FLIGHT SAFETY FOUNDATION
CABIN CREW SAFETY
Vol. 35 No. 6 *For Everyone Concerned With the Safety of Flight* November–December 2000

Many Flight Attendants Learn to Use Automated External Defibrillators

Heart problems — including sudden cardiac arrest — have been among the most common serious in-flight medical events worldwide. The growing availability of automated external defibrillators on transport aircraft and in airports may lead to a public perception that most flight attendants can operate these medical devices.

FSF Editorial Staff

Recent medical studies show that the carriage of automated external defibrillators (AEDs) aboard commercial transport aircraft has improved in-flight medical care for sudden cardiac arrest (SCA).[1] SCA is an abrupt cessation of a person's heartbeat, usually caused by interference with the heart's natural electrical signal, and often is associated with coronary heart disease. SCA causes 300,000 deaths a year in the United States, but should not be confused with a heart attack (acute myocardial infarction), which occurs when blood flow is blocked in major vessels of the heart muscle and part of the heart begins to die.[2]

SCA typically is caused by ventricular fibrillation (VF), a type of uncoordinated, chaotic electrical activity that can occur within the heart for reasons such as heart disease, drowning, asphyxiation, electrical shock, poisoning or drug overdose. Unlike coordinated mechanical contractions controlled by the heart's natural pacemaker, VF is a rapid and unproductive quivering of the heart muscle that prevents blood from reaching the brain and other parts of the body. Death occurs within a few minutes unless VF is stopped by defibrillation, a therapeutic electrical shock to stop VF momentarily, allowing the heart to pause and enabling the heart to regain normal control of its rhythm.[3]

Unlike the more complex equipment in hospitals, AEDs are portable, computerized medical devices that show and tell the rescuer what to do. They have been designed specifically for operation by people who are not health care professionals. Via two adhesive electrode pads attached to a victim's chest, the AED analyzes the victim's heart rhythm, recognizes shockable VF and advises the rescuer through voice prompts, flashing lights and display-screen messages whether to administer a shock by pressing a button. As AEDs become more common in aviation and elsewhere, the traveling public may assume that most flight attendants (and pilots) are familiar with AEDs.

Since the early 1990s, more than a dozen airlines in several countries have announced AED programs and provided training to their cabin crews. In 2000, international guidelines for emergency cardiac care identified flight attendants as members of one of six occupations worldwide who should receive AED training as lay rescuers. Flight attendants who have not received such training may want to learn about AEDs

and the latest cardiopulmonary resuscitation (CPR) methods in light of growing interest in public-access defibrillation programs.

Scientists and public health officials from nearly all regions of the world in 2000 reached a consensus on the most effective methods of using AEDs and encouraged government funding of public-access defibrillation programs. The American Heart Association (AHA) said that public support for such programs and public familiarity with AEDs gradually are increasing.[4]

AHA said that such programs "have the potential to be the greatest advance in the treatment of pre-hospital [SCA] since the invention of CPR [in the 1950s and 1960s]."

For example, in the United Kingdom, the Department of Health, in its 2000–2001 expenditure plan, said that a public-access defibrillation initiative for airports, railway stations and shopping complexes would be implemented over a one-year period, including training for lay rescuers.[5]

The report said, "The initiative aims to increase survival rates from out-of-hospital cardiac arrest by reducing the critical time between cardiac arrest and the first defibrillation — a key element in the 'chain of survival.'" Chain of survival refers to the following four actions advocated by AHA to improve chances of survival from SCA:

- "Early access to treatment (recognizing the signs of a cardiac arrest and calling 911 [or other emergency telephone number] immediately);
- "Early CPR (being trained to administer CPR);
- "Early defibrillation; and,
- "Early advanced care (by trained [emergency medical technicians (EMTs)]-paramedics prior to reaching a hospital."[6]

In commercial air transport, the carriage of AEDs has been addressed by some civil aviation authorities, but not by the International Civil Aviation Organization in its standards and recommended practices.

Between July 1998 and June 1999, the U.S. Federal Aviation Administration (FAA) collected data on in-flight medical emergencies among 15 U.S. air carriers to study events involving operation of AEDs and opportunities to use AEDs.

FAA said, "Assuming [that] four passengers [in the study] survived due to the use of AEDs, the AED survival rate per 100 million passenger enplanements is 0.7193. The survival rate may have been different if AEDs had been aboard all participating [air] carriers' aircraft for the entire data-collection period. … Applying the survival rate to the estimated 7.5819 billion enplaned passengers over the next 10 years may result in 55 passenger medical event outcomes being changed by AEDs during that period."[7]

In May 2000, FAA proposed regulations that would require carriage of at least one AED on board each flight under U.S. Federal Aviation Regulations Part 121 by all passenger-carrying airplanes with a maximum payload capacity of more than 7,500 pounds/3,400 kilograms and required to have at least one flight attendant on board. This would include, at the lighter end of this category, aircraft such as the Avions de Transport Regional 42, the Bombardier Dash 8 and RJ-200ER, the Embraer ERJ-135ER and the Fairchild Dornier 328JET. Among other provisions, the proposed regulation would require initial and recurrent AED/CPR training for all flight attendants; and initial training for all pilots on the location of the AED and its instruction set [that is, AED/CPR training was not proposed for pilots].

FAA said that additional medications and medical kit devices also were proposed "based on the proposed addition of the AED and on best medical practice" — including an additional preparation of epinephrine, a drug that may be used for heart stimulation under a physician's orders. The additional preparation would complement the dosage of epinephrine currently required in medical kits and intended for use as a muscle relaxant, FAA said.

Candace Kolander, health and safety coordinator for the Association of Flight Attendants (AFA), a U.S. flight attendant union, said that AFA believes that proposed regulations to require airlines to carry AEDs should include standards for initial and recurrent AED training because variations exist among airlines in the hours of training provided. She said that such standardization and guidance from FAA should address gaps that some flight attendants have perceived in their preparation to use AEDs under the programs already adopted by airlines, and other concerns such as appropriate equipment and bloodborne-pathogen training (correct use of gloves, CPR face masks and other protection from bodily fluids for rescuers).[8]

Kolander said, "AED training needs to be realistic for the aircraft environment. One of AFA's concerns is what you do with a [victim] during landing, for example. Flight attendants must be in the jump seats for safety — but some carriers teach that this is a personal decision. Our position is that the flight attendant should be in the jump seat. If the [victim] is stabilized, the flight attendant could use other passengers to watch the [victim] during landing. This is unclear, so a flight attendant could be in an awkward situation with the [victim's] family — torn between the safety of a planeload of passengers and the needs of one passenger."

Some flight attendants now have a couple of years of experience with AEDs and some of their initial concerns have been resolved, she said.

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Medical Studies Demonstrate Effectiveness of AEDs

In May 2000, the U.S. Federal Aviation Administration (FAA) said that among 188 in-flight medical events studied, an automated external defibrillator (AED) was used in 17 separate events to administer at least one shock to a victim's heart —14 events occurred on the aircraft and three events occurred on the ground. Four victims who were administered at least one AED shock survived; the agency confirmed that they continued to survive following the study of events reported by 15 U.S. airlines from July 1998 to June 1999.[1]

"It is believed [that] the AED use was the event that changed the outcome for [the four victims in the study] who were reported as having survived," FAA said. "Subsequent to the data collection, further FAA investigation has revealed that more passengers, and a flightcrew member, have had similar experiences. Therefore, the option of not requiring action [to place AEDs on specified transport aircraft] appears inappropriate."

FAA said that 177 of the events occurred on the aircraft (either in flight, at the gate, or while taxiing), 10 events occurred on the ground (either in the jetway or the terminal) and one event occurred when the victim was en route to the airport. The report included the following findings:

- "Of the 177 events that occurred on the aircraft, 119 were thought to be of cardiac origin, based on a review of all the information provided on the event reports;
- "The average age of those passengers on the aircraft with reported cardiac problems was 62 years. Sixty-four of these 119 passengers were reported as having died. For the remainder, 42 passengers had unknown dispositions and 10 passengers were reported as having survived. Three events had unreported results;
- "In AED events, four passengers were reported as having survived, 11 as having died, and two as having unknown outcomes;
- "For cardiac-related events on the aircraft, an AED was reported as 'not available' for 40 events, 'not needed' for 12 events, and 'not reported' for 40 events;
- "[Cardiopulmonary resuscitation (CPR)] was reportedly performed 82 times on the aircraft;
- "Physicians were reported available on the aircraft for 92 events, nurses [were reported available on the aircraft] for 49 events;
- "A total of 74 diversions for passenger medical emergencies [was] reported; 52 for cardiac events; [and,]
- "Aircraft emergency medical kit item usage also was reported: six uses of epinephrine and six uses of nitroglycerin. (Both epinephrine and nitroglycerin currently are required to be carried [by FAA] in the emergency medical kits.) Intravenous saline and atropine (neither currently required by the FAA but carried by some airlines) were reported used once each. All events reporting these medications were apparent cardiac problems."

In October 2000, the *New England Journal of Medicine* published the results of two additional studies of AED use: one involving a U.S. airline's AED program, the other involving an AED program implemented by a group of U.S. gambling casinos.[2]

The airline study analyzed data for 200 victims for whom AEDs were used by American Airlines between June 1, 1997, and July 15, 1999. The report said that 191 victims were treated on aircraft and nine victims were treated in airports. Ninety-nine victims lost consciousness.

The report said, "The administration of shock was advised in all 14 patients who had electrocardiographically documented [ventricular fibrillation (VF)], and no shock was advised in the remaining patients (sensitivity and specificity of the defibrillator in identifying [VF], 100 percent). The first shock successfully defibrillated the heart in 13 patients (defibrillation was withheld in one case at the family's request). The rate of survival to discharge from the hospital after shock with the [AED] was 40 percent. A total of 36 patients either died or were resuscitated after cardiac arrest. No complications arose from the use of the [AEDs] as a monitor in conscious patients."

In the study of AED use by approximately 1,350 trained security officers at 10 casinos in Nevada, U.S., and Mississippi, U.S., 105 victims were treated, and 56 of the victims survived to discharge from the hospital. The study was conducted from March 1, 1997, to Oct. 12, 1999. The report said that the survival rate was 74 percent for victims who received their first defibrillation no more than three minutes after a witnessed collapse and 49 percent for those who received their first defibrillation after more than three minutes.

The study said that among 90 victims whose collapse was witnessed by others, an average 3.5 minutes elapsed from the victim's collapse to attachment of the AED, an average 4.4 minutes elapsed from the victim's collapse to delivery of the first AED defibrillation shock and an average 9.8 minutes elapsed from the victim's collapse to the arrival of paramedics.

Since AEDs have been installed under public-access defibrillator programs, preliminary data also are available from some airports, and additional medical studies have begun.

Sherry Caffrey, program director of HeartSave at the Chicago Department of Aviation, Illinois, U.S., said that Chicago O'Hare International Airport has had nine "saves" — successful operations of AEDs to resuscitate a victim — of 13 events that occurred from June 1, 1999, to Oct. 25, 2000.[3]

"Airports are the number one public place where sudden cardiac arrest [SCA] occurs, according to a 1992 American Heart Association study," Caffrey said. "People treated with AEDs at [two Chicago] airports have walked out of the hospital neurologically intact and are living a normal life as before their [SCA]."[4]

Based on contacts with her counterparts at other U.S. airports, Caffrey said that about 20 airports have implemented public-access defibrillator programs or are engaged in implementing such programs. She said that federal legislation was introduced in September 2000 to require such programs at specified U.S.

Medical Studies Demonstrate Effectiveness of AEDs *(continued)*

airports. (FAA said in June 2000 that the agency would not propose regulations to make AEDs mandatory at airports.)[5]

Caffrey said, "We found that among all of our cases, 55 percent of rescuers were 'good Samaritans' [bystanders] who had not been trained to use AEDs, but they knew the purpose of the AED. This was kind of a unique and compelling argument for public access — I did not expect to see this many cases of AEDs used by people walking by."

The department installed 42 publicly accessible AEDs at O'Hare (spaced at one-minute walking distances), seven publicly accessible AEDs at Chicago Midway Airport and 20 other AEDs at airport work sites not accessible to the public, such as airport maintenance complexes, security offices, police offices, remote buildings and radio facilities. Caffrey said that 3,000 people who work at these airports have received AED/CPR training to date.

O'Hare employees, including plumbers, electricians, concession operators and secretaries, volunteered to take eight hours of unpaid AED training in addition to police, fire and security personnel who typically receive CPR training and first aid training. Quarterly drills are conducted to maintain proficiency, she said.

The program makes AEDs available in unlocked cabinets connected to the airports' systems of access control and security monitoring. Opening an AED cabinet sounds an audible alarm and sends a silent message to dispatch police officers, security officers and paramedics to the location, Caffrey said. A sign on the cabinet says that the FDA restricts use of the device to emergency use by trained responders and that tampering with the device, except in a medical emergency, is punishable by a fine.

She said that 50,000 flight attendants work at O'Hare, with large numbers trained to use AEDs and to perform CPR. This statistic had a significant effect on the department's decision to implement a public-access defibrillator program, she said.♦

Notes and References

1. U.S. Federal Aviation Administration (FAA). "Emergency Medical Equipment." Notice of Proposed Rulemaking (NPRM), U.S. Federal Aviation Regulations (FARs) Part 121 and Part 135. Docket no. FAA-2000-7119, Notice no. 00-03. May 18, 2000. 17–22.
2. Page, Richard; Joglar, José; Kowal, Robert; Zagrodzky, Jason; Nelson, Lauren; Ramaswamy, Karthik; Barbera, Severio; Hamdan, Mohamed; McKenas, David. "Use of Automated External Defibrillators by a U.S. Airline." *New England Journal of Medicine,* Volume 343, October 26, 2000. 1210–1216. Valenzuela, Terence; Roe, Denise; Nichol, Graham; Clark, Lani; Spaite, Daniel, Hardman, Richard. "Outcomes of Rapid Defibrillation by Security Officers After Cardiac Arrest in Casinos." *New England Journal of Medicine,* Volume 343, October 26, 2000. 1206–1209.
3. Caffrey, Sherry. Telephone interview with Rosenkrans, Wayne. Alexandria, Virginia, U.S. October 25, 2000. Flight Safety Foundation, Alexandria, Virginia, U.S.
4. Sudden cardiac arrest is an abrupt cessation of a person's heartbeat, usually caused by interference with the heart's natural electrical signal, and often is associated with coronary heart disease.
5. On September 27, 2000, U.S. Rep. Bill Lipinksi of Illinois and U.S. Rep. John Duncan of Tennessee introduced in the U.S. Congress the "Airport Medical Assistance Act of 2000," a bill to require FAA to issue a rule to mandate publicly accessible, automated external defibrillators in U.S. airports that have more than 100,000 enplanements annually. FAA. "Notice of Decision: Emergency Medical Equipment." *Federal Register*, 35971–35973. June 6, 2000.

"When AEDs first came out, I was somewhat apprehensive," Kolander said. "I had signed up to be flight attendant, not a nurse. Later, I began to feel a bit more comfortable with this device — it all comes back to good training."

She said that flight attendants generally are willing to use their AED training and CPR skills when there is an opportunity away from the aircraft, jetway or airport gate environment.

"Flight attendants typically are not given a map of [public-access] AED locations in airports," Kolander said. "I would use an AED that happens to be available, but that would be a personal decision — just like for other people who have had AED training."

AED/CPR Procedures on Aircraft Involve Several Challenges

Carol Stemple, R.N., president of Lifework of Ellicott City, Maryland, U.S., a Heartsaver AED course instructor for AHA and a volunteer AHA spokeswoman in Maryland, Virginia and the District of Columbia, said that training in the use of AEDs and CPR has been designed to instill knowledge, skills and confidence to provide appropriate care for a person who may be experiencing SCA.[9]

Stemple said that the benefits of training include knowing that rapid action is critically important, how to turn on the AED, how to place the electrode pads on the victim's chest, how to integrate CPR with AED operation and how to change batteries. Students also learn that AEDs are not cleared by the U.S. Food and Drug Administration (FDA) for treatment of children younger than 8 years old, and how to protect themselves from disease with gloves, CPR face shields and CPR face masks.

Stemple said that AED/CPR training also may provide immunity from legal liability in the unlikely event that a rescuer is sued after attempting to assist a victim. Such immunity or limitation of liability is based on national or state laws. In

the United States, federal law specifically limits air carriers' liability when they request that medically qualified nonemployee passengers provide assistance, and limits nonemployee passengers' liability for providing assistance during an in-flight medical event unless the assistance is grossly negligent or is willful misconduct.[10]

Nevertheless, she said that people should realize that even if they have no AED training, many actual rescues show that an AED can be operated successfully by an untrained bystander who can follow the voice prompts at the scene.

Stemple said, "In our training, the priority is to have the victim defibrillated within 90 seconds of placing the AED at the victim's side. The goal is to get a defibrillator to the victim. If you have an AED, it does not matter if there is a doctor's office next door. When it comes to basic life support outside a hospital, there is no difference whether the person responding is a cardiologist or a lay rescuer in the first few minutes. When the students leave the course, they understand the time factor — that seconds count for the victim of [SCA]. The student really can grasp this concept during the course when waiting for the AED to analyze whether to shock or not — seconds seem like an eternity."

Prompts from the AED alone provide sufficient information for a rescuer to take the appropriate action more than half the time, she said. Training enables rescuers to make informed decisions about unusual circumstances and to recognize the differences in victim responses and outcomes, however.

"If you shock the victim out of VF, the likelihood that the heart will refibrillate is very, very high," Stemple said. "Because of that, you want to leave the AED on [the victim] until paramedics arrive. You may have to shock the victim again if, after further analysis, the AED advises to shock.

"The AED is preprogrammed to administer up to three shocks in a row if needed, then begins a pause mode for one minute of CPR to keep oxygen reaching the brain and vital organs. If the AED determines that the victim does not have a shockable rhythm, then the AED will advise not to shock and will not charge to shock. The AED will reanalyze the victim at set intervals, and if needed, may advise additional shocks if the victim develops another shockable rhythm. After repeated shocks, time is elapsing, and so is any viable electricity within the heart. If there is no VF present, the AED cannot be effective.

"Ventricular fibrillation rapidly deteriorates to an asystolic rhythm [flat line on a cardiac monitor] — typically in five minutes to six minutes," she said. "Defibrillation cannot restart someone's heart. With an AED, we are merely aiding the body's natural system. Physicians trained in advanced cardiac life support may give medications to stimulate some electrical activity so that the rescuer can use the defibrillator."

Airline Teaches Rapid Response in Limited Space

Linda Campbell, R.N., COHN-S, aeromedical nurse manager for American Airlines, said that in placing AEDs on its aircraft to save lives, the airline recognized that people treated successfully with an AED might remain seriously ill until reaching emergency medical care.[11]

Campbell said, "In adding the AEDs, we did not change protocols, we gave flight attendants an extra tool. I expected some reluctance but was amazed that they welcomed this tool with open arms. Backup medications and equipment were added to stabilize the [victim] while the airplane is diverting to an emergency facility. In the United States, the airplane can divert quickly — that still could be 45 minutes from cruise altitude to a jetway. An airplane half way to Honolulu [Hawaii, U.S., from the continental United States] is 3.5 hours from any place to land. We may need cardiac medications, syringes or other medical equipment to stabilize the person until landing is feasible."

She said that with ground-based medical advice available and medical personnel aboard about 82 percent of flights and willing to help, the AED can assist in analyzing a passenger.

Campbell said, "An AED with a display screen can assist a physician when administering cardiac medication."

American Airlines has used a four-hour AED/CPR training program with instructions for providing appropriate care in the cabin, Campbell said. This training was developed before the AHA Heartsaver AED course but covers all the major points, she said. The airline's program includes the following cabin-specific protocols:

- Flight attendants learn to place the victim on the floor where the victim was found if possible. They do not spend time attempting to lift or pull the victim to a galley or bulkhead;
- AED training is conducted in a cabin simulator, rather than a classroom, to increase realism;
- Flight attendants learn to follow AED voice prompts and AED display prompts, and to take the appropriate actions under conditions of loud engine noise or other noise. Placing the AED on a seat near the AED rescuer's head, rather than on the floor, also makes prompts from the AED's built-in speaker easier to hear;
- Flight attendants learn to perform CPR from the standard position kneeling at the victim's side, as well as in an aisle above the victim's head;
- In one training scenario, flight attendants learn that if serving carts block access to the AED, the AED can be passed or thrown over seats to save time;

- Flight attendants learn to use scissors, the razor, protective equipment for rescuers and other tools to address problems quickly, such as victims with hairy chests, turtle-neck sweaters or exposure to bodily fluids.

"We had a save [successful resuscitation] with an AED last Friday; training made the cabin crew a smoothly functioning team," Campbell said. She said that a significant challenge in AED training is that four or five flight attendants often do not know one another before a flight.

Linda Halevy, R.N., an emergency medical technician-paramedic and MedAire contract instructor, demonstrates one-rescuer cardiopulmonary resuscitation (CPR) chest compressions on a manikin (simulated victim) that she has positioned in the narrow aisle of a corporate jet airplane. An automated external defibrillator (AED) near the victim's head is connected to two electrode pads on the victim's bare chest. The AED's voice prompts tell the rescuer step-by-step when to stay clear of the victim for automatic heart-rhythm analysis, when to administer a shock if necessary, and when to perform CPR chest compressions/rescue breathing. The face mask on the victim enables the rescuer to administer rescue breaths without contacting the victim's bodily fluids. (FSF photograph)

"In training, flight attendants have to be taught to follow procedures — they do not deviate," Campbell said. "If they follow procedures, they can work as a team. During their preflight checks, they must verify where the AED is stowed and that it is functional."

Campbell said that flight attendants increasingly may find themselves in public areas where a person has collapsed and an AED is readily available, such as inside airports.

"When our flight attendants are on duty, it does not matter where the victim is — on an aircraft, on a jet bridge or in a terminal," Campbell said. "Our AEDs have been used in parking lots, baggage areas, different airline terminals. We saved another airline's passenger with one of our AEDs. It is a personal decision, but many of our flight attendants have used their training while off duty."

Although the airline reviews each use of its AEDs for medical quality assurance and training, learning a passenger's medical outcome has been difficult, Campbell said.

"I try to call the hospital, but most of the time, the hospital will not give any information due to patient confidentiality," Campbell said. "We know what happened in the lounge or on the jet bridge, but if a crewmember only performed CPR, we do not know if [the victim] made it [survived to hospital discharge]."

Business Aviation Crews Trained to Use AEDs

Joan Sullivan Garrett, president and CEO of MedAire, a company that provides crewmember training and MedLink in-flight medical advice, said that MedLink physicians currently respond to approximately 800 calls per month from aircraft crews with in-flight medical emergencies, including many emergencies involving the use of AEDs by cabin attendants, passengers or others. By the summer of 2001, MedAire's course instructors will incorporate into their instructional materials the AHA international guidelines for CPR and emergency cardiovascular care (ECC), including the use of AEDs. Because AEDs are well-suited to use by lay rescuers, carrying an AED has become appropriate not only for commercial air transport operations, but also for smaller aircraft that do not have a flight attendant, she said.[12]

Garrett said, "Without a flight attendant, passengers are dependent on flight crewmembers for assistance during in-flight medical emergencies. The mechanics of using the AED are easy [because] a crewmember can talk another passenger in back through the correct use. An AED must be used immediately — from the time a [victim] becomes unconscious and not

During a training demonstration, Linda Halevy, R.N., an emergency medical technician-paramedic and MedAire contract instructor, follows the voice prompts of an automated external defibrillator (AED) to administer a therapeutic shock to the heart of a manikin (simulated victim) while keeping herself and others clear of the victim. While not the rescuer's first choice, treating a victim in the aircraft seat may be necessary if the victim cannot be moved quickly to the aisle or if the victim will not fit in the adjacent floor space. This alternative victim position allows time-critical in-flight treatment of apparent sudden cardiac arrest. A hard, flat object such as a tray should be placed under the reclined victim for CPR and the rescuer must manage the victim's airway. (FSF photograph)

breathing — or you have lost the war. The AED takes precedence over everything except safety of flight — you can defibrillate a [victim] in an aircraft seat, but you also must help the crew to develop a plan of action, to know that they can manage this. If you can defibrillate a [victim] experiencing VF in two minutes, you can have a 90 percent survival rate. We have seen that among our commercial airline clients. It would be impossible to land the aircraft first and have the same result."

The need to act immediately when using AEDs has caused some airlines and other aircraft operators to reassess their assumptions about the best way to respond to in-flight medical emergencies, she said. Some are changing procedures to get such emergencies under control during normal cruise flight, then making arrangements to divert and land at an appropriate airport.

"The problems that have occurred with AEDs involved poor crew coordination," Garrett said. "Delay from lack of coordination is the key problem. People need to know what their roles are — that the captain will be calling [ground-based medical advice] and that one of the flight attendants will go for the AED as soon as he or she understands that a person is unconscious and has no breathing or pulse. Preparation also includes a preflight check that the AED is on the aircraft and in working order."

She said that a complete AED program should include protocols for collecting data, medical quality assurance and critical-incident stress debriefing for crewmembers involved in the use of an AED. The availability of an enhanced medical kit aboard the aircraft, health care professionals on the flight and a communication link to a physician trained in advanced cardiac life support all increase the options available for in-flight medical care, she said. The remote physician often can take advantage of skills, equipment and medications on the flight — but diagnosis of the underlying condition typically cannot be done while the patient is in flight.

"Typically, the [ground-based] physician will not be able to diagnose a patient who is in the air using an AED because there is not enough information to make a diagnosis," Garrett said. "To diagnose a heart attack is virtually impossible using an AED. In many cases, if not interpreted correctly, the limited information could be a disadvantage. Nevertheless, if a physician on board sees [asystole, a flat line on the display screens of some AEDs,] that could be a reason for the physician to decide to discontinue CPR."

In the future, remote diagnostic devices will augment information from AEDs, transmitting electrocardiograms to physicians on the ground and enabling some in-flight diagnosis, she said. The FDA is testing such devices, she said.

AEDs are simple to use safely and effectively, and various laws remove or reduce liability in lawsuits in specific circumstances. Nevertheless, Garrett said that liability for the outcome of in-flight medical care remains a focus of ongoing debate in the United States. She said that her company recommends blanket liability-insurance coverage, which requires initial AED/CPR training and annual recurrent training with program oversight by the medical director.

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Step-by-step Voice Prompts Adapt AEDs to Many Scenarios

Carol Stemple, R.N., president of Lifework of Ellicott City, Maryland, U.S., a Heartsaver AED course instructor for the American Heart Association (AHA) and a volunteer AHA spokeswoman in Maryland, Virginia and the District of Columbia, said that AHA teaches the following basic steps for the operation of automated external defibrillators (AEDs):

- Power the AED and listen to the voice prompts and visual prompts;
- Stop cardiopulmonary resuscitation (CPR) chest compressions and attach the electrode pads as shown to the victim's bare chest;
- Keep clear of the victim while the AED analyzes the heart rhythm; and,
- Keep clear of the victim and press the shock button if shock is advised, or follow other AED prompts to continue CPR and/or AED analysis of the heart rhythm.

Stemple described the following hypothetical scenario in which an AED is operated by a flight attendant to assist an adult passenger (or other person 8 years of age or older) in the cabin of a transport aircraft:

- The cabin crew learns that a passenger is unresponsive. The victim is unconscious, not moving and does not wake up in response to shouts or a firm touch. Typically, a flight attendant immediately follows the airline's procedure to alert other crewmembers to the emergency. One flight attendant typically takes the role of AED rescuer while another takes the role of CPR rescuer;
- The AED rescuer opens the victim's airway by tilting the head to see if the victim is breathing. If the victim is not breathing and not moving, or has a pale, blue or dusky skin color, the AED rescuer and CPR rescuer — under the 2000 AHA international guidelines for lay rescuers — presume that the victim also does not have a pulse (under earlier guidelines, the rescuer also checks for a pulse in the neck);
- The AED rescuer immediately calls for a flight attendant to bring the AED to the victim or gets the AED, using the fastest method;
- While the AED is brought to the AED rescuer, the CPR rescuer maintains an open airway for the victim and begins CPR cycles of breaths and chest compressions;
- When the AED arrives, the AED rescuer immediately turns on the device and follows the voice prompts to remove all clothing from the victim's chest (unbuttoning, lifting or cutting clothing to save time as necessary), open the package of two adhesive electrode pads, connect the electrode pads to the cables (if necessary) and the cables to the AED (if necessary) and apply the electrode pads to the chest. Diagrams in the AED kit show that the right electrode pad must be attached to the right of the breastbone (victim's right side), below the collar bone and above the victim's right nipple. The left electrode pad must be attached outside the victim's left nipple with the upper edge of the pad several inches below the left arm pit. The electrode pads, which have a strong adhesive and are pre-gelled for conduction of electricity, are ready for use when removed from their packaging;
- As soon as the electrode pads are attached to the victim's chest and connected to the AED — with the AED rescuer confirming these connections and that no one is touching the victim — the AED immediately begins operating in its analyze mode to determine whether the AED should charge to shock. Touching the victim during analysis can slow the process or prevent analysis. If there is poor contact between electrode pads and the victim's chest, the AED advises the rescuer to correct this so analysis can proceed. (Razors typically are supplied in AED kits for quickly removing some chest hair before applying the electrode pads; the first set of pads also can be pulled from the victim's chest — removing hair in the process — and a second set of pads can be applied for better conduction.);
- Within a few seconds, the AED signals via voice prompt, lighted buttons and a digital display either "shock advised" or "no shock advised" (exact terminology is specific to each AED model but has the same meaning);
- If the AED identifies shockable ventricular fibrillation (VF), chaotic electrical activity that stops the normal heartbeat, the AED charges and advises the AED rescuer that the shock energy level has been reached. The AED rescuer yells, "I am clear, you are clear, everybody is clear," checks the victim visually from head to toe to ensure that no one is touching the victim, then presses the shock button on the AED to administer the first shock. (AED voice prompts also tell the rescuer to remain clear of the victim.);
- At the instant the AED delivers the shock, the AED rescuer typically sees the victim's body move or jerk slightly. Nevertheless, only the AED's analysis and prompts should be used to determine what to do next;
- The AED then reanalyzes the victim's heart rhythm and provides appropriate prompts for the situation, including instructions to continue CPR. The AED does not advise whether the victim has a pulse or is breathing, only whether the victim has shockable VF. Therefore, many scenarios are possible and the AED rescuer must be responsible for checking the victim and providing appropriate care. For example, the victim may have no pulse and no breathing and the AED may say "no shock advised." The rescuer should follow training guidelines for continuing CPR and continuing to operate the AED to analyze the victim;
- When the victim has VF, the first shock may be successful. The AED rescuer may see the victim's color improve, detect a pulse and see movement, breathing and return of consciousness. The rescuers then place the victim on his side or her side in a recovery position that adjusts the head to keep open the airway. Rescuers also will continue analyzing the victim with the AED so that any recurrence of VF can be detected immediately and shocked. A normal heart rhythm may return, but the victim may not begin breathing; in such instances, CPR rescue breathing must continue;

Step-by-step Voice Prompts Adapt AEDs to Many Scenarios *(continued)*

- Rescuers should stay with the victim and help the victim remain comfortable for the remainder of the flight; and,
- If a health care professional aboard the flight has advanced cardiac life support training or can communicate with a similarly qualified physician on the ground, medications and intravenous fluids from the emergency medical kit may be administered under a physician's orders to help the victim.

Stemple said that CPR remains an essential part of the response because the desired outcome is for all people who have had sudden cardiac arrest to wake up with normal brain activity rather than a functional deficit caused by lack of oxygen to vital organs. CPR maintains circulation of oxygen-rich blood to the brain and heart and should be provided throughout the resuscitation process except when attaching the AED electrode pads to the chest, and when analyzing, charging or shocking VF, she said.♦

— FSF Editorial Staff

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"The department of health for each state has imposed different requirements for AED/CPR training, recurrent training and prerequisites — it can be extremely confusing," Garrett said. "Because there are no precedents in terms of legal cases or lawsuits relative to this issue, our method is to remove the client from the position of trying to comply with every state statute — in essence, we have removed the fear factor that could inhibit a crewmember from getting involved."

ASRS Reports Show Use of AED Sometimes Contradicts Training

Reports in the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) show that, in some instances, AEDs have been used with patients who had not lost consciousness or stopped breathing, a practice that is contrary to AHA guidelines, except when directed by a physician. Linda Halevy, R.N., EMT-P, a MedAire contract instructor, said that one reason for adhering to guidelines is that attaching electrode pads to a conscious victim may induce anxiety, which may exacerbate a heart problem.[13]

The following NASA ASRS reports show examples of such AED scenarios:

- "[The] passenger complained of severe chest pains. [The] passenger was grabbing his chest in pain, leaning over the tray table. I, the purser of the flight, paged a physician. None [was] onboard. [I] shaved the passenger's chest and applied the [electrode pads] of the AED. [The] passenger kept experiencing the chest pains for over one hour. The [AED] advised not to shock. [The passenger] was always conscious. [The AED] monitored the heart. Callback conversation with [the ASRS] reporter revealed … that the ill passenger appeared to be in his mid-30s, traveling alone for the first time to South America and, in hindsight, [the reporter] realized [that] the passenger was suffering from anxiety. The [AED] was applied but never administered shock due to a regular heartbeat. In the absence of a physician on board, the reporter felt [that] the symptoms required the treatment. The passenger recovered before landing and did not need further medical assistance;"[14] [and,]

- "[The] passenger in seat [XX] was sweating and staring blankly forward. We gave him oxygen and paged a doctor. [A registered nurse] came forward, and we retrieved the medical kit, and she took his blood pressure. It was 118/60, and he started to come around, and we asked [him] if he was on any medication or if this had happened before. He told us it had not and then complained that his left arm was going numb. The [nurse] took his blood pressure again, and it was now 90/50. We got the AED and applied the [electrode] pads, and no shock was needed. The [nurse] advised the captain that we did need to land as soon as possible. We landed … and he was taken to the aft stairs and loaded onto the ambulance. It was good to have the AED onboard, and [we] relied on it to help this passenger to make it until we got him to the hospital."[15]

Current Generation of AEDs Matches Needs of Lay Rescuers

The current generation of AEDs — those introduced since the mid-1990s and cleared by the FDA since 1996 for use in the aircraft environment — has been characterized by the following features:

- Small size;
- Light weight;
- Low maintenance requirements;

- Ease of use by lay rescuers;
- Automated heart-rhythm diagnosis;
- Automated shock/no shock decisions; and,
- Voice prompts, lighted buttons and display messages that signal the rescuer what to do step by step.

Physicians — who must prescribe AEDs and must serve as medical directors of AED programs in the United States — also consider AED differences in terms of ease of use, electric shock wave forms and energy levels, shock efficacy and potential side effects.

Christian Cary, product manager of Agilent Technologies, a U.S. AED manufacturer, said that developing current AED models involved many design challenges because even trained lay rescuers would use the device infrequently and under high-stress conditions.[16]

Cary said, "The breakthrough is that these devices have been made so effective and easy to use that lay people are up to the task of cardiac defibrillation. We wanted to be sure that the process of resuscitating goes as quickly and smoothly as possible, so ease of AED use is at the top of the list. Our goal was to minimize the decision making and steps required of a responder, and just help them react. The machine decides on its own whether a shock is appropriate or not — and will not let the rescuer shock inappropriately."

Current AED models are designed to be reliable and rugged enough to operate in harsh environments with minimal maintenance. Cary said that the Agilent model, for example, conducts automatic daily self-tests.

"In the unlikely event that there is a problem with the AED's internal circuitry or battery, [the problem] can be identified long before the AED needs to be used on a [victim] with just a glance at a status indicator. Batteries typically are designed to be ready for use even after standing by for five years." Nevertheless, AHA recommends that a spare battery and extra disposable electrode pads be kept with each AED for backup purposes, he said.

International Guidelines Specify How to Use AEDs Effectively

Current training programs for the use of AEDs conform to the guidelines of various professional organizations, such as the European Resuscitation Council's 1998 *Guide to Automated External Defibrillation* or, in the United States, those of AHA, American Red Cross and National Safety Council. Nevertheless, significant steps were taken in 2000 to develop updated, common resuscitation guidelines based on international scientific research.

The use of AEDs is a prominent element of AHA international guidelines for CPR and ECC, which were introduced in August 2000 by international authorities as a common standard for the treatment of cardiovascular emergencies such as sudden cardiac arrest, heart attack and stroke.[17]

The document — entitled *Guidelines 2000 for Cardiopulmonary Resuscitation and ECC: International Consensus on Science* — is a major revision of recommendations for CPR and the treatment of cardiovascular emergencies, covering subjects such as AEDs, CPR and recommendations for emergency medical personnel.

AHA said, "The updated guidelines place major emphasis on early defibrillation for [VF] and AEDs as a tool to increase [SCA] survival. Prompt bystander CPR combined with early defibrillation have produced survival rates exceeding 50 percent in some early defibrillation programs."

AHA said that one of the major changes was the recognition that a pulse check by lay rescuers is unreliable, with the resulting recommendation that no pulse check be done before bystanders begin administering CPR chest compressions to an unconscious person. The new guidelines recommend that members of the general public instead look for normal breathing, movement, coughing, response to stimulation and other signs of circulation when deciding whether to begin CPR chest compressions.

Vinay Nadkarni, M.D., chairman-elect of AHA's ECC committee and director of pediatric intensive care at the A.I. duPont Hospital for Children in Wilmington, Delaware, U.S., said, "We recognize that it is very difficult for a lay person to assess whether a patient has a pulse within the first few seconds of a cardiovascular emergency." Research indicates that at least 35 percent of lay rescuers are wrong about whether a victim has a pulse, Nadkarni said.

AHA said that the changes in CPR guidelines mean that people who previously have been trained in CPR will need to be retrained with new course materials that incorporate the recommendations when their current certification expires; such courses are expected to be widely available by July 2001. AHA said that the following changes for lay rescuers also will be covered in the new training:

- "Streamlining/standardizing the ratio of chest compressions to breaths during adult CPR [so that cycles of 15 chest compressions for every two breaths are used for people 8 years of age or older in both one-rescuer CPR and two-rescuer CPR, and a rate of at least 100 chest compressions per minute is used while compressions are given to infants, children and adults]; [and],
- "Simplification of CPR instruction — for example, techniques to teach management of choking (airway

obstruction) in an unconscious victim have been greatly simplified."

Deletion of the pulse check from lay person CPR training previously has been implemented successfully by the United Kingdom and European Resuscitation Council, Nadkarni said. Nevertheless, the AHA international guidelines continue to recommend that trained health care professionals check for a pulse before doing CPR chest compressions, AHA said.♦

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