breathing) is crucial to early recognition. Since aircrew need to respond early and promptly, the first aircrew to identify the cardiac arrest would need to call for help and start CPR. It is, therefore, crucial for airline operators to ensure that all aircrew, and not only the cabin crew-in-charge, be trained and currently certified in CPR and the use of the AED. For airline operators, it is important that their training be accredited by their own National Resuscitation Councils so as to avoid any claims from potential litigants of low quality of care rendered. It is also essential that there is a system of maintenance of the AEDs available in all aircrafts.

Cabin environment

The restrictive environment of the cabin may also interfere with the management of on board cardiac arrest, as treatment may be hampered by poor access, restricted space, interference from noise and vibration that makes it difficult to assess pulse and breathing for CPR, and lack of

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privacy from having to work in a confined space.[13] Airline operators need to work closely with their medical advisors to ensure that prompt care can be rendered in the event of cardiac arrest in spite of the space limitations.

'Lethal cocktail'

Passengers are potentially exposed to increased stress from flying; getting to the airport and gate on time, altered circadian rhythms and lower cabin oxygen tensions, all of which may trigger underlying coronary artery disease and sudden cardiac death.[14]

AIRLINE CARDIAC ARREST PROGRAMME

The successful introduction of AEDs for use by Emergency Medical Technicians outside of hospitals, resulting in VF survival rates comparable to those achieved by paramedics with Advanced Life Support capabilities,[15,16] have prompted many airline organisations to introduce AEDs into their aircraft fleet. Qantas was one of the earliest such passenger carriers to begin this with their international Boeing fleet (747 and 767) and at major Australian terminals between 1991 and 1992. This was the first large-scale airline adoption of the AED as part of the on board resuscitation equipment for cardiac arrest.

The aeroplane flight service directors were assigned the responsibility for the use of the AED. They were trained to operate the AED as well as to supervise the management of cardiac arrest on board. The rest of the cabin crew were trained in extrication methods and how to perform CPR while awaiting the arrival of the AED. In addition, on board personnel were given improved communications with Qantas medical staff in Sydney, should the need for medical advice arise. A comprehensive on board medical kit containing various resuscitation equipment (suction devices, endotracheal tubes) and drugs (adrenaline, atropine, lignocaine) was also available in case an on board physician was present and requested for it. Cabin crews were sent for regular retraining on CPR and AED use.[16]

A review of inflight cardiac arrests in the carrier's vehicles noted that 27 passengers suffered from cardiac arrest on board over a 65-month period. Six of these had an initial arrest rhythm of VF, five of whom were successfully defibrillated, allowing an appropriate diversion of the aeroplane to the nearest major terminal. There were two long-term survivors with no subsequent neurological impairment. Of the 27 passengers, only 16 arrests were witnessed. Eight passengers could not be awoken from sleep, and seven had an initial rhythm of asystole. Interestingly, all of the 19 cardiac arrests that occurred at the airline terminals were witnessed cardiac arrests, with 17 of them having VF as their initial arrest rhythm. 16 of these 17 passengers were successfully defibrillated initially and four (24%) were long-term survivors. The Qantas Airline experience also showed that AEDs could be used safely by non-medical personnel with good results and that these machines could also serve to help in monitoring critically ill patients in the presence of medical personnel. The cost of purchasing and maintaining the AEDs, as well as training personnel in CPR and AED use, was offset by the potential savings of avoiding a needless diversion in the case of cardiac arrest with no pulse and no shockable rhythm recorded on the AED.[16]

Another major airline company to implement on board AEDs was American Airlines, which began installing AEDs on selected aircrafts in March 1997. It is highly probable that this drive to start AED use was indirectly triggered by an investigative report entitled "Code blue: survival in the skies,"[1] published in the Chicago Tribune on June 30, 1996, which revealed the number of on board deaths on US airliners to be up to 316 annually. This report also unfavourably compared the then existing on board resuscitation equipment and medications available to those found on other international airlines. Their programme eventually documented that over a two-year period (on board and in the terminal), a total of 15 patients were diagnosed with VF and received shocks. Of these, 11 occurred on board and six survived to discharge from the hospital, yieding a survivor rate of 55%.[17] Another important finding of this two-year review was that the AED was safe and useful for monitoring other patients without cardiac arrest (usually with the aid of a medically trained passenger), and provided information which could help in directing the decision to divert the aeroplane. Since the 1997 implementation of the AED, 80 lives have been saved on American Airlines, and currently, all 18,000 crew members are proficient in the use of the AED. American Airlines was also awarded the prestigious 'Heart of Gold' award by the American Heart Association for its successful AED programme.[18]

The US Federal Aviation Administration has made it mandatory for all US-based commercial passenger aircraft with at least one flight attendant to carry on board AEDs since April 2001.[19] Singapore Airlines introduced AEDs in all their passenger aircraft in 1997, and the cabin crew-in-charge was trained in the skills of CPR and AED use. The use of AEDs on board commercial airlines has not been addressed by the International Civil Aviation Organisation (ICAO) in its standards and recommended practices. ICAO has, instead, stated the following in its guidelines on first-aid medical supplies:[20] "*Based on the limited available evidence, only a very small number of passengers are likely to benefit from the carriage of*

automated external defibrillators (AED) on aeroplanes. However, many operators carry them because they offer the only effective treatment for cardiac fibrillation. The likelihood of use, and therefore of potential benefit to a passenger, is greatest in aircraft carrying a large number of passengers, over long duration sector lengths. The carriage of AEDs should be determined by operators on the basis of a risk assessment taking into account the particular needs of the operation." Commercial airlines are still surprisingly not legally obliged to provide medical care for their passengers.[21]

LIMITATIONS OF AED

There have been several reported limitations of the use of AED, including operator failure to deliver the shocks due to patient movements interfering with analysis, or the operator turning off the AED prematurely, not following instructions to deliver shocks, not realising that the AED leads are off or misreading the AED screen instruction to start CPR.[22]

One major concern has been regarding the interference with the ability of the AED to reliably diagnose a shockable rhythm from vibrations of the aeroplane while in flight. This concern, however, has not been borne out in real practice.

CPR ON BOARD AEROPLANES

The provision of CPR on board aeroplanes is limited by the closed, confined spaces in which rescuers are forced to operate within. The lack of space may make it difficult for rescuers to kneel comfortably by the side of the patient to perform standard CPR. One study showed that for two-man CPR, both standard CPR and a straddle technique (which was easier to perform in a restricted space) performed equally well.[23] This same study showed, however, that for one-man CPR (which is presumably less frequently used than two-man CPR in the aeroplane cardiac arrest setting), standard CPR is superior to an over-the-head technique.[23] This study was limited by small numbers and the fact that it did not actually simulate real-life scenarios, as it was carried out on mannequins in simulated flight cabins and not in moving planes. Local experience by emergency doctors and medical students appears to indicate that in simulated real-life scenarios enacted in simulated flight cabins, two-man standard CPR outperformed one-man CPR, and that with adequate training, CPR could be performed in any location on the plane, including on passenger seats in economy class and first class cabins. These observations need to be verified with prospective studies conducted in such environments and with measurements of compression depth, rate and flow times.

If cardiac arrest were to occur in a passenger seated in the cabin, the options available to any rescuer, either a member of the aircrew or a fellow passenger would be:

(1) Lay the collapsed person on the seats (if the arm-rests can be folded back promptly) and initiate CPR. This is the fastest option and allows initiation of essential life-saving procedures with the least interruption to precious time after cardiac arrest. The concerns would be whether chest compressions can be performed effectively on the patient who is lying flat on an airline seat. Adopting the principle of pushing hard and pushing fast, one should be able to perform chest compressions adequately. It would be unlikely that a firm board would be available to be placed underneath the patient. Just as patients on a hospital bed can be resuscitated by good chest compressions without a stiff board underneath, the same principles could be applicable to airline seats. The space afforded in the cabins, whether in the economy, business or first class sections, would be adequate for simultaneous assistance by a second rescuer performing mouth-to-mouth ventilation or applying AED to the patient.

(2) Lay the collapsed person on the aisle next to his seat and perform CPR. The positive aspect of this would be that the patient would be on a firm-to-hard surface. Optimally, the rescuer should be positioned in front of one of the aisle seats in the kneeling position for performance of chest compressions, and a second rescuer in front of the opposite aisle seat performing ventilation or applying the AED to the patient. The limitations would be the small space for either rescuer to perform their tasks. However, an experienced life support provider would not find this a limitation.

(3) Move the collapsed person to an area with more space, such as near an emergency exit and then begin the resuscitative manoeuvers. While this may address the space and ground issues discussed earlier, the time that would be taken to mobilise the resources and move a collapsed patient from his seat to a spacious area on the aeroplane would amount to precious downtime, which would mean decreasing the chances of a successful resuscitation.

ROLE OF DOCTORS IN ASSISTING IN AN ON BOARD CARDIAC ARREST

Almost 43% of on board cardiac arrests have been managed with the help of doctors who answered the call for help when cardiac arrest situations arose during flights.[24] A recent issue of the Medical Protection Society's casebook[25]

indicates that in an emergency, doctors have an ethical obligation to provide any medical assistance they can be reasonably expected to. The article suggests that doctors need to assess their own immediate competence before doing so (use of alcohol, drugs, fatigue), offer assistance within the boundaries of their capabilities, and assist the airline crew and not try to take over the situation. In terms of indemnity, the article also indicates that UK airlines operating outside the UK do not offer legal indemnity to Good Samaritans, whereas American doctors are indemnified for similar acts aboard American aircraft.

CONCLUSION

Cardiac arrest on board aeroplanes, although not common, is a growing problem with the increasing number of people taking to the skies. Early CPR and AED use have been shown to be effective in saving lives, and as such, all commercial airline companies should ensure that AEDs are readily available in aeroplanes and all their crew are trained in these skills.

REFERENCES

1. Crewdson J. Code blue: survival in the sky. Chicago Tribune, Special Report. June 30, 1996; section 2: 1-10.
2. Friend T. Cardiac equipment on planes could save hundreds. USA Today. Nov 17, 1994.
3. Select Committee on Science and Technology. Air travel and health, Fifth Report. London UK House of Lords, Nov 15, 2000.
4. Learmount D. Deadly lessons - Flight International airline safety review. Flight International 2007; 171:14-8.
5. Kannel WB, Cupples LA, D'Agostino RB. Sudden death risk in overt coronary heart disease: the Framingham Study. Am Heart J 1987; 113:799-804.
6. Green HL. Sudden arrhythmic cardiac death--mechanism, resuscitation and classification: the Seattle perspective. Am J Cardiol 1990; 65:4B-12B.
7. Cobb LA, Weaver WD, Fahrenbruch CE, Hallstrom AP, Copass MK. Community-based interventions for sudden cardiac death. Impact, limitations, and changes. Circulation 1992; 85(Suppl 1):I98-102.
8. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 4: the automated external defibrillator: key link in the chain of survival. The American Heart Association in Collaboration with the International Liaison Committee on Resuscitation. Circulation 2000; 102 (Suppl 8):I60-76.
9. Larsen MP, Eisenberg MS, Cummins RO, Hallstrom AP. Predicting survival from out-of-hospital cardiac arrest: a graphic model. Ann Emerg Med 1993; 22:1652-8.
10. Eftestøl T, Wik L, Sunde K, Steen PA. Effects of cardiopulmonary resuscitation on predictors of ventricular fibrillation defibrillation success during out-of-hospital cardiac arrest. Circulation 2004; 110:10-5.
11. Valenzuela TD, Roe DJ, Cretin S, Spaite DW, Larsen MP. Estimating effectiveness of cardiac arrest interventions: a logistic regression survival model. Circulation 1997; 96:3308-13.
12. Cummins RO. The "chain of survival" concept: how it can save lives. Heart Dis Stroke 1992; 1:43-5.
13. Donaldson E, Pearn J. First aid in the air. Aust N Z J Surg 1996; 66:431-4.
14. Aldrette JA, Aldrette LE. Oxygen concentrations in commercial aircraft flights. South Med J 1983; 76:12-4.
15. Weaver WD, Hill D, Fahrenbruch CE, et al. Use of the automatic external defibrillator in the management of out-of-hospital cardiac arrest. N Engl J Med 1988; 319:661-6.
16. O'Rourke MF, Donaldson E, Geddes JS. An airline cardiac arrest program. Circulation 1997; 96: 2849-53.
17. Page RL, Joglar JA, Kowal RC, et al. Use of automated external defibrillators by a U.S. airline. N Engl J Med 2000; 343:1210-6.
18. Youngwith J. Saving hearts in the air. Online bulletin [online]. Available at: www.dailyherald.com/special/americanheartmonth/2008/index. Accessed January 1, 2009.
19. Federal Aviation Administration. Emergency Medical Equipment, Final Rule [online]. Available at: www.faa.gov/apa/pr/pr.cfm?id=1262. Accessed January 1, 2009.
20. ICAO Health Related Documents. 2009; 2-3. In: ICAO Cooperative Arrangement for the Prevention of Spread of Communicable Disease through Air Travel (CAPSCA) [online]. Available at: www.capsca.org/Documentation/CAPSCAICAOHealthRelatedDocsEN.pdf. Accessed March 27, 2011.
21. Jagoda A, Pietrzak M. Medical emergencies in commercial air travel. Emerg Med Clin North Am 1997; 15:251-60.
22. Katis PG, Dias SM. Potential error in the use of an automated external defibrillator during an in-flight medical emergency. CJEM 2004; 6:45-7.
23. Handley AJ, Handley JA. Performing chest compressions in a confined space. Resuscitation 2004; 61:55-61.
24. Cummins RO, Chapman PJ, Chamberlain DA, Schubach JA, Litwin PE. In-flight deaths during commercial air travel. How big is the problem? JAMA 1988; 259:1983-8.
25. Flying Doctors: is protection plain? MPS Asia Casebook 2008:16 [online]. Available at: www.medicalprotection.org/uk/casebook-january-2008/in-flight-emergencies. Accessed January 1, 2009.