EFCOG Best Practice #112

Best Practice Title: Electrical Safety Position Paper "Use of Automated External Defibrillators"

Facility: DOE Complex

Point of Contact: Greg Christensen, Phone: 208-526-5380, email: chrigk@inl.gov

Brief Description of Best Practice: This best practice indicates Automated External Defibrillators are easy to use and when deployed can provide a valuable long term survival benefit to victims of sudden cardiac arrest (SCA).

Why the best practice was used: Early intervention with both CPR and defibrillation can result in high long-term survival rates for victims of SCA.

What are the benefits of the best practice: Use of this best practice would serve as a means of preventative intervention for over 14,000 DOE employees and 193,000 contract workers. It is estimated 1 per 1,000 adults 35 years of age and older will experience SCA in a given year.

What problems/issues were associated with the best practice: Procedures that prescribe training of personnel administering AEDs, and deployment and maintenance requirements are necessary for an effective program.

How the success of the Best Practice was measured: Studies by the American heart Association (AHA) and American Medical Association (AMA) indicate long-term survival rates is high for victims of SCA, if early intervention with both CPR and defibrillation is provided.

Description of process experience using the Best Practice: This practice utilizes the ISMS process to evaluate risk to victims of SCA if early intervention is not provided.

ENERGY FACILITY CONTRACTORS GROUP (EFCOG)

ENVIRONMENTAL HEALTH AND SAFETY WORKING GROUP

ELECTRICAL SAFETY SUB GROUP

ELECTRICAL SAFETY POSITION PAPER
USE OF AUTOMATED EXTERNAL DEFIBRILLATORS

Point of Contact: Greg Christensen (208·526·5380)

February 23, 2009

1. CONTENTS

2. ACRONYMS

AED	Automated External Defibrillator
AHA	American Heart Association
AMA	American Medical Association
CPR	Cardio Pulmonary Resuscitation
DOE	Department of Energy
SCA	Sudden Cardiac Arrest
SCD	Sudden Cardiac Death
VF	Ventricular Fibrillation

1. INTRODUCTION

In an effort to improve survival from cardiac arrest, the American Heart Association (AHA) has promoted the Chain of Survival concept, describing a sequence of prehospital steps that result in improved survival after sudden cardiac arrest. These interventions include immediate deployment of emergency medical services, prompt cardiopulmonary resuscitation, early defibrillation when indicated, and early initiation of advanced medical care. Early defibrillation has emerged as the most important intervention with survival decreasing by 10% with each minute of delay in defibrillation.

According to the AHA, more than 950,000 adult Americans die each year of cardiovascular disease making it the No. 1 cause of death in the United States. At least 250,000 people die of sudden cardiac arrest (SCA) before they reach the hospital. SCA strikes people of all ages and degrees of fitness and can strike without any warning. Ischemic injury to the brain and permanent death begin to occur within four to six minutes after an individual experiences SCA.

Despite recent advances in resuscitation science, survival from cardiac arrest remains low, and sudden cardiac death (SCD) is a major public health issue. However, the magnitude of SCD in the general population still remains unknown. Estimates of the annual incidence of SCD in the U.S. range from 184,000 to 400,000. ["Effectiveness of bystander cardiopulmonary resuscitation and survival following out-of-hospital cardiac arrest"]

Ventricular Fibrillation (VF) is a condition in which there is uncoordinated contraction of the heart cardiac muscle of the ventricles in the heart, making them tremble rather than contract properly. VF is a medical emergency and if the arrhythmia continues for more than a few seconds, blood circulation will cease, and death can occur in a matter of minutes. During VF, contractions of the heart are not synchronized, blood flow ceases, organs begin to fail from oxygen deprivation and within 10 minutes, death will occur. When VF occurs, the victim must be defibrillated in order to establish the heart's normal rhythm. On average, the wait for an ambulance in populated areas of the United States is about 11 minutes. The implication for certain categories of employees (i.e. electrical workers) is significant as exposure to small amounts of electricity in the milliamp range can lead to VF.

In view of these facts, the EFCOG Electrical Safety Task Group initiated this review to evaluate the potential value of deployment and use of automated external defibrillators (AEDs) for treatment of SCA victims. This evaluation indicates the long term survival benefit to victims of SCA is high if treated with CPR plus defibrillation within the first 3-5 minutes after collapse. According to the American Heart Association (AHA), survival rates as high as 74% are possible if treatment and defibrillation is performed in the first 3 minutes. In contrast survival rates are only 5% where no AED programs have been established to provide prompt CPR and defibrillation. ["CPR statistics" American Heart Association]

2. SURVIVAL RATES AND EARLY INTERVENTION

Early intervention with both CPR and defibrillation can result in high long-term survival rates for SCA, as demonstrated by a study investigating the beneficial effects of AED devices at Chicago's O'Hare and Midway airports. The American Medical Association (AMA) advocates the widespread placement of AEDs [see AMA Res. 413, A-02; Res. 424, A-04]; supports increasing government and industry funding for the purchase of AED devices; and encourages the American public to become trained in CPR and the use of AEDs. Some states, including Maryland, have enacted legislation requiring AED devices and a certified responder be available at high school and school-sponsored athletic events due the risk of SCA to athletes (the most common cause of death in young athletes). Ensuring AED availability at Department of Energy (DOE) sites would serve as a means of preventative intervention for over 14,000 DOE employees and 193,000 contract workers. It is estimated 1 per 1,000 adults 35 years of age and older will experience SCA in a given year.

Speed is paramount when it comes to sudden cardiac arrest- each minute without intervention reduces the patient's chance of survival by 10 percent. If someone suddenly collapses the following simple steps can save a life:

1. Check for a pulse - if no pulse, assume the person has gone into cardiac arrest.
2. Call the emergency-response system and seek an AED.
3. Administer chest compressions. Overlap your hands and place them palms-down at the center of the person's chest and push hard at a rate of about two pushes per second. Keep compressing the chest until someone brings an AED.
4. Deploy the AED which will clearly guide you in the process of resuscitation.

NOTE: Mouth-to-mouth breathing is no longer a part of first-responder doctrine. CPR is unlikely to restart the heart, but rather its purpose is to maintain a flow of oxygenated blood to the brain and the heart, thereby delaying tissue death and extending the brief window of opportunity for a successful resuscitation without permanent brain damage. [see "Automated External Defibrillation Implementation Guide 2004," American Heart Association 70-2272 September 2004].

An effective AED program has the capability to deliver a shock to a victim within 3 to 5 minutes of collapse. Therefore, a 3 minute response time is a good guideline for evaluating AED placement and services should be evaluated to determine if unacceptable delays in early treatment and intervention for SCA could occur. Rescuer training that meets the American Heart Association requirements for CPR and defibrillator application should be established and maintained. Public Access Defibrillation (PAD) programs are available that can meet the expectations for a lay rescuer training program. [see

"Community Lay Rescuer Automated External Defibrillator Programs," JAMA AHA Policy Recommendation, May 8, 2006.]

3. MODERN AEDS

AEDs are designed to safely restart the normal healthy rhythm of a heart that is in VF and have been refined to the point where the training needed is minimal to administer them and effectively save someone's life. AEDs have been deployed in many public places including office buildings, transportation hubs, gyms; police cars, schools, and governmental institutions. The price of an AED is modest and units sell for as little as $1000.00.

The technological sophistication of modern AEDs is described in "Idiot-proofing the Defibrillator". The modern simplistic design of an AED allows even a layman to operate it with a simple tutorial. When the AED's box is opened, audio instructions prompt the rescuer with simple commands. First, the rescuer is instructed to place two adhesive electrode pads on the victim's bare chest, following the diagrams on the pad wrappers. The defibrillator's built-in electrocardiograph automatically detects and analyzes the state of the patient's heartbeat, and its software determines if a shock is needed. If, the victim's heart is indeed in VF, the AED will announce "Push the button". The rescuer presses the only button, a shock is delivered, and this may be all that is necessary to restore the normal heartbeat. If not, the AED will prompt the rescuer to push the button again after a short time. If the shock is delivered within the first minute of VF, in more than 90 percent of cases the heart will regain a normal sequence of electric signals, and the steady contractions will return. **Some AEDs are now entirely automated and do not require the rescuer to push a button.**

Modern AED technology includes sophisticated diagnostic capabilities and the change to a biphasic waveform has greater efficacy and reduces power requirements for defibrillation. The second phase appears to help heal the membranes of cells closest to the electrodes (which receive the most extreme current) and to discharge cells that are only marginally charged. It is known the heartbeat is most vulnerable during a period known as the T wave and a shock administered to a heart not in fibrillation during this phase could potentially induce fibrillation. To provide a check on such situations, AED designs began incorporating an analysis system that checks for a pulse. Once the AED is turned on and the electrode patches are attached the device will evaluate the EKG signal to see if VF has occurred. The system starts by delivering a low-voltage, almost imperceptible 30-kilohertz signal through the two electrodes. A sophisticated peak detector analyzes the signal and while a normal heartbeat will display clear voltage peaks followed by comparatively flat regions, a heart in VF will indicate a noisy, messy signal interpreted as a series of rapid, randomly spaced heartbeats. The AED makes its initial diagnostic decision by measuring the heart rate. If this rate is more than 150 beats per - minute (2.75 hertz), the defibrillation-detection algorithm presumes that VF has occurred, and the device will announce that the rescuer should administer a shock.

To deal with possible confounding rhythms and interferences from such things as pacemakers, atrial fibrillation (a fairly benign condition) or external AC sources the AED defibrillation-detection algorithm performs a simple spectral analysis leading to a tentative diagnosis which is repeated during a three-second window, to produce three diagnoses. If two or all three analyses indicate VF, the shock is authorized. Atrial fibrillation is ruled out when the algorithm calculates the average derivative of the Electrocardiographic voltage and a critical threshold is exceeded (atrial fibrillation has a zero derivative). Electrocardiographic readings are stored in semiconductor memory for later downloading to a computer at the emergency-response headquarters, from which data can be sent back to the AED's manufacturers. Researchers use the database of diagnoses to develop and refine future algorithms. [see "Idiot-proofing the Defibrillator" Published November 2008 (IEEE Spectrum]

CPR is considered to be the weak link in emergency response and researchers are in the process of developing an automated electrical form of CPR incorporated into AEDs. Preliminary results indicate the constrictions appear to move blood as effectively as would chest compressions performed by a trained human rescuer

4. IMMUNITY FROM LEGAL LIABILITY

The Federal Cardiac Arrest Survival Act (CASA) 22 was enacted in 2000 with provisions to encourage AED use in federal buildings and create immunity for qualified individuals who use AEDs. CASA provides conditional immunity from legal liability for harm resulting from use or attempted use of an AED by lay responders, but does not provide protection from liability for licensed or certified health care professionals acting within the scope of their license and within the scope of their employment. [see Good Samaritan Protections Regarding Emergency, "Use of Automated External Defibrillators, Public Health Improvement Act," Public Law 106-505, Section 404 and "The Automated External Defibrillator-Clinical Benefits and Legal Liability,"]

5. SECURITY

Concerns have been raised regarding the potential misuse of an AED's voice recording and internal memory capability that could be used to compromise security of information and technology. An analysis of this concern indicates the perceived security risk is low in comparison to other cyber security threats to computers and communications technologies that could be compromised.

Voice recording - while some AED units have background recording capability others do not. Therefore selecting a unit with other than voice recording capability would be a simple way to address this issue.

Internal memory - AEDs record EKG and other physiological data which is downloaded to a database for future technology research. A perceived risk that the memory capability of an AED could be removed and exploited is considered to be minimal as there are other devices, i.e., jump drives, disks, etc. which are easily concealed and do not require any adaptation to be exploited. Nonetheless, traditional security measures may be deployed including storage of the AED in a secure locker or cabinet, and, assignment to a security official or cleared personnel to ensure devices are deployed in a secure manner. Security personnel are commonly assigned in private industry as first responders.

6. MAINTENANCE

It is essential, as an emergency medical treatment device, AEDs are maintained in accordance with the manufacturer's instructions to ensure functionality of the devices in the event of an emergency. In particular, AEDs contain batteries that will deteriorate over time. The lack of maintenance could lead to a failure to defibrillate a person in VF. In addition, there exists potential liability in the event a non-maintained AED were to be associated with a delay in treatment resulting in injury or death to a victim of VF. Therefore, AEDs should be included in a rigorous maintenance program similar to other emergency equipment such as self contained breathing apparatus.

7. RESOURCES

Numerous sources of information are available to provide additional guidance on the implementation of an AED program. In addition, to previously cited sources, the Department of Health and Human Services and the General Service Administration published Guidelines for Public Access Defibrillation Programs in Federal Facilities following passage of Public Law 106-505 November 13, 2000, the *Public Health Improvement Act*. The Act authorized placement of AEDs in federal buildings and provided immunity from civil liability for anyone using an AED in a federal building. In addition, the American College of Occupational and Environmental Medicine, the professional association representing occupational physicians, has issued guidelines for establishing and managing a workplace AED program. [see Department of Health and Human Services and General Services Administration "*Guidelines for Public Access Defibrillation Programs in Federal Facilities"* May 23, 2001].

8. REFERENCES

1. Gallagher, EJ; Lombardi G; Gennis P (December 1995). "Effectiveness of bystander cardiopulmonary resuscitation and survival following out-of-hospital cardiac arrest". *JAMA* 274 (24).
2. "CPR statistics" American Heart Association. Accessed 9/3/2008. http://www.americanheart.org/presenter.jhtml?identifier=4483
3. American Medical Association H-440.890 Availability of Automated External Defibrillators (Res. 413, A-02; Res. 424, A-04)
4. American Medical Association Medical Student Section 130.002 MSS Use of Automatic External Defibrillators (MSS Sub Res 12, A-98)
5. "Idiot-proofing the Defibrillator" By Mark W. Kroll, Karl Kroll, and Byron Gilman First Published November 2008 (IEEE Spectrum) http://spectrum.ieee.org/nov08/6921
6. "Automated External Defibrillation Implementation Guide 2004," *American Heart Association* 70-2272 September 2004.
7. "Community Lay Rescuer Automated External Defibrillator Programs," *Journal of the American Medical Association, American Heart Association Circulation, AHA Policy Recommendation*, May 8, 2006.
8. Good Samaritan Protections Regarding Emergency, "Use of Automated External Defibrillators, Public Health Improvement Act," Public Law 106-505, Section 404.
9. "The Automated External Defibrillator-Clinical Benefits and Legal Liability," Journal of the American Medical Association, February 8, 2006.
10. Department of Health and Human Services and General Services Administration. "Guidelines for Public Access Defibrillation Programs in Federal Facilities" May 23, 2001.
11. Occupational Safety and Health Administration "Cardiac Arrest and Automated External Defibrillators" (AEDs) TIB 01-12-17

APPENDIX A
Background Data

American Heart Association

These statements are fair generalizations:

- *Early CPR and defibrillation (de-fib"rih-LA'shun) within the first 3–5 minutes after collapse, plus early advanced care can result in high (greater than 50 percent) long-term survival rates for witnessed ventricular fibrillation (ven-TRIK'u-ler fib"rih-LA'shun).*
- *The value of early CPR by bystanders is that it can "buy time" by maintaining some blood flow to the heart and brain during cardiac arrest. Early bystander CPR is less helpful if EMS personnel equipped with a defibrillator arrive later than 8–12 minutes after the collapse.*

Sudden cardiac death (S.C.D.)

- *Sudden cardiac death from coronary heart disease occurs over 900 times per day in the United States. The risk in adults is estimated to be about 1 per 1,000 adults 35 years of age and older per year.*
- *Sudden cardiac death in the young (people less than 35 years old) is much less common than in adults, occurring in only 0.5 to 1 child per 100,000 per year.*
- *A review of published studies that report initial heart rhythms during cardiac arrest in children indicates that the majority (40–90 percent) have asystole (a-SIS'to-le) or pulseless electrical activity when first evaluated. However, ventricular fibrillation or ventricular tachycardia (ven-TRIK'u-ler tak"eh-KAR'de-ah) is found in about 7–14 percent of all children in cardiac arrest in the prehospital setting.*

Automated external defibrillators (AEDs)

- *AEDs are computerized devices that are now about the size of a laptop computer. They can be used by healthcare providers (such as Emergency Medical Response providers) and by lay rescuers. They are attached to victims who are thought to be in cardiac arrest, and they provide voice and visual prompts to lead rescuers through the steps of operation. AEDs analyze the victim's heart rhythm, determine if a defibrillation shock is needed, then prompt the rescuer to "clear" the victim and deliver a shock.*
- *Lay rescuer AED programs (also known as Public Access Defibrillation or PAD programs) train lay rescuers such as security guards, police and firefighters in CPR and use of an AED and equip the rescuers with automated external defibrillators (de-FIB'rih-la-torz).*
- *The first out-of-hospital defibrillation device weighed 110 pounds; today they weigh less than 8 pounds.*

Increased survival with CPR and AEDs

- *Studies have repeatedly shown the importance of immediate bystander CPR plus defibrillation within 3–5 minutes of collapse to improve survival from sudden VF cardiac arrest.*
- *In cities such as Seattle, Washington, where CPR training is widespread and EMS response and time to defibrillation is short, the survival rate for witnessed VF cardiac arrest is about 30 percent.*
- *In cities such as New York City, where few victims receive bystander CPR and time to EMS response and defibrillation is longer, survival from sudden VF cardiac arrest averages 1–2 percent.*

- *Some recent studies have documented the positive effect of lay rescuer AED programs in the community. These programs all ensure adequate training, and a planned response to ensure early recognition of cardiac arrest and EMS call, immediate bystander CPR, early defibrillation and early advanced care. Lay rescuer AED programs consisting of police in Rochester, Minn., security guards in Chicago's O'Hare and Midway airports, and security guards in Las Vegas casinos have achieved 50–74 percent survival for adults with sudden, witnessed, VF cardiac arrest. These programs are thought to be successful because rescuers are trained to respond efficiently and all survivors receive immediate bystander CPR plus defibrillation within 3–5 minutes."*

House of Delegates Resolutions:

H-440.890 Availability of Automated External Defibrillators *Our AMA: (1) advocates the widespread placement of automated external defibrillators; (2) supports increasing government and industry funding for the purchase of automated external defibrillator devices; and (3) encourages the American public to become trained in CPR and the use of automated external defibrillators. (Res. 413, A-02; Res. 424, A-04)*

130.002 MSS Use of Automatic External Defibrillators *AMA-MSS will ask the AMA to support legislation for the increased use of automatic external defibrillators (AEDs) for the purpose of saving the life of another person in cardiac arrest provided that: (1) A person or entity who acquires an automatic external defibrillator ensures that: (A) Expected defibrillator users receive American Heart Association CPR and/or an equivalent nationally recognized course in defibrillator use and cardiopulmonary resuscitation; (B) The defibrillator is maintained and tested according to the manufacturer's operational guidelines; and (C) Any person who renders emergency care or treatment on a person in cardiac arrest by using an automatic defibrillator activates the emergency medical services system as soon as possible. (2) Any person or entity who acquires an automatic external defibrillator is encouraged to register the existence and location of the defibrillator with the emergency communications district or the ambulance dispatch center of the primary provider of emergency medical services where the automatic external defibrillator is to be located. (MSS Sub Res 12, A-98) (AMA Res 503, I-98, Referred) (BOT Rep 21, A-99, Adopted in lieu of Res 503, I-98) (Reaffirmed: MSS Rep E, I-03)*