

Automated external defibrillator

An **automated external defibrillator** or **AED** is a portable electronic device that automatically diagnoses the potentially life threatening cardiac arrhythmias of ventricular fibrillation and ventricular tachycardia in a patient,^[1] and is able to treat them through defibrillation, the application of electrical therapy which stops the arrhythmia, allowing the heart to reestablish an effective rhythm.

AEDs are designed to be simple to use for the layman, and the use of AEDs is taught in many first aid, first responder and basic life support (BLS) level CPR classes.^[2]



An automated external defibrillator, open and ready for pads to be attached

Usage

Conditions that the Device Treats

An automated external defibrillator is used in cases of life threatening cardiac arrhythmias which lead to cardiac arrest. The rhythms that the device will treat are usually limited to:

1. Pulseless Ventricular tachycardia (shortened to VT or V-Tach)^[1]
2. Ventricular fibrillation (shortened to VF or V-Fib)

In each of these two types of shockable cardiac arrhythmia, the heart is active, but in a life-threatening, dysfunctional pattern. In ventricular tachycardia, the heart beats too fast to effectively pump blood. Ultimately, ventricular tachycardia leads to ventricular fibrillation. In ventricular fibrillation, the electrical activity of the heart becomes chaotic, preventing the ventricle from effectively pumping blood. The fibrillation in the heart decreases over time, and will eventually reach asystole.

AEDs, like all defibrillators, are not designed to shock asystole ('flat line' patterns) as this will not have a positive clinical outcome. The asystolic patient only has a chance of survival if, through a combination of CPR and cardiac stimulant drugs, one of the shockable rhythms can be established, which makes it imperative for CPR to be carried out prior to the arrival of a defibrillator.



Effect of Delayed Treatment

Uncorrected, these cardiac conditions (ventricular tachycardia, ventricular fibrillation, asystole) rapidly lead to irreversible brain damage and death. After approximately three to five minutes,^[3] irreversible brain/tissue damage may begin to occur. For every minute that a person in cardiac arrest goes without being successfully treated (by defibrillation), the chance of survival decreases by 10 percent.^[4]

Requirements for Use

AEDs are designed to be used by laypersons who ideally should have received AED training. This is in contrast to more sophisticated manual and semi-automatic defibrillators used by health professionals, which can act as a pacemaker if the heart rate is too slow (bradycardia) and perform other functions which require a skilled operator able to read electrocardiograms.

Bras with a metal underwire and piercings on the torso must be removed before using the AED on someone to avoid interference.^[5]

A study analyzed the effects of having AEDs immediately present during Chicago's Heart Start program over a two year period. Of 22 individuals 18 were in a cardiac arrhythmia which AEDs can treat (Vfib or Vtach). Of these 18, 11 survived. More interestingly, of these 11 patients, 6 were treated by good Samaritan bystanders with absolutely no previous training in AED use.^{[6] [7]}

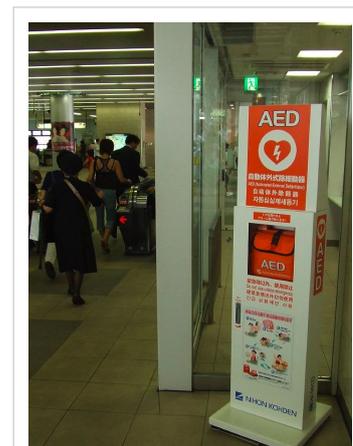
Placement and Availability

Automated external defibrillators are generally either held by trained personnel who will attend events or are public access units which can be found in places including corporate and government offices, shopping centres, airports, restaurants, casinos, hotels, sports stadiums, schools and universities, community centers, fitness centers, health clubs, workplaces and any other location where people may congregate.

The location of a public access AED should take in to account where large groups of people gather, regardless of age or activity. Children as well as adults may fall victim to sudden cardiac arrest (SCA)

In many areas, emergency vehicles are likely to carry AEDs, with some ambulances carrying an AED in addition to manual defibrillators. Police or fire vehicles often carry an AED for first responder use. Some areas have dedicated community first responders, who are volunteers tasked with keeping an AED and taking it to any victims in their area. AEDs are also increasingly common on commercial airlines, cruise ships, and other transportation facilities.

In order to make them highly visible, public access AEDs often are brightly colored, and are mounted in protective cases near the entrance of a building. When these protective cases are opened or the defibrillator is removed, some will sound a buzzer to alert nearby staff to their removal, though this does not necessarily summon emergency services; trained AED operators should know to phone for an ambulance when sending for or using an AED. In September 2008, the International Liaison Committee on Resuscitation issued a 'universal AED sign' to be adopted throughout the world to indicate the presence of an AED, and this is shown at right.^[8]



An AED at a railway station in Japan.



A trend that is developing is the purchase of AEDs to be used in the home, particularly by those with known existing heart conditions.^[9] The number of devices in the community has grown as prices have fallen to affordable levels. There has been some concern among medical professionals that these home users do not necessarily have appropriate training,^[10] and many advocate the more widespread use of community responders, who can be appropriately trained and managed.

Typically, an AED kit will contain a face shield for providing a barrier between patient and first aider during rescue breathing; a pair of nitrile rubber gloves; a pair of trauma shears for cutting through a patient's clothing to expose the chest; a small towel for wiping away any moisture on the chest, and a razor for shaving those with very hairy chests.^[11]

Preparation for operation

Most manufacturers recommend checking the AED before every period of duty or on a regular basis for fixed units. Some units need to be switched on in order to perform a self check; other models have a self check system built in with a visible indicator.

All manufacturers mark their pads with an expiry date, and it is important to ensure that the pads are in date. This is usually marked on the outside of the pads. Some models are designed to make this date visible through a 'window', although others will require the opening of the case to find the date stamp.

Mechanism of operation

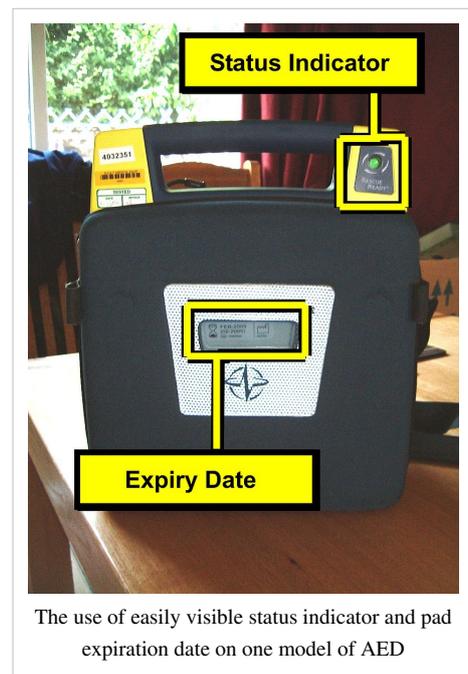
An AED is *external* because the operator applies the electrode pads to the bare chest of the victim, as opposed to internal defibrillators, which have electrodes surgically implanted inside the body of a patient.

Automatic refers to the unit's ability to autonomously analyse the patient's condition, and to assist this, the vast majority of units have spoken prompts, and some may also have visual displays to instruct the user.

When turned on or opened, the AED will instruct the user to connect the electrodes (pads) to the patient. Once the pads are attached, everyone should avoid touching the patient so as to avoid false readings by the unit. The pads allow the AED to examine the electrical output from the heart and determine if the patient is in a shockable rhythm (either ventricular fibrillation or ventricular tachycardia). If the device determines that a shock is warranted, it will use the battery to charge its internal capacitor in preparation to deliver the shock. This system is not only safer (charging only when required), but also allows for a faster delivery of the electrical current.

When charged, the device instructs the user to ensure no one is touching the patient and then to press a button to deliver the shock; human intervention is usually required to deliver the shock to the patient in order to avoid the possibility of accidental injury to another person (which can result from a responder or bystander touching the patient at the time of the shock). Depending on the manufacturer and particular model, after the shock is delivered most devices will analyze the patient and either instruct CPR to be given, or administer another shock.

Many AED units have an 'event memory' which store the ECG of the patient along with details of the time the unit was activated and the number and strength of any shocks delivered. Some units also have voice recording abilities to monitor the actions taken by the personnel in order to ascertain if these had any impact on the survival outcome. All this recorded data can be either downloaded to a computer or printed out so that the providing organisation or



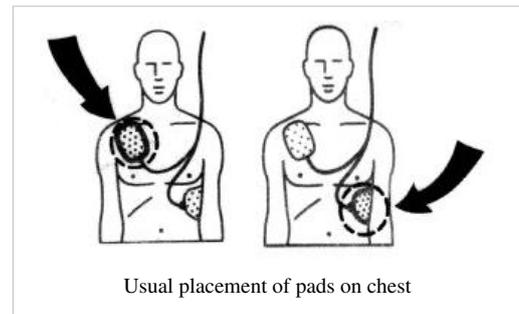
The use of easily visible status indicator and pad expiration date on one model of AED

responsible body is able to see the effectiveness of both CPR and defibrillation.

The first commercially available AEDs were all of a monophasic type, which gave a high-energy shock, up to 360 to 400 joules depending on the model. This caused increased cardiac injury and in some cases second and third-degree burns around the shock pad sites. Newer AEDs (manufactured after late 2003) have tended to utilise biphasic algorithms which give two sequential lower-energy shocks of 120 - 200 joules, with each shock moving in an opposite polarity between the pads. This lower-energy waveform has proven more effective in clinical tests, as well as offering a reduced rate of complications and reduced recovery time.^[12]

Simplicity of use

Unlike regular defibrillators, an automated external defibrillator requires minimal training to use. It automatically diagnoses the heart rhythm and determines if a shock is needed. Automatic models will administer the shock without the user's command. Semi-automatic models will tell the user that a shock is needed, but the user must tell the machine to do so, usually by pressing a button. In most circumstances, the user cannot override a "no shock" advisory by an AED. Some AEDs may be used on children



- those under 55 lbs (25 kg) in weight or under age 8. If a particular model of AED is approved for pediatric use, all that is required is the use of more appropriate pads. Some organizations, such as the American Heart Association, recommend that if pediatric AED pads are not available, adult pads should be used to determine if the child is in a shockable rhythm. There is insufficient evidence to suggest that a child, in a shockable cardiac arrest, can be "hurt" by an adult defibrillation energy setting.

All AEDs approved for use in the United States use an electronic voice to prompt users through each step. Because the user of an AED may be hearing impaired, many AEDs now include visual prompts as well. Most units are designed for use by non-medical operators. Their ease of use has given rise to the notion of public access defibrillation (PAD), which experts agree has the potential to be the single greatest advance in the treatment of out-of-hospital cardiac arrest since the invention of CPR.^[13]

Liability

Automated external defibrillators are now easy enough to use that most states in the United States include the "good faith" use of an AED by any person under the Good Samaritan laws.^[14] "Good faith" protection under a Good Samaritan law means that a volunteer responder (not acting as a part of one's occupation) cannot be held civilly liable for the harm or death of a victim by providing improper or inadequate care, given that the harm or death was not intentional and the responder was acting within the limits of their training and in good faith. In the United States, Good Samaritan laws provide some protection for the use of AEDs by trained and untrained responders.^[15] AEDs create little liability if used correctly;^[16] NREMT-B and many state EMT training and many CPR classes incorporate or offer AED education as a part of their program. In addition to Good Samaritan laws, Ontario, Canada also has the "Chase McEachern Act (Heart Defibrillator Civil Liability), 2007 (Bill 171 – Subsection N)", passed in June, 2007,^[17] which protects individuals from liability for damages that may occur from their use of an AED to save someone's life at the immediate scene of an emergency unless damages are caused by gross negligence.

External links

- American Heart Association: Learn & Live ^[18]
- American Red Cross: Saving a Life is as Easy as A-E-D ^[19]
- FDA Heart Health Online: Automated External Defibrillator (AED) ^[20]
- Resuscitation Council (UK) ^[21]

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- [11] *CPR/AED for the Professional Rescuer, supra*, page 65 ("[a] safety surgical razor should be included in the AED kit.") The other items not directly mentioned in this text but are used in AED preparation, such as the gloves (used throughout patron assessment) and the towel, as the chest should be dried prior to AED pad attachment (id, at page 64).
- [12] "AED Plus Biphasic Waveform" (http://www.zoll.com/product_resource.aspx?id=728). ZOLL Medical Corporation. . Retrieved 2008-10-27.
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