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In-flight cardiac arrest on commercial flights

Paro cardiaco en vuelos comerciales

Jorge Álvarez de la Cadena-Sillas,* Enrique Asensio-Lafuente‡

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ABSTRACT

The number of air travelers has increased over the past years, and after the limitations imposed by the COVID-19 pandemic, are expected to increase further. Given these conditions, the possibility for a health professional to find himself needing to assist an in-flight cardiac arrest is also increased. The present work describes some of the most common problems in managing an inflight cardiac arrest and emphasizes the relevance of cardiopulmonary resuscitation (CPR) performance and automated external defibrillators (AED) use on board of commercial airliners.

RESUMEN

El número de viajeros por avión ha aumentado en años pasados, y después de las limitaciones impuestas por la pandemia de COVID-19, se espera que esas cifras crezcan aún más. En vista de esta situación, la posibilidad de que un profesional sanitario se encuentre en posición de tener que asistir una parada cardiaca durante un vuelo comercial es también mayor. El presente trabajo describe algunos de los problemas más frecuentes en el tratamiento de un paro cardiaco durante un vuelo y enfatiza la relevancia de realizar reanimación cardiopulmonar y emplear un desfibrilador automático externo a bordo de una aeronave comercial

INTRODUCTION

Cardiac arrest aboard a commercial flight is a rare problem with many possible outcomes. Although it has a low frequency, it is estimated that approximately five billion people travel by commercial airlines yearly and about 2000 will have a sudden cardiac arrest.[1,2] This number of fatalities is substantially higher than the one from aircraft crashes, in 2021, for example, they were 176 dead persons worldwide.[3] In 2021 there were no deaths from accidents in the United States (US) civil aviation records.[4]

More sudden cardiac arrest events will occur in the future since there are increasing numbers of people flying, elderly travelers, and passengers with various cardiac diseases.[5] Between 1 in 14,000 and 1 in 50,000 passengers will experience an in-flight acute medical problem.[6] Nonetheless, in-flight cardiopulmonary resuscitation (CPR) and automatic external defibrillator (AED) use occur in one per 5 to 10 million passengers every year, or, according to the German Society of Aerospace Medicine, up to 0.3% of all in-flight emergencies.[6,7] Ventricular fibrillation (VF) is usually the first documented rhythm (up to 70% of sudden cardiac arrest victims), making defibrillation one of the first interventions to be done with real life-saving possibilities. In-flight cardiac arrest (IFCA) has shown a different pattern, although a significant 25 to 50% of subjects showed VF as the initial rhythm.[2,8-10] A study that recorded IFCA over a 65-month period, found that 27 passengers suffered from cardiac arrest aboard an airplane. Sixteen events were witnessed, and six had an initial VT/VF successfully treated with CPR, defibrillation, and diversion to the nearest suitable airport. Seven out of 27 subjects had an initial asystole and did not recover.[6,11]

In the context of out-of-hospital cardiac arrest (OHCA), successful reversion of the arrest

* Cardiologist, private practice. San Miguel Allende, Guanajuato, Mexico.
‡ Cardiologist, electrophysiologist.

Instituto de Corazón de Querétaro. Mexico.

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has been reported in up to 30% of cases, given timely interventions are performed (hands-only cardio-pulmonary resuscitation [CPR], early defibrillation and proper emergency cardiac care). Those survival numbers strongly rely on early defibrillation: if an effective shock is applied within the first three minutes of the OHCA, most patients will regain spontaneous circulation. If that first shock is delayed beyond 16 minutes, survival possibilities are minimal, even if effective CPR has been performed.[12-15] When the OHCA happens during a flight, return of spontaneous circulation (ROSC) occurs in 44% of cases, and 15% of patients are discharged alive from the hospital.[2]

The conditions on board an aircraft are particular, and legislations are mostly unknown, although Lufthansa has estimated that in 80% of their flights,[7] there is a healthcare professional (physician, nurse, technician, or others) that will volunteer to assist in an in-flight medical emergency. In the present work, we will review some of the most common problems concerning IFCA and some of the solutions currently available.

GENERAL CONSIDERATIONS

For a physician, his conduct should be the same in an in-flight emergency as it is on the ground, but some considerations must be kept in mind.

First, the cabin has a pressurized atmosphere equivalent to an altitude of about 8,000 feet (2,400 meters). This implies that oxygen's partial pressure is 110 mmHg, about 25 to 30% lower than at sea level. The risk of gas expansion has to be taken into account to avoid pneumothorax in susceptible subjects, as well as complications from recent intracranial, abdominal, or ophthalmic surgeries. Because of the reduced partial pressure of oxygen, there will be a reduced oxygen blood saturation and, thus, compensatory tachycardia and tachypnea that might trigger other cardiovascular events.[7]

According to the Federal Aviation Administration (FAA), the European Aviation Safety Agency (EASA), and the Joint Aviation Authorities (JAA), aircraft have to be equipped with a minimum of medical equipment to face an in-flight emergency. The FAA requires that every plane flying in the US carry an (AED), a bag-valve-mask resuscitator, and an infusion system with normal saline solution.[7]

The laws applicable in an aircraft are those of the country under whose jurisdiction the airline operates; for example, Mexican laws will apply to any Mexican ships, while US laws will be applied to American Airlines. Some countries (France and Germany, among others) require that a physician on board must administer assistance, while the British, US and Canadian laws do not require physicians to help if there is an incident unless there is a pre-existing physician-patient relationship. In Mexico, there is no clear legislation aside from the ethical obligation to assist a person in an emergency. In order to facilitate assistance, many airlines provide a declaration of assumption of liability that is insurance against any claims arising from medical assistance except if there is gross negligence or deliberate harm to the ill person. If the assisting person does not obtain any monetary or equivalent compensation for the given assistance, it must be specified that insurance applies. In the US, physicians providing assistance under the «good Samaritan law» are not liable except in cases of gross negligence or willful misconduct.[7,16]

ROLE OF DOCTORS IN ASSISTING AN IFCA

There are different numbers around the world, but approximately 43% of IFCAs have been managed with the help of a passenger physician who responded to the call for help from the aircrew. As mentioned, Lufthansa personnel mentions that in up to 80% of the recorded emergencies in that airline, there was a health-related professional that could assist a fellow ill passenger.[5,7] The role of medical volunteers in an IFCA is to manage the emergency to the best of their ability and keep open communication with the aircrew and ground-based consultant to ensure that everyone involved in the emergency is fully aware of the situation's needs.[17]

Physicians have the ethical obligation to provide medical assistance when they can be reasonably expected to do so in any type of emergency, including IFCA.[18] That is why, even if every aircraft is subject to its country-of-origin laws, as previously mentioned, they are protected by the «good Samaritan laws».[7]

THE CHAIN OF SURVIVAL

Early recognition of cardiac arrest is the first link in the «chain of survival». It must be followed by the activation of the emergency medical services and immediate administration of CPR, preferably «hands-only CPR» followed by timely defibrillation, since CPR alone is unlikely to eliminate ventricular tachycardia or fibrillation and restore spontaneous circulation. It is known that for every minute delay between collapse and defibrillation, if no CPR is provided, survival rates decrease by 7 to 10%, but if CPR is administered, that decay in survival rate reaches 3 to 4% per minute *(Figure 1 and Table 1)*. These facts should prompt early recognition of an in-flight cardiac arrest and consequent interventions since the only opportunity to save a prehospital cardiac arrest victim is to treat him at the scene.[19] The main actions, such as CPR administration, AED use, and flight plan changes, will be discussed further.

FAILURE TO RECOGNIZE IN-FLIGHT CARDIAC ARREST

A collapsed passenger may be mistakenly considered a sleeping person. If the IFCA is not recognized, CPR and AED use will be delayed, and thus, the survival of the patient will be jeopardized. The aircrew should be trained to assess an unresponsive passenger who is not breathing as the first step in the survival chain. The aircrew should be trained to administer hands-only CPR and use the AED.[19,20]

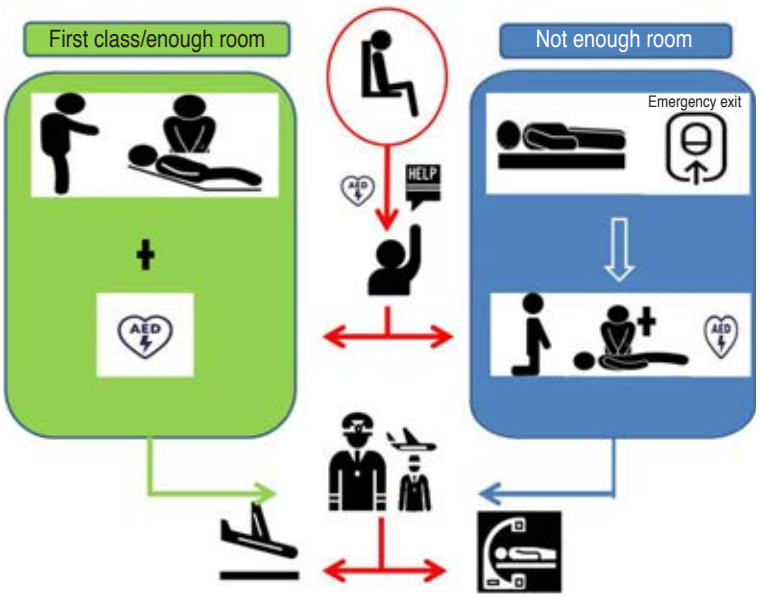

Figure 1: Suggested in flight cardiac arrest flowchart.

DELAYED TIME TO DEFIBRILLATION

By international regulations, aircraft should have an AED on board, and the aircrew has to be trained to start early CPR and connect an AED. Failure to recognize the cardiac arrest reduces the chances of identifying VF as the initial rhythm and, thus, reverses it by proper use of an AED, as is the case with passengers asleep or seemingly sleeping. That is why certain studies have shown that only 25 to 35% of the patients with IFCA have VF or VT as the initial rhythm. Training the aircrew to perform early recognition of IFCA in an unresponsive patient who is not breathing, start hands-only CPR, and attach the AED is mandatory to reach better survival rates.[10,20]

CABIN SETTING AND SURROUNDINGS

The management of an IFCA can be challenging in the restricted space of an aircraft cabin as there might be poor access, interference from vibration noise that precludes an adequate assessment to look for breathing and cardiac sounds and no privacy to work. The spectators of the intervention might not only not help but instead contribute to exacerbating a stressful situation by itself, even in proper medical settings. When possible, moving the patient to an ample space, such as an emergency exit, is recommended, and then start resuscitation maneuvers. Some large aircraft might be equipped with a special area to treat medical emergencies.[6,7,20]

The following are general recommendations for treating a passenger with IFCA in the main cabin:

1. Layback the unresponsive person in the seat and start hands-on CPR. At his point, the main concern should be if effective chest compression can be performed on

Table 1: Suggested action sequence for an in-flight cardiac emergency.

Problem	Action 1	Action 2
1. Unresponsive passenger	1.1. Ask for help to the crew and a AED	
2. Passenger first class Or seat able to lean back	2.1. Start high quality hands only CPR use of AED	
3. Passenger not in first class	3.1. Move him to the floor	3.2. Start high quality hands only CPR use of AED
	3.1.1. Place him next to emergency exit	
4. Patient receiving high quality hands only CPR and AED use	4. Get in touch with the rest of the crew	4.1. Ground support
		4.2. Possible diversion of the aircraft

AED = automated external defibrillators. CPR = cardiopulmonary resuscitation.

the seat. In the same way that a patient can receive high-quality CPR in a hospital bed, another patient might receive it as well in an aircraft, although this is probably more easily achievable out of the economy class.

2. If the CPR maneuvers can not be administered correctly in the seat, the passenger must be moved to the floor in the aisle near his seat to get a hard surface suitable for appropriate chest compressions, with the rescuer kneeling between seats. Another rescuer should be placed in front of the first one to take care of the airway. No matter if the patient is in the economy, business, or first class, the cabin space is usually scarce, and at least two rescuers AED and other equipment layout has to be optimized to make the most of it.
3. In very cramped cabins, the patient might be moved near an emergency exit or other suitable spaces (galley) to perform effective CPR. This will provide more space, but it will delay the initiation of CPR, with the consequent decreased chance of a successful outcome.[20]

GROUND SUPPORT

Airlines should have a ground-based medical support consultant, and they must get involved in the management of an IFCA or any other medical emergency. Their role is to assist medical decision-making through direct advice, support on-board medical volunteers and crew, and guide the pilot about flight diversion decisions. The latter recommendations must be made in the best patient's interest (to solve the emergency) and must take into account the patient's status, presumptive diagnosis, ground needs, and other in-flight and ground safety options.[16,21]

DIVERSION OF THE AIRCRAFT

The decision to divert an aircraft from its original flight plan depends primarily on the medical condition and the stability of the patient. There are standard protocols that must be strictly followed.[13] Even if there is a clear need to divert the flight to the nearest appropriate airport, this is unlikely to happen before 20 minutes –remember that the utility window for an AED to perform defibrillation is a maximum of 16 minutes–. Even after landing, it can take 10 to 15 minutes to get back to a bay after permission has been asked and obtained from the air traffic control.

The «nearest appropriate airport» has to be determined by the patient's disease. In the case of acute myocardial infarction, the pilot, controllers and ground personnel have to be aware that the aircraft has to land in the nearest possible position to a 24 hours available cath lab, with the proper services in the hospital (Intensive Care Unit, 24 hour emergency room). In certain situations, the plane can be diverted to the nearest airport, but then coordination to have a ground or heli-ambulance available and ready to transport the patient to another city with a cath lab available as soon as possible has to be made.

In some instances, the AED might be used as a monitor (supervised by a medically trained volunteer/passenger) and provide valuable information for the diversion of the aircraft, as can be the case with acute coronary syndromes.

Other reasons to divert a flight are emergencies such as continuing myocardial ischemia, acute myocardial infarction or stroke, where time to reperfusion treatment is of the essence,[22] as in other respiratory, metabolic or surgical emergencies.

EXTERNAL DEFIBRILLATORS (AEDs)

One of the major concerns regarding the use of AEDs in an inflight emergency is a possible malfunction of the device or a failure to recognize a shockable rhythm induced by the vibrations in the cabin, although no interference of the sort has been documented so far.[23] Katis also found that AED's with monitoring capabilities could be safe and useful for evaluating patients without cardiac arrest, with the help of a medically trained passenger, to decide whether to divert the flight or take other pertinent decisions.[23,24]

An important consideration is that the AED requires periodic maintenance to ensure its proper function if needed in an in-flight emergency. As Sheehan reported, even if there is limited information and there are rare cases of IFCA, AED use is safe, feasible, and is associated with improved outcomes, given that apparatus is in working order.[25] In this regard, current international regulations require that at least one flight attendant is trained in the use and operation of the AED.[19,26]

CONCLUSIONS

The number of air travelers has increased over the past years, as has the risk of witnessing an IFCA as a health professional. In-flight cardiac arrest has some peculiarities due to the characteristic confined space, the limited medical resources and personnel and the international regulations that tend to protect by the Good Samaritan Laws any person volunteering to assist a fellow passenger in distress. Performing CPR and using an AED is the most helpful treatment that can be administered on board, while a decision is made to divert the flight plan to a location with suitable services to treat the patient. Timely cardio-pulmonary resuscitation and defibrillation on board are the best options for an IFCA victim to regain spontaneous circulation, given that cardiac arrest is recognized. Aircrews need training in CPR and AED use, and assistance by volunteer medical personnel is of utmost importance to increase recovery chances for a patient.

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Correspondence:
Jorge Álvarez de la Cadena-Sillas, MD
E-mail: jalvarezdelacadena@gmail.com