Air Traveler's Health: Considerations for Travelers with Pulmonary Disease

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Outline

1. Introduction
2. Effect of Altitude on Pulmonary Physiology
3. High Altitude Hypoxia Simulation Testing
4. Traveling with Supplemental Oxygen
5. In-flight Emergencies: What Clinicians Should Know
6. Prevention of Jet-Lag

Introduction

- Almost 3 billion people travel by air every year worldwide
- While in flight emergencies are rare, incidence is on the rise due to increasing number of air travelers, medical tourism, and increased access to low-cost air travel
- While healthy passengers are able to tolerate the physiologic effects of air travel, passengers with pre-existing conditions may be at risk for adverse events

Introduction

- A common cause of in-flight emergencies is respiratory symptoms, including asthma and COPD exacerbations. Cardiac and neurologic events are the most common cause of in-flight emergencies.
- Cabin crew may solicit assistance from on-board medical professionals during an in-flight emergency, thus making knowledge of in-flight resources imperative
- The key steps in preparing your patient for air travel are:

1. Understanding the physiologic effects of altitude
2. Assessing risk in your patient
3. Preparing your patient for travel well in advance to the travel date

Physiology of Altitude

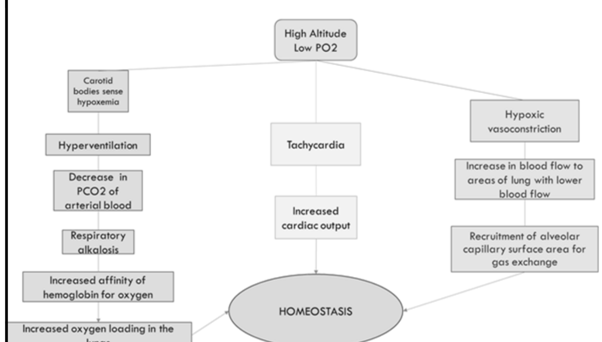
- Aircraft generally travel at 30,000-60,000 feet
- The Federal Aviation Administration (FAA) requires that cabin pressure be maintained at a pressure-equivalent of 8,000 feet
- The pressure is maintained using a combination of exterior compressed air and re-circulated cabin air
- As the aircraft ascends and cabin pressure decreases, some passengers may feel "popping" in the ears, which is due to air escaping from the middle ear and sinuses due to gas expansion

Physiology of Altitude

- At sea level, the barometric pressure is 760 mmHg
- During ascent, the barometric pressure decreases. The partial pressure of oxygen (PO2) in the atmosphere and the arterial partial pressure of oxygen (PaO2) also decrease proportionally
- At sea level, we breathe 20.9% oxygen
- At 8,000 feet, the partial pressure of oxygen drops to the equivalent of breathing 15.1% oxygen at sea level. This translates into a lower PaO2, about 55mmHg
- In healthy individuals without pulmonary disease, this lower PaO2 is tolerated because the body compensates through a variety of mechanisms

Symptoms of Hypoxemia at High Altitude

Cabin Altitude	Symptoms
Sea level	none
5000 ft	Night vision may affected
8000 ft	Night vision is affected
12000-15000 ft	Impaired judgement and memory, decreased alertness, headache, euphoria
Above 15000 ft	Peripheral vision defects unconsciousness



Effects of Altitude in Pulmonary Disease

- In passengers with pulmonary disease, these compensatory mechanisms are impaired, thus placing them at risk of further hypoxemia
- In passengers with COPD, the increased minute ventilation may result in hyperinflation, thus exacerbating dyspnea
- In passengers with interstitial lung disease, there may be an underlying impairment in gas exchange, which is further exacerbated by hypoxic conditions

Assessing Risk for Hypoxemia: Pre-Flight Assessment

- Patients who may be at risk for hypoxemia during flight include those with:
  - COPD or asthma
  - Severe restrictive lung disease, including those with neuromuscular disease of chest wall deformities
  - Baseline hypercapnia or hypoxemia
  - Cystic fibrosis
  - History of air traveler intolerance due to respiratory symptoms
  - History of recent hospitalization for respiratory illness with last 6 weeks

Assessing Risk for Hypoxemia: Pre-Flight Assessment

- Patients who may be at risk for hypoxemia during flight include those with:
  - Recent pneumothorax or thoracic surgery within the last 6 weeks
  - Previous venous thromboembolism
  - Pre-existing requirement for supplemental oxygen or ventilator support
  - Tuberculosis*

*Tuberculosis (TB)

- Recommendations for physicians from the World Health Organization:
- Physicians should inform all infectious and potentially infectious TB patients that they cannot not travel by air on a commercial flight until they have two negative AFB sputum smears on at least two different occasions.
- Physicians should inform all MDR-TB and XDR-TB patients that they must not travel by any commercial flight under any circumstances until they are proven to be non-infectious.
- Physicians should inform public health authorities if an infectious or potentially infectious TB patient intends to travel against medical advice.

*Tuberculosis (TB)

- Physicians should immediately inform the relevant public health authority when they are aware that an infectious or potentially infectious TB patient may have exceptional circumstances requiring commercial air travel. In the U.S., this require submission of documentation to the Federal Aviation Administration (FAA), who will then make a decision regarding the specific case.

Pre-flight Assessment

- A pre-flight assessment should be performed in those who are at risk of in-flight hypoxia
- This assessment should include:
  - History and physical exam
  - Spirometry (do not perform in those with active tuberculosis)
  - Assessment of baseline, resting SpO2
  - Arterial blood gas if hypercapnea is known or suspected

Predicting In-flight Hypoxia

SaO2	PaO2
97	95-105
94	70-75
92	67-73
90	58-62
87	52-58
84	46-52

These values are approximate. Each patient's physiology is unique and therefore predicting the degree of hypoxia/hypoxemia while in flight based on resting oxygen saturations at sea level can be unreliable.

Predicting In-flight Hypoxia: Hypoxia Altitude Simulation Test (HAST)

- In-flight hypoxia should be considered in those with underlying pulmonary disease or in those who have risk factors for adverse pulmonary events
- If the pre-flight SpO2 is greater than 95% on room air at rest, then no further testing/evaluation is required

Predicting In-flight Hypoxia: Hypoxia Altitude Simulation Test (HAST)

- If the pre-flight SpO2 is 92-95% and the patient has risk factors
  - hypercapnea
  - FEV1 <50% predicted
  - lung cancer
  - cardiac or cerebrovascular disease
  - Recent COPD exacerbation or hospital admission for COPD or CHF exacerbation recently
  - On ventilatory support
- If the pre-flight SpO2 is less than 92%, prescribe supplemental O2 (no testing needed)

Hast: Pre-procedure

- Patients should wear comfortable clothing, take regular medications, and refrain for exercising prior to procedure
- The patient's resting heart rate and oxygen saturation will be recorded
- The patient will be monitored through out the procedure with ECG and pulse oximetry. The respiratory therapist will also monitor for changing symptoms

The patient will also wear a nasal cannula underneath the reservoir mask. In the case that the SpO2 drops to < 90% during the test, the nasal cannula with supplemental oxygen can be applied

HAST: The Procedure- Part 1

- The first part of the procedure is to obtain values at rest
- The patient will breathe 15.1 O_2 through a tight-fitting mask (like a non-rebreather mask) or mouth-piece for 10 minutes
- If the oxygen saturation decreases to less than 89% during the test, the supplemental oxygen is applied. The respiratory therapist will titrate the supplemental oxygen by 1lpm every minute to at least 90% for the remainder of the test.
- The oxygen prescription will be based on the level of the supplemental oxygen that is necessary to keep the oxygen saturation at or above 90% for the duration of the test.

HAST: The Procedure- Part 2

- The second part of the procedure is obtaining values with exertion
- The patient will continue to breath 15% oxygen via a non-rebreather mask
- If the patient required supplemental oxygen for part 1 (at rest), this will be continued with exercise
- The patient will exercise on a cycle ergometer or treadmill for 6 minutes, with the respiratory therapist adjusting the resistance to a low level
- If the oxygen saturation decreases to less than 89% during the test, the supplemental oxygen is applied. The respiratory therapist will titrate the supplemental oxygen by 1lpm every minute to at least 90% for the remainder of the test.

HAST: The Procedure

- Alternatively, an arterial blood gas (ABG) is obtained prior to the test
- The test is performed as outlined previously
- An ABG is obtained after the test:
  - If PaO2 is less than 50 mmHg, then oxygen is applied at 2lpm (if the patient was not previously on oxygen) or at a level that is double dose of the usual supplemental oxygen prescription
  - The test is repeated on supplemental oxygen to ensure that hypoxia is treated
  - If the PaO2 is between 50-55 mmHg, then the test may be repeated with exertion and measurements are re-obtained

HAST: The Procedure

HAST: Other Considerations

- A physician should be available during the test to respond to any significant events during the test (for example, significant cardiac arrhythmia, severe dyspnea, loss of consciousness, severe chest pain.)
- Should the patient have any significant adverse symptoms during the test, the test should be stopped. The physician should be called if symptoms persist despite stopping the test and recovery.
- If the patient needs greater than 6lpm supplemental oxygen during part 1 of the test (resting), then part 2 (exercise) should not be performed

Other Considerations for Air Travel

- Check the altitude of the layover airports and also destination
- Most airlines do not provide supplemental oxygen
  - For example, United Airlines does not provide supplemental oxygen, except on flights to Guam from Tokyo
  - Patients CANNOT check-in full oxygen tanks; some airlines will allow empty tanks to be checked-in

Other Considerations for Air Travel

- An FAA-approved portable oxygen concentrator (POC) can be carried in-flight for supplemental oxygen needs
- Most airlines require at least 48 hour notice that the passenger will be traveling with supplemental oxygen
- Make sure that the POC has enough battery charge for the duration of the flight PLUS three hours
- Physicians may need to fill out a medical necessity form for POCs
- Patient should travel with their oxygen prescription at all times. It is also advisable that they carry all prescription medications in their carry-on luggage

Pulmonary Disease-Specific Considerations

- Asthma: It is advised that the patient carry their inhalers and space in their carry-on luggage
- COPD: It is advised that the patient carry their inhalers and space in their carry-on luggage. If there is significant walking involved at layover airports
- Cystic fibrosis: It is advised that the patient divide their medications between the carry-on and check-in luggage. Physiotherapy can be done during layovers. Due to the sensitive nature of some medications, consultation with a pharmacist about proper storage prior to travel is advised.

In-flight Emergencies

- In-flight emergencies are rare
- FAA requires that all flights weighing 7500 lbs or more have at least one flight attendant that is trained to use an AED and enhanced emergency medical kit
- Flight attendants must be certified in CPR and AED use
- The Aerospace Medical Association Air Transport Medicine Committee determines what is in the emergency kit

In-flight Emergency Medical Kit

Medications
Epinephrine 1:1000
Antihistamine, injectable (Inj)
D50, 50 ml
Nitroglycerin tabs or spray
Major analgesic, inj or oral
Sedative anti-convulsant, inj
Anti-emetic, inj
Bronchodilator inhaler
Corticosteroid, inj
Diuretic, inj
Medication for post-partum bleeding
Normal saline
Acetylsalicylic acid, oral
Oral beta blocker
List of all medications

In-flight Emergency Medical Kit

Supplies	
Sphygmomanometer	Flashlight and batteries
Oral airway	Non-mercury thermometer
Syringes, various sizes	Emergency tracheal catheter
Needles, various gauges	Umbilical cord clamp
IV catheters, various sizes	BLS card
Antiseptic wipes	ACLS card
Gloves	
Sharps disposal box	
Urinary catheter	
IV fluid system	
Venous tourniquet	
Sponge gauze	
Tape adhesive	
Surgical mask	

Responding to In-flight Emergency

- **In the case of an in-flight medical emergency, the flight crew may ask for the assistance of a medical professional**
- **The following tips may help guide your interaction in an in-flight emergency:**
  - **Introduce yourself to the cabin crew and state your qualifications (nurse, physician, etc)**
  - **Ask the patient for permission to provide care**
  - **Elicit a history and perform a physical exam**
  - **If the situation is critical, you may request the flight crew to consider re-routing the flight to the nearest airport in order to get expeditious medical help. You may help the ground medical crew in the transition as needed.**
  - **Keep a written medical record of your encounter**
  - **Only provide treatments or perform procedures for which you are qualified**
- **Source: https://www.acep.org/Clinical---Practice-Management/Be-Prepared-for-In-Flight-Medical-Emergencies/**

Responding to In-flight Emergencies

Medical-Legal Liability

- **Air Carrier Access Act of 1998 requires that “volunteers must be "medically qualified," render care in good faith, and receive no monetary compensation to be protected under this Act.”**
- **"an individual shall not be liable for damages in any action brought in a Federal or State court arising out of the acts or omissions of the individual in providing or attempting to provide assistance in the case of an in-flight medical emergency unless the individual, while rendering such assistance, is guilty of gross negligence or willful misconduct."**

Jet Lag

- **Jet lag usually occurs about one or two days after travel across two or more time zones**
- **Symptoms include excessive daytime sleepiness, insomnia during usual sleeping hours, fatigue, constipation**
- **Jet lag is more apparent with eastward travel**
- **Generally, it will take one day per each time zone traveled eastward to recover from jet lag and 1.5 days per each time zone traveled traveled westward**
- **Jet lag is distinguished from “travel fatigue” in that jet lag is related to time zones crossed whereas travel fatigue is fatigue, headache, weariness related to to travel itself**
- **Travel fatigue usually occurs during long-distance north-south travel**

Prevention of Jet Lag

- **Goal is to prevent insomnia and excessive fatigue**
- **This is done by trying to align a traveler's internal circadian rhythm with the light-dark cycle at the destination**
- **For trips less than three days, it may not be beneficial to try to align these clocks**
- **For eastward travel longer than three days, it is recommended that a combination of timed light exposure and melatonin be used**

Timed Light Exposure

- **In essence, the circadian rhythm is trained prior to travel**
- **Bright light therapy is started up to three days prior to travel**
- **The source of light can be outdoor light or a light box**
- **For eastward traveling, traveler will wake up one hour early per day and expose themselves to bright light for at least 1 hour. This is repeated for three days, trying to awaken earlier each successive day**
- **Likewise, traveler should try to go to bed one hour earlier each day**

Timed Light Exposure

- **At the destination, the goal is to expose the internal clock to bright light mid-day (avoiding bright light first thing in the morning), and then slowly waking up earlier each day**
- **There are numerous applications on smartphones that can help start timed light exposure prior to travel and also at the destination**

Timed Melatonin

- **Melatonin is considered a dietary supplement by the FDA and therefore can be purchased without prescription**
- **Melatonin should be taken upon arrival at the destination, at desired bedtime**
- **The dose of melatonin ranges from 0.5 to 10 mg**
- **Higher doses do not necessarily produce quicker or more intense effects**

Jet lag: Other Strategies

- Zolpidem has also shown to produce sleep and assist with insomnia at destination
- Benzodiazepines are not recommended to aid with jet lag symptoms such as insomnia
- Caffeine can be used in moderation for daytime fatigue
- Naps during the day should be limited to 30 minutes, so that the nighttime sleep is not affected
- Naps should be be no later than 8 hours prior to bedtime

Airplane Medical Emergencies

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In-flight Medical Emergencies

- Almost 900 million air travelers in U.S. alone in 2015 (2015, DOT report)
- 2013 NEJM Study: 44,000 in-flight medical emergencies each year
- Cardiac Arrest, 0.3% of medical emergencies but responsible for 86% of deaths in-flight

In-flight Medical Emergencies

- The FAA requires all American commercial airlines weighing 7,500 pounds or more and serviced by at least one flight attendant to carry an automatic external defibrillator (AED) and an enhanced emergency medical kit (EMK).
- AED use during the commercial flight environment has been validated as safe and effective
- Flight attendants must be CPR and AED certified every 2 years.

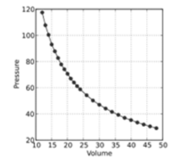
Airplane Physics

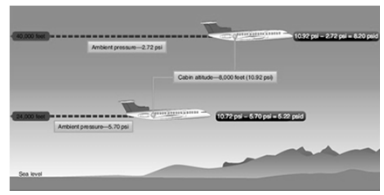
- Humans do not physiologically function well at altitude (>8,000-10,000 ft) without proper acclimatization
- Average passenger jet cruising altitude is 30,000 - 40,000 ft (Mt. Everest - 29,029 ft)
- FAA requires all flight in U.S. above 15,000 ft to be pressurized
- Hypoxia is biggest factor (due to reduced partial pressure of gases), along with rate of ascent and individual physiology; Barotrauma, DCS, Altitude Sickness
- Most U.S. are pressurized to around 8,000 ft. This creates best balance of passenger comfort and reduced stress on aircraft fuselage

Physics of Flight

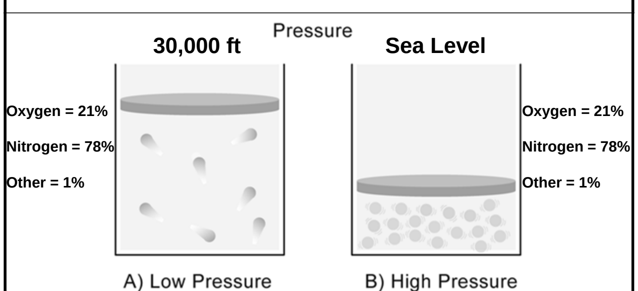
Boyle's Law or
The Pressure-Volume Law

Pressure at Sea Level = 760 mmHg/14.7 psi
Pressure at 30,000 ft = 226.1 mmHg/4.37 psi





Physics of Flight



In-flight Medical Emergencies

- **Altitude-Related Illness**
  - Hypoxia
  - Altitude Illness
  - Barotrauma
  - Decompression Sickness (DCS)
- **Medical-Related Illness**

Altitude-Related Illness

- Hypoxia - lack of oxygen to the tissues; Brain is most important
  - usually not an issue
  - concern if sudden loss of cabin pressure
  - Symptoms: lightheadedness, HA, vision loss, fainting (syncope) within seconds to minutes
  - Treatment: Oxygen! Grab the mask as quickly as possible

Altitude-related illness

- Altitude Illness - physiologic effects on humans due to relative hypoxia from sudden changes in elevation
  - Sea level to 7,000 - 8,000 ft in short amount of time (minutes)
  - Not usually life-threatening
  - Symptoms: HA, malaise, nausea (+/-) vomiting, lightheadedness
  - Treatment: Supportive care; hydration, anti-emetics,acetaminophen / ibuprofen for HA

Altitude-Related Illness

- Barotrauma - Injuries caused by increased air or water pressure, such as during airplane flights or scuba diving
  - occurs as the cabin is pressurized on ascent; there is still a pressure difference between the air that is trapped in your body (higher pressure) and the air in the cabin (lower pressure)
  - air wants to ‘move’ from high pressure to low pressure; so it expands
  - expansion of air most often in ears (eustachian tubes) and sinuses; but also in bowels and lungs
  - Symptoms: Ear pain, headaches, sinus pressure, eye pain, bloating, but in rare cases - eardrum rupture, pneumothorax
  - Treatment: Equilibration; ‘clearing’ your ears, passing flatus (gas), needle decompression

Altitude-Related Illness

- Decompression Sickness (DCS) - when dissolved gases (mainly nitrogen) come out of solution (water/blood) in bubbles and can affect just about any body area including joints, lung, heart, skin and brain
  - very rare in healthy individuals and pressurized spaces below 18,000 ft; some risk if person was recently diving however (within 24hrs)
  - Symptoms: stroke symptoms, neurologic deficits, headache, joint pain, skin pain, chest pain
  - Prevention: breathing100% oxygen prior to takeoff to ‘flush’ nitrogen out of tissues; not practical, not 100% effective
  - Treatment: 100% O2 until a decompression chamber can be reached; if loss of consciousness with clear risk factors this is a medical emergency

Medical-Related Illness

- Approach to the In-flight Medical Emergency
  - Identify yourself and your training/expertise
  - Treat in the seat whenever possible; use of the aisle blocks mobility of flight crew
  - Document your findings and treatments administered
  - Communicate and coordinate with flight crew and ground resources (MedAire, STAT-MD)
  - Do not attempt to practice beyond your expertise
  - Request access to the emergency medical kit (EMK)
  - Use a translator if necessary

Medical-Related Illness

- In a review of recent literature on in-flight emergencies these are stated to be the most common (source: Singapore Med J. 2017 Jan; 58(1): 14–17.
  - Near-syncope (lightheadedness) - 37%
  - Respiratory Symptoms - 12.1%
  - Nausea/Vomiting - 9.5%
  - Cardiac Symptoms - 7.7%
  - Seizures - 5.8%
  - Abdominal Pain - 4.1%

Medical-Related Illness

- Syncope - Assess vital signs, cardiovascular exam, and neurological exam. Recommend diversion for hypotension, arrhythmia, or suspected stroke.
- Altered Mental Status - Assess for toxidromes. Administer oxygen, establish intravenous access and administer normal saline and dextrose 50%.
- Seizure - Clear space around passenger. Administer sedative/anticonvulsant (benziodiazepine if available). Provide supportive care during post-ictal period. Recommend diversion for status epilepticus.

Medical-Related Illness

- Chest Pain - Assess vital signs. Perform cardiovascular and respiratory exam. Administer oxygen, nitroglycerin, and aspirin. Recommend diversion for arrhythmia, abnormal vital signs, or concern for myocardial infarction.
- Respiratory
  - Asthma Exacerbation -Administer inhaled bronchodilator and oxygen. Consider intravenous steroid for moderate to severe symptoms. Consider intramuscular epinephrine (0.3 to 0.5 ml of 1:1000 solution) for severe symptoms.
  - PTX - Perform needle thoracostomy for suspected tension pneumothorax (unequal breath sounds, chest pain, dyspnea). Recommend diversion.
  - CHF - Administer oxygen, assess vital signs and establish intravenous access. Administer oral nitroglycerin and intravenous diuretic. Recommend diversion.

Medical-Related Illness

- **Allergic Reaction - For mild allergic reaction, administer intravenous antihistamine and corticosteroids. For severe allergic reaction/anaphylaxis, administer intramuscular epinephrine (0.3 to 0.5 ml of 1:1000 solution).**
- **GI Symptoms - Administer antiemetic. Establish intravenous access and administer normal saline.**
- **Pregnancy - Assess vital signs and establish intravenous access. Recommend diversion for abdominal pain or vaginal bleeding.**

Emergency Medical Kit (EMK)

Source: http://www.airlinereporter.com/2014/09/how-lufthansa-cares-for-passengers-medical-needs/

Emergency Medical Kit (EMK)

- **Minimum requirements in EMK mandated by FAA**
- **Most airlines supplements with a variety of addition medications**

Part 121, appendix A, specifies that the following items must be carried in EMKs:

CONTENTS	QUANTITY
Sphygmomanometer	1
Stethoscope	1
Airways, oropharyngeal (3 sizes): 1 pediatric, 1 small adult, 1 large adult or equivalent	3
Self-inflating manual resuscitation device with 3 masks (1 pediatric, 1 small adult, 1 large adult or equivalent)	1: 3 masks
CPR mask (3 sizes), 1 pediatric, 1 small adult, 1 large adult, or equivalent	3
IV Admin Set: Tubing w/ 2 Y connectors	1
Alcohol sponges	2
Adhesive tape, 1-inch standard roll adhesive	1
Tape scissors	1 pair
Tourniquet	1
Saline solution, 500 cc	1
Protective nonpermeable gloves or equivalent[1]	1 pair
Needles (2-18 ga., 2-20 ga., 2-22 ga., or sizes necessary to administer required medications)	6
Syringes (1-5 cc, 2-10 cc, or sizes necessary to administer required medications)	4
Analgesic, non-narcotic, tablets, 325 mg	4
Antihistamine tablets, 25 mg	4
Antihistamine injectable, 50 mg, (single dose ampule or equivalent)	2
Atropine, 0.5 mg, 5 cc (single dose ampule or equivalent)	2
Aspirin tablets, 325 mg	4
Bronchodilator, inhaled (metered dose inhaler or equivalent)	1
Dextrose, 50%/50 cc injectable, (single dose ampule or equivalent)	1
Epinephrine 1:1000, 1 cc, injectable, (single dose ampule or equivalent)	2
Epinephrine 1:10,000, 2 cc, injectable, (single dose ampule or equivalent)	2
Lidocaine, 5 cc, 20 mg/ml, injectable (single dose ampule or equivalent)	2
Nitroglycerine tablets, 0.4 mg	10
Basic instructions for use of the drugs in the kit	1

Automated External Defibrillator (AED)

- **Required by FAA on U.S. Airlines since 2001**
- **Pilot study published in the Oct. 26, 2000 issue of *The New England Journal of Medicine*, researchers had tracked the results of an American Airlines program in which flight attendants were trained in using AEDs.**
- **Devices were used on 200 people who were experiencing cardiac arrest, and 40 percent of those treated with an AED survived**

Automated External Defibrillator (AED)