A COMMUNITY NEEDS ASSESSMENT FOR PUBLIC ACCESS DEFIBRILLATION

STRATEGIC MANAGEMENT OF CHANGE

BY: ***Patrick J. Mullen***
Naperville Fire Department
Naperville, IL

An applied research project submitted to the National Fire Academy as part of the Executive Fire Officer Program

October 2000

Appendix A Not Included. Please visit the Learning Resource Center on the Web at http: www.lrc.fema.gov to learn how to obtain this report in its entirety through Interlibrary Loan.

ABSTRACT

Recent technological advances in computer and electronics design have enabled medical device manufacturers to develop lightweight, intrinsically simple automatic external defibrillators (AED). Simple to operate, minimally trained non-medical personnel may successfully operate these devises. Due to their proven accuracy and reliability in treating sudden cardiac arrest (SCA), the American Heart Association recognizes them as essential in treating victims of sudden cardiac arrest in certain situations. Because of these factors, AEDs have gained in popularity among municipal service providers as well as private industry as a means to broaden the availability of defibrillation to the general populace and to reduce the time it takes to bring a defibrillator to the side of a stricken patient.

Acknowledging that the City of Naperville has yet to develop a program to promote public access defibrillation (PAD) within the community, research was undertaken through descriptive method to conduct an assessment to evaluate the need for implementing a PAD program in Naperville. The project attempted to answer the following questions.

1. What is the prevalence of sudden cardiac arrest patients treated by the Naperville Fire Department?
2. What are the essential components of a public access defibrillation program?
3. What community groups should be considered for inclusion in an implementation plan?
4. What have other organizations done to successfully implement public access defibrillation programs?

Research procedures combined the use of two retrospective studies and a survey questionnaire. One study consisted of a three-year review of patient care reports to determine the location of sudden cardiac arrest events treated by Fire Department personnel. A second look-back study sought to quantify cardiac arrest survival data for patients treated in 1999. The third research effort included the distribution of a survey questionnaire to organizations, both public and private, that had previously implemented PAD programs.

Results indicated that the Naperville Fire Department demonstrated a hospital discharge rate of 5.8 percent for individuals treated for out-of-hospital sudden cardiac arrest. This contrasted with a successful resuscitation rate of 15.15 percent reported by questionnaire survey participants using AEDs. Despite the posting a relatively rapid response time for ALS services to SCA events (averaging 3:52 minutes), most cardiac arrest patients treated by Naperville paramedics presented with an initial EKG of asystole. The majority of arrests occurred in the home (62.24%) and appeared to result from a cardiac etiology 84.06 percent of the time.

Based upon the demonstrated survival rate and the apparent successes of police agencies participating in the survey, recommendations were made to promote the implementation of a PAD program. With the Fire Department serving as the lead agency, target priorities for deployment included police department patrol vehicles, appropriate public access government buildings, institutional residential care occupancies, and large corporate campuses.

TABLE OF CONTENTS

INTRODUCTION

The affliction of sudden cardiac arrest (SCA) represents a significant public health problem to the citizens of the United States. The American Heart Association (AHA) projects that this year nearly 1,100,000 Americans will suffer a new or recurrent heart attack. More than 40 percent of these individuals, 440,000 – or more than 1200 per day, will die, making SCA one of the leading causes of death in this country. Approximately 225,000 people die each year of SCA prior to being hospitalized (AHA, 2000, p.1-2).

Since the late 1960s and early 1970s, local government agencies across the United States have expended generous sums of money to build, equip, and staff Emergency Medical Service (EMS) Systems. For the most part these systems serve local communities well in terms of delivering quality prehospital emergency medical care to meet the medical and psychological needs of patients. Despite these huge investments in EMS, SCA remains a major unsolved community health threat. "Currently the chances of surviving an SCA in the United States are one in twenty." (Communicore, 1996, p. 1)

Most deaths due to sudden cardiac arrest occur from an electrical disruption of the heart rhythm (arrhythmias). Many victims have no previous history of heart disease, precipitating symptoms, or functional impairment. In the presence of cardiac muscle damage due to acute myocardial infarction or severe oxygen deprivation, the heart becomes most susceptible to electrical derangement. The most common rhythm disruption, ventricular fibrillation, results in a chaotic electrical discharge of heart muscle with an associated loss of pulse, blood pressure, and blood flow. If not corrected within minutes, death of the patient ensues.

Fortunately, a proven definitive treatment option for ventricular fibrillation exists in the form of defibrillation. Defibrillation is the controlled delivery of an electrical shock to a heart in

cardiac arrest. This directed shock resets the chaotic electrical activity of ventricular fibrillation and restores coordinated electrical-muscular activity as well as heart beat and blood flow. The American Heart Association recognizes defibrillation as "the major determinant of survival in cardiac arrest due to ventricular fibrillation." (1992, p. 2211) Studies have demonstrated that victims of sudden cardiac arrest who receive defibrillation therapy within the first few minutes of onset may experience survival rates as high as 80 to 90 percent. (Gisnburg, 1998, p. 315) Rapid delivery of this treatment is essential. Eisenberg et al. (1990) noted that the likelihood of successful resuscitation decreases by approximately 10 percent for each minute that ventricular fibrillation persists. By the time 10 minutes pass, very few resuscitation attempts result in success.

Until recently, the availability of defibrillation to patients outside the hospital setting has been limited to those EMS systems providing advanced life support services delivered by highly trained paramedics. Despite the heroic efforts by such high performance EMS systems to reduce response times and treatment delays, the overall survival rate for patients treated by prehospital medical providers for sudden cardiac arrest remains low. Impediments to rapid provision of defibrillation may include delays in recognition by patients and bystanders, in notification to EMS agencies, or in response by personnel due to obstacles such as traffic, geography, or accessibility.

Technological advances in computer and electronics design have enabled medical device manufacturers to develop simple, lightweight, and reliable automatic external defibrillator (AED) devices capable of analyzing cardiac rhythms and, if appropriate, advising or delivering a defibrillation shock automatically. These devices are so simple to operate they may be successfully utilized by minimally trained non-medical personnel. AEDs have proven so

accurate and reliable that the American Heart Association recognizes these devices as an essential component in the "chain of survival" (AHA, 1992, p. 2291) for cardiac arrest. The links in this chain include the following.

- Early Access – rapid recognition of the signs of distress, rapid notification of the EMS system, and rapid response of EMS responders.
- Early CPR – bystander CPR is the best treatment a cardiac arrest victim may receive prior to the arrival of a defibrillator and advanced cardiac care.
- Early Defibrillation – the key link in the chain most likely to improve a patient's chances of survival.
- Early Advanced Cardiac Life Support (ACLS) – early delivery of ACLS by paramedics at the scene forms another critical link vital to sustaining the patient's long-term survivability.

If potential rescuers delay or neglect one of these critical interventions, patient survival becomes doubtful. "A logical extension of the AED concept is 'public access defibrillation' (PAD) or widespread distribution and use of AEDs by non-medical, minimally trained personnel (e.g., security guards, spouses of cardiac patients)." (Kerber et al., 1998, p. 2-3) While the concept of public access defibrillation poses unique logistical challenges with respect to funding, training, and oversight, it also provides a significant opportunity to reduce mortality from sudden cardiac arrest by decreasing the response time for the delivery of defibrillation therapy by trained personnel.

The Naperville Fire Department has yet to develop a program to promote the proliferation of AEDs within the community. Promotional messages distributed by the AHA, AED manufacturers, and the electronic and print media has served to heighten the public's

awareness of the efficacy of these devices and fueled a desire to have access to them. Legislative changes promulgated by the Illinois General Assembly (AED Act of 1999) have reduced medical practice barriers, thereby enabling the development of PAD programs. As members of the public, whether as individuals or as corporate entities, pursue their interests in implementing public access defibrillation programs, they will look to the Fire Department, as the primary provider of prehospital emergency medical services to the community, for advice and direction. Therefore, it becomes essential that the Naperville Fire Department develop guidelines to address the implementation of a community public access defibrillation effort.

The purpose of this research is to analyze the need for implementing a PAD program for the City of Naperville. This effort utilizes the first phase, analysis, of the four step change management model identified in the Strategic Management of Change course developed by the National Fire Academy. It also makes use of descriptive research to identify the prevalence of sudden cardiac death in the Naperville community as well as to gauge the strategies of select organizations that have already implemented PAD programs.

This project will attempt to answer the following research questions.

1. What is the prevalence of sudden cardiac arrest patients treated by the Naperville Fire Department?
2. What are the essential components of a public access defibrillation program?
3. What community groups should be considered for inclusion in an implementation plan?
4. What have other organizations done to successfully implement public access defibrillation programs?

BACKGROUND AND SIGNIFICANCE

The Naperville Fire Department provides fire and EMS to the City of Naperville, Illinois, an upscale suburban community located approximately 31 miles due west of the City of Chicago, Illinois along Interstate 88. The Fire Department delivers EMS as part of a single tier, all ALS system. The service area covers more than 53 square miles, encompassing the corporate limits of the City of Naperville as well as unincorporated areas within the City's planning boundaries. The protected population exceeds 145,000.

The Operations Division, the emergency service bureau of the Naperville Fire Department, functions with a staff of 167 officers and firefighters. Medical licenses and certifications include the following.

- 120 EMT-Ps
- 18 EMT-Bs
- 29 First Responder-Defibrillation

Operating out of seven fire stations, the Department utilizes 6 ALS ambulances to deliver primary emergency response and transportation on a 24-hour basis to patients requesting emergency medical assistance. Ambulances operate with a minimum of two personnel licensed to the EMT-P level. Eight ALS engine companies function as secondary EMS response units to fill any gaps that occur in community coverage and thus keep response times low. Established procedures call for the simultaneous dispatch of ALS engine companies with ALS ambulances to an EMS request either as back up for specifically designated types of calls or as primary response when circumstances clearly indicate that the engine company will have a shorter response time to the incident. ALS engine companies operate with a minimum of one EMT-P and two First Responder-Ds.

As a tertiary response option, the Department has equipped two ladder companies to operate as BLS EMS response units utilized during times of exceedingly high community service demand. Though infrequently used for primary EMS response, BLS ladder companies will respond to EMS requests when circumstances indicate the ladder company will have a shorter response time to an EMS incident than the next closest ambulance or engine company. Ladder company personnel bring advanced airway and AED capability to the scene. Minimum staffing consists of one EMT-P and two First Responder-Ds.

The City of Naperville also operates a 911 public service answering point (PSAP) and dispatch center through the Naperville Police Department. PSAP personnel maintain enhanced 911 service to the community and handle the radio communications and dispatching duties for both the Naperville Fire and Police Departments. All PSAP telecommunicators function as emergency medical dispatchers (EMD) in accordance with U.S. DOT curriculum. Naperville EMDs utilize dispatch protocols and prearrival medical instructions approved by both the Naperville Emergency Telephone Board and the local EMS System.

In 1999, the Naperville Fire Department answered a total of 5048 requests for emergency medical services. Emergency medical personnel treated 6081 patients and transported 4030 to the hospital. Forty percent of all patients received advanced life support treatment from Fire Department paramedics. Of the total patient mix, 7 percent presented with cardiac symptoms while 6 percent complained of respiratory problems. Department personnel administered resuscitation care to 69 patients in cardiac arrest in 1999.

Fire Department staff calculates response times to EMS incidents by measuring the time elapsed from initial notification of the PSAP by the caller, until arrival of the first ALS unit on

the scene. Response times to EMS incidents averaged 4:28 minutes during 1999. Fractile response time measurements demonstrate the following.

Response Time	Percentage of Total Calls
$\leq$ 4 minutes	35.24%
>4 $\leq$ 6 minutes	52.70%
> 6 $\leq$ 8 minutes	9.83%
> 8 minutes	2.23%

The response time data detailed above demonstrates evidence of a high performance EMS system with respect to the arrival of advanced life support on the scene of an emergency. Despite this, nearly one-half of patients treated by the Naperville Fire Department wait more than four minutes for the arrival of EMS personnel. The prospect of AEDs being accessible to trained members of the public demands consideration of a number of legitimate issues.

For one, having an AED available to a trained lay person in the event of a witnessed sudden cardiac arrest may have a dramatic effect in reducing the time interval between onset of symptoms to the arrival of definitive treatment. Applied in this fashion, public access AEDs potentially offer a means to improve the outcome of some cardiac arrest patients by getting defibrillation therapy to the patient sooner. If successful in reducing this response time, the strategic placement of AEDs may provide some cost-effectiveness benefits to the community as well. This becomes more evident when you compare the costs associated with staffing and equipping additional EMS units to the price of one AED ($3000-$3500).

Another issue associated with public access AEDs deals with the logistics of training and medical oversight. Legislators created the Illinois AED Act to encourage the growth of public access AED programs. Within the past year, the Naperville Fire Department has seen the implementation of AED programs by four major corporations within the corporate limits of the City; Lucent Technologies, Hewlett-Packard, Dow Jones Inc., and Nalco Chemical. These

represent the programs that have notified the Fire Department. Three of these companies contacted the Fire Department for direction and advice prior to implementation. This level of interest indicates a necessity for the Department to become more informed on the use of, need for, and regulatory requirements governing AED programs. By developing such expertise, the Department will be better equipped to advise and encourage the public to adopt AED initiatives.

Another issue of importance regarding public access AEDs deals with the concerns of EMS professionals. Public access AED programs represent a dramatic departure from traditional methods of providing prehospital care. These programs essentially certify non-medical personnel to administer defibrillation, a highly invasive and potentially harmful medical treatment procedure once the exclusive province of highly trained medical professionals. The successful implementation of any AED program should also include provisions to educate and inform community EMS professionals.

This project correlates with the Strategic Management of Change course by identifying external change forces on the Fire Department and attempting to apply specific components of the Change Management Model to guide acceptance and implementation within the organization for the benefit of the community.

LITERATURE REVIEW

Defibrillation

The American Heart Association has established defibrillation as the therapy of choice for the treatment of patients suffering from sudden cardiac arrest who present with an electrocardiograph rhythm of ventricular fibrillation or pulseless ventricular tachycardia. (JAMA, 1992) Mosby's Paramedic Textbook defines defibrillation as follows.

> "Defibrillation is the delivery of electrical current through the chest wall for the purpose of terminating ventricular fibrillation and pulseless ventricular tachycardia. The shock depolarizes a large mass of myocardial cells at once. If about 75% of these cells are in the resting state (depolarized) after the shock is delivered, a normal pacemaker may resume discharging. Early defibrillation is supported by the following rationale.
>
> - The most frequent initial rhythm in sudden cardiac arrest is ventricular fibrillation.
> - The most effective management for ventricular fibrillation is electrical defibrillation.
> - The probability of successful defibrillation diminishes rapidly over time.
> - Ventricular fibrillation tends to convert to asystole within a few minutes." (Sanders, 2000, p. 877)

When delivered within a relatively short time frame, defibrillation is highly effective in successfully converting ventricular fibrillation to a viable heart rhythm. Studies of cardiac arrests occurring in supervised cardiac rehabilitation centers (Mead, et al. 1976, Fletcher et. al. 1977, Hossack and Hartwig, 1982) showed a successful resuscitation rate of more than 90 percent. (Communicore, 1996, p.2) Through a study of cardiac arrest and resuscitation rates for 29 cities, Eisenberg et al. (1990) found the likelihood of resuscitation decreased by approximately 10 percent for each minute post cardiac arrest that ventricular fibrillation persists. The successful application of defibrillation to a patient in need requires the presence of trained personnel, access to definitive care support, and access to a defibrillator.

In simplistic terms, a defibrillator consists of a minimum of three things; a power source capable of storing and delivering energy on demand, cables to conduct energy from the power source directly to the patient, and a connective medium (paddles or pads) to transmit the energy to the patient's body. Edmark, the founder of Physio Control Corporation, produced the first commercially available defibrillators in the early 1960s. These consisted of large cumbersome devices. The first battery powered portable defibrillators appeared in 1968. Further enhancements to these devices followed with the addition of EKG monitors in 1972 and paper rhythm strip recorders in 1974. (Morgan, 1997, p. S-12) The medical community applauded and quickly embraced these improvements in monitor/defibrillator technology, the operation of which required the hands of skilled physicians, nurses, or paramedics. Operators required extensive training in the interpretation of electrocardiograms in order to identify appropriate cardiac rhythm disturbances treatable with defibrillation and to manually charge the machine and deliver the shock. The application of defibrillation to a patient not in cardiac arrest might actually interrupt viable cardiac conduction and cause a cardiac arrest.

Emergency cardiac care practitioners had to be able to discern the difference between EKG rhythms that might improve with defibrillation and those that would not. This involved being able to differentiate between viable cardiac rhythms, shockable cardiac arrest, and non-shockable cardiac arrest.

- Viable Cardiac Rhythms – patients not in cardiac arrest, with an intact heart beat and a coordinated cardiac rhythm should not receive defibrillation.
- Shockable Cardiac Arrest – the most common rhythm seen at the onset of cardiac arrest is ventricular fibrillation. In this state, the heart muscle quivers in response to uncoordinated electrical activity in the conduction system. This quivering action is

incapable of producing a heartbeat. Application of a defibrillation shock is the only way to terminate this uncoordinated electromechanical activity and restore a heartbeat capable of providing blood flow.

- Non-shockable Cardiac Arrest – A heart in non-shockable cardiac arrest will not benefit from defibrillation. These cardiac arrest patients may present with asystole (a complete lack of electrical activity) or electromechanical dissociation (EMD). In asystole, there is no electrical activity to restore with defibrillation. With EMD the patient presents with some type of organized electrical activity, however the heart muscle is incapable of responding due to some type of circulatory, mechanical, or obstructive dysfunction. Because of the presence of organized electrical activity, defibrillation is ill advised. Treatment of non-shockable cardiac arrest consists of CPR and other advanced definitive therapy to correct the underlying dysfunction and restore circulation. (Drake, 2000, p. 18)

What is an AED?

An automatic external defibrillator (AED) is a device capable of accurately identifying and interpreting ventricular fibrillation, advising the user that a defibrillation shock is warranted, and delivering that shock to the patient. AEDs use an internal microprocessor to analyze a patient's EKG automatically. By measuring specific parameters of the EKG such as electrical frequency, amplitude, and/or rate, the device discriminates between shockable and non-shockable cardiac rhythms. (Mercer, 1993, p. 37) The AED calculates this rhythm evaluation by applying a formula called an algorithm. An algorithm goes through a series of analyses to determine the presence of a shockable rhythm by receiving and filtering EKG data, evaluating the information, and voting to determine whether to deliver a defibrillation shock.

AED algorithms perform three basic steps.

1. The algorithm analyzes two or three short (2-3 seconds in length) EKG rhythm segments.
2. The algorithm votes on whether to enable the defibrillator resulting in a decision to do one of the following;
    a) A shockable rhythm does not exist, defibrillation is not indicated
    b) A shockable rhythm exists, the device charges but does not commit to treat
    c) A shockable rhythm exists, the device charges and commits to treat
3. If the shock is not delivered within a specified time period (typically 15-30 seconds), algorithm automatically dumps the charge internally (within the machine).

The accuracy of an AED algorithm depends on two important parameters, sensitivity and accuracy. (Weigel and White, 1994, p. 56) Sensitivity deals with the rate of success an algorithm demonstrates in correctly identifying a shockable rhythm. It is expressed as a percentage by dividing the number of correct shock decisions by the total number of true shockable rhythms.

Specificity evaluates the rate at which an algorithm correctly identifies and withholds a shock from a non-shockable rhythm. It measures how well a device performs with respect to identifying nontreatable rhythms. It is also expressed as a percentage by dividing the number of correct no-shock decisions by the total number of true no-shock rhythms.

While much skepticism accompanied the introduction AEDs in the mid 1980s regarding their ability to detect shockable rhythms with a high degree of sensitivity and specificity, studies by Weaver (1988) and Cummins, et al. (1988) demonstrated sensitivity above 90 percent and specificity of nearly 100 percent. (Morgan, 1997, p. S-12) The ability of these devices to make shock decisions compared favorably with that of paramedics.

In general terms, AEDs come in two versions; fully automated external defibrillators and semiautomated external defibrillators. (Drake, 2000, p. 25) Though both types have the capability of analyzing and identifying shockable and non-shockable EKG rhythms, operating procedures differ slightly between the two.

Fully automated external defibrillators function just as indicated, fully automatic. Once turned on and attached to a patient in cardiac arrest, the AED analyzes the EKG, determines whether a shock is appropriate, prompts the rescuer to clear for the impending shock, and delivers a shock to the patient's heart without any human intervention.

Semiautomated external defibrillators require greater operator participation. Sometimes described as shock advisory defibrillators, these AEDs require the rescuer to respond to prompts or advisories by performing a task or pressing a button in order to proceed through the various steps of patient assessment, rhythm analysis, and shock delivery. Unlike the fully automatic version, the semiautomated AED will not defibrillate automatically. This buffer created by requiring a human authorization to deliver a defibrillation shock makes these devices theoretically safer than the fully automated version. It has also made them significantly more popular.

Early versions of AEDs came with a number of design and technological shortcomings, which effectively relegated their use to highly trained healthcare professionals. Early units were large and heavy. Due to their complexity, they typically required intensive training to teach personnel to properly maintain and operate them. The technology available at the time for rechargeable lead-acid or nickel-cadmium batteries called for rigorous maintenance regimens. Lastly, early AED units were relatively expensive to purchase.

Advances in technology and improvements in design have standardized configuration and simplified operation of AEDs throughout the healthcare industry. These enhancements have reduced barriers to ownership by lowering costs, diminishing training requirements, and curtailing maintenance needs thereby making AEDs commercially available to a much broader group of responders including the lay public. Technological improvements include the following.

- Highly portable
- Intuitive to use
- Durable
- Data collection
- Impedance controlled defibrillation
- Biphasic waveform
- Maintenance Free
- Low cost

Highly Portable: Having gained FDA approval in 1995, the current generation of AEDs on the market have benefited from improvements in microelectronics resulting in considerable reductions in size and weight from those devices that preceded them. Early units weighed up to 20 pounds and took up the same amount of space as a portable typewriter or typical cardiac monitor/defibrillator. Newer ones range between 4-6 pounds and come in the dimensions of a moderately sized textbook.

Intuitive To Use: By making extensive use of audible prompts and visual/text icons, new AEDs provide clear, concise instructions guiding operators through all steps in the therapeutic process. This intuitive design has helped reduce the training requirements for operators and

improved their retention of skills. It has simplified operations to the point where minimally trained non-medical personnel may effectively deploy the units in an emergency situation.

Durable: The electromechanical components of the early AED units have given way to microchip technology allowing for more rugged and durable design configurations to withstand the rigors of prehospital use.

Data collection: Digital data technology has replaced tape-based recording systems in AEDs. Units now have the capability to record and reproduce a comprehensive record of an emergency incident including; EKG data, analysis and treatment decisions, operator actions, event times, and voices from the surrounding area during usage. This enables oversight agencies to provide better quality improvement monitoring.

Impedance Controlled Defibrillation: In order to be effective, a defibrillation shock must reach the heart with enough current to terminate the chaotic activity of ventricular fibrillation. With external defibrillation, this charge must overcome the resistance to current flow, or impedance, caused by anatomical and physiological characteristics of a patient's chest wall. Traditional defibrillators have relied on high dose energy to ensure sufficient current to overcome chest wall impedance. This resulted in some patients with low impedance receiving more electrical current than necessary, increasing their risk of heart damage from the electrical shock. The new AEDs have the ability to measure patient chest impedance automatically and quickly compensate the defibrillation charge for patient impedance variations.

Biphasic Waveform: Prior to 1996, commercial defibrillators almost universally delivered defibrillation shocks in a monophasic waveform. Through means of delivering defibrillation therapy, the electrical current pulse flows in one direction through the body from one electrode pad to another. While therapeutically effective and relatively easy to generate, a

monophasic waveform requires a considerable energy source to deliver a defibrillation shock. This requires heavy, high capacity, rechargeable batteries to energize the defibrillation pulse generator.

In the 1980s the biomedical industry introduced biphasic waveform technology into implantable-cardioverter defibrillators. Instead of flowing in one direction, current delivered in a biphasic waveform reverses direction partway through the defibrillation pulse. As with a monophasic wave, the biphasic wave flows in a positive direction (from a negative electrode to a positive electrode) for a specified duration; however, in a second phase, the device reverses the direction of current flow to a negative direction. Biphasic waveforms require considerably less energy to generate than monophasic waveforms. In a short period of time after introduction, biphasic waveforms became a standard feature on nearly all implantable-cardioverter defibrillators. (Morgan, 1997, p. S-14)

In a limited trial, Green et al. (1995) demonstrated that low energy (171 joules) biphasic waveform shocks delivered externally (transthoracic) achieved a better rate of conversion out of ventricular fibrillation, 100%, than higher energy (215 joule) monophasic waveforms, 79%. Brady et al. (1996) documented no statistical difference between the efficacy of low energy (115-130 joule) external biphasic shocks and high-energy monophasic shocks (200-360 joule). With FDA approval in 1996, the first commercial AED with biphasic waveform technology became available.

The adoption of biphasic technology into AED design, has significantly reduced the requirements for high-power energy delivery capacity. It has allowed manufacturers to incorporate the use of less powerful but highly reliable lithium batteries. Being only a fraction of

the size and weight of rechargeable lead-acid or nickel-cadmium batteries, lithium battery systems have lead to considerable downsizing in the weight and configuration of newer AEDs.

Maintenance Free: Several technological developments have made newer generation AEDs virtually maintenance free and more reliable. The incorporation of lithium batteries has nearly done away with the need for daily hands on testing and complicated battery maintenance schedules required with the use of rechargeable batteries. Computer programs built into newer generation AEDs permit the units to perform automated self-testing and recording on a daily basis. Audible and visual alarms provide indications that a unit has detected an irregularity with a battery or the electrical circuitry requiring operator attention. These features have greatly reduced the common risks of defibrillator failure resulting from poor user vigilance and maintenance, as noted by the FDA which found that fewer than 8 percent of AED users maintained or replaced their rechargeable batteries according to manufacturers' recommendations. (Cummins, Chesemore, and White, 1990)

Low Cost: The initial purchase costs of early AEDs, which varied from $5000-10,000, posed a significant impediment to widespread acceptance and adoption. The aforementioned technological improvements have resulted in dramatic price reductions to a more affordable range of $3000-4000. These price decreases have made AEDs more affordable to organizations and communities throughout the country making purchase cost less of a barrier to widespread deployment.

Evolution of Public Access AED

Prior to 1980, paramedics almost exclusively provided administration of defibrillation in the prehospital environment, performing EKG recognition using manual devices. The idea behind the development of AEDs was to develop a device that would enable basic level

providers to perform defibrillation and thus promote wider availability of this therapy throughout the community. The idea of allowing basic responders to perform defibrillation without extensive training in electrocardiography met with some initial resistance by the medical community. Gradually, lead by visionary pioneers, an expanding body of research eventually demonstrated the efficiency and effectiveness of automatic defibrillator use.

Eisenberg et al. (1980, 1984) documented the success of training emergency medical technicians in treating patients in ventricular fibrillation by administering rapid defibrillation in the prehospital setting. Ornato et al. (1988) identified the cost effectiveness of EMT defibrillation, noting the cost-per-life saved from sudden cardiac arrest by early defibrillation at $2100-2300 as contrasted with $35,000-45,000 for renal dialysis or $50,000 for primary prevention of coronary artery disease. Weaver and Hill et al. (1986, 1988) observed the efficacy of automatic defibrillators in field use. Sedgwick et al. (1993) noted that AED use by EMT-B personnel through the Heartstart program in Scotland, UK resulted in the survival to discharge of 174 cardiac arrest patients. This survival to discharge rate of 10 percent when contrasted to a previous study of sudden death patients in Glasgow showed an improvement of 9 percentage points, strongly suggesting that the availability of early defibrillation had improved the survival rate of out of hospital cardiac arrest significantly.

The marketing of AEDs that did not require care givers to perform rhythm recognition lead to a tremendous expansion in the number of EMT-Defibrillation (EMT-D) programs in the United States. Between 1985 and 1995 the number of such programs grew from 225 to 5716. Likewise, the number of first responder defibrillation programs increased from 10 in 1988 to nearly 1000 in 1995(Newman, 1997, p. S-5) In 1987, the International Association of Fire Chiefs strongly endorsed the concept of early defibrillation by calling for all fire suppression

vehicles to be equipped with AEDs and for all firefighting personnel to be trained in their operation (Murphy, 1987). The American Heart Association echoed this endorsement of the principle of early defibrillation in their 1992 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care stating "that all personnel whose jobs require that they perform basic CPR be trained to operate and permitted to use defibrillators, particularly automated external defibrillators." (JAMA, 1992, p. 2199) By 1994 the U.S. Department of Transportation incorporated defibrillation into the EMT-Basic National Standard Training Curriculum, requiring all basic EMTs to be trained to operate an AED. In 1995 they followed up on this by including an AED module in the First Responder Training Curriculum.

The successful expansion of AEDs into prehospital EMS encouraged proponents of early defibrillation to turn toward the public sector. Motivated by the success of EMT-D programs and encouraged by the simplistic design of newer AED units, the American Heart Association appointed a Task Force on Automatic Defibrillation in 1993. The AHA charged the committee with the following.

- Conduct a conference on automatic external defibrillation
- Evaluate research needed for broader community use of AEDs
- Evaluate the feasibility and desirability for use by healthcare professionals and the lay public

In December 1994, the taskforce conducted a conference on PAD in Washington, DC. As a result of this conference, attendees reached agreement on the general proposition of providing greater public access to defibrillation. Conference Participants formulated 13 specific recommendations that included the following. (Circulation, 1995)

1. Increase public awareness of the issues surrounding sudden death through public education.
2. Prepare specific guidelines for use of AEDs by first responders
3. Collaborate with the Association for the Advancement of Medical Instrumentation (AAMI) and the Emergency Care Research Institute (ECRI) to develop criteria for assessing the safety and efficacy of AEDs.
4. Work with the medical manufacturing industry to define markets, to identify barriers to widespread use, and to promote development of an AED unit that is easy to use, low maintenance, and low cost.
5. Participate actively in device evaluation and the regulatory process, including support for postmarket surveillance.
6. Promote legislation that would permit use of AEDs by the lay public.
7. Form relationships with the National Organization of Police Chiefs and Fire Chiefs to facilitate implementation of AEDs by public services such as firefighters and police.
8. Initiate and obtain funding for collaborative research designed to test the assumption that AEDs will substantially improve outcomes.
9. Advocate the need for research by other agencies.
10. Explore medical device industry funding of research.
11. Develop methods for evaluating AED training.
12. Prepare general guidelines in collaboration with other organizations outlining current and future efforts and desired outcomes of the AED movement.
13. Explore social considerations in the use of AEDs with pediatric victims of sudden cardiac arrest.

The AHA Board of Directors, in June 1995, issued a Statement for Healthcare Professionals on Automatic External Defibrillation recognizing "automatic external defibrillation as one of the most promising method for achieving rapid defibrillation" and identifying public access defibrillation as the next step in strengthening the chain of survival.

The AHA defined public access defibrillation as having two components. (Circulation, 1995, p. 2763)

- The performance of defibrillation by lay persons at home and by firefighters, police, security personnel, and non-physician care providers in the community.
- The use of bystander-initiated automatic external defibrillation in rural communities and congested urban areas where resuscitation strategies have had little success.

The rationale for PAD identifies the two major contributors to survival of adult victims of sudden cardiac arrest as early bystander CPR and prompt defibrillation. Despite the existence of sophisticated emergency medical service systems and efforts to integrate AED technology into the operations of all prehospital EMS responders, there are still many remote rural or densely populated urban areas where conventional EMS responders do not respond fast enough. Proponents for public access AED see training and enabling members of the lay public to administer defibrillation as viable means to reduce delays in the availability of defibrillation to victims of sudden cardiac arrest.

A second conference on PAD held by the AHA in April of 1997 established nomenclature identifying four levels of PAD. These levels consist of the following. (Ornato and Hankins, 1999, p. 297)

1. Level 1 – AED use by traditional first responders who have an inherent duty to respond in a cardiac emergency, such as firefighters and police.

2. Level 2 – AED use by non-traditional first responders who have a secondary duty to respond, including flight attendants, security personnel, and lifeguards.
3. Level 3 – AED used by laypersons that have received training in CPR and AED use who volunteer to respond in a cardiac emergency. This might include office personnel, mall merchants, or family members of high-risk patients.
4. Level 4 – AED use by minimally trained lay witnesses or laypersons with little or no formal training who witness a sudden cardiac arrest and who have access to an AED.

In order to be successful, a good PAD training program should include the following elements; effective public education, wide spread public CPR training, universal precautions training, and education regarding the most effective placement and maintenance of AEDs. (Spivak, 1998, p. 23) In order to promote layperson use of AEDs, members of the public should receive effective education about the safety and efficacy of these devices to reduce their reluctance and concerns over liability. A second component involves educating the public to provide CPR and promoting an understanding of the nature of sudden cardiac arrest and the vital role CPR plays in sustaining a victim until defibrillation becomes available. The third part deals with providing people with training in communicable disease prevention. Finally, the fourth essential element of a PAD training program should make sure that persons using AEDs know how to effectively maintain them and where to place them to assure accessibility.

The Illinois Department of Public Health, in the Automated External Defibrillator Code implemented in April of 2000, identifies the following as essential elements for an AED program. (77 Illinois Administrative Code, 2000)

1. Approved Training – AED training curriculum shall include complete training in CPR according to nationally recognized AHA or American Red Cross guidelines.

2. Recognition of training shall be valid for a period not to exceed two years.
3. Each AED use shall be reported to the local EMS Resource Hospital.
4. Devices shall be maintained in accordance with manufacturer's guidelines.
5. Users of AEDs must register with the local EMS Resource Hospital
6. The EMS Resource Hospital shall submit quarterly quality assurance reports to the Illinois Department of Public Health.

Clinical experience with PAD has been encouraging. In 1991, Quantas Airlines placed AEDs on all of its transoceanic flights and in its main terminals. By 1997 they had recorded a 26 percent (6 of 23) long-term survival rate for victims of sudden cardiac arrest defibrillated with AEDs. (Wolbrink, 1998, p. 1) In the Casino Project, conducted from May 1996 to December 1997, Valenzuela et al. (1998) documented the results of a PAD program involving eighteen Las Vegas gaming establishments. Security officers were trained to use AEDs and to perform CPR in an effort to reduce the interval from collapse of a stricken patient until availability of defibrillation in large casinos and hotel complexes. During the trial, AED users demonstrated a 47 percent (7 of 15 patients) survival rate for victims of cardiac arrest and a 70 percent (7 of 10) rate for victims found to be in ventricular fibrillation initially. Since 1999, when the City of Chicago placed AEDs in public areas throughout their O'Hare and Midway airports, trained users have successfully resuscitated 9 of the 13 cardiac arrest patients treated.

Despite these identified successes, PAD programs appear to have some limitations. The majority of the clinical success with PAD comes from the Level 2 responders (flight attendants, security personnel, etc.) personnel selected and trained by their employers to "take-charge" in an emergency. (Ornato and Hankins) Persons trained to operate at Level 3, who do not ordinarily play such a role on a daily basis, may not be so disposed to act in an emergency, especially if

their training took place 6 or more months previously. Other concerns surmise that laypersons initiating AED care might forget or delay calling 911, compromising patient survival.

Another concern deals with the nature of the local responding EMS system. Sophisticated EMS systems with the ability to deliver advanced cardiac care with short response times may not benefit from PAD. Studies by Shuster et al. (1993), Kellermann et al. (1993), and Sweeney et al. (1998) demonstrated where the addition of AEDs to first responders in two-tier urban EMS systems failed to improve survival in patients experiencing sudden cardiac death. A final limitation to the widespread implementation of AEDs involves determining the target population for PAD. Litwin (1987) in Seattle noted that the majority of cardiac arrests did not occur in public but rather happened in the home. In order to assess the cost-benefit of PAD, agencies should assess the prevalence and frequency of sudden cardiac arrest in public places. Therefore, placement should focus on high-risk areas with dense populations, lengthy response times, and relatively high prevalence of sudden cardiac arrest.

PROCEDURES

This project attempted to analyze key aspects of community need with respect to the implementation of a PAD program. In doing so it endeavored to identify existing community as well as fire service environmental conditions to be considered in developing a plan to address the need for public access defibrillation in Naperville. The study employed descriptive research to;

- Examine current technical data on the topic of automated external defibrillators and public access defibrillation,
- Describe recent historical experience of the Naperville Fire Department in treating victims of sudden cardiac arrest.

- Describe the characteristics of other agencies and organizations that have implemented PAD programs.

A literature review was conducted. References included sources identified through the National Fire Academy Learning Resource Center in Emmitsburg, MD, on-line information obtained through the American Heart Association website (www.americanheart.ort), and relevant aspects of Illinois regulatory law.

Research Studies

Several studies were conducted in conjunction with this project. These included the following.

- A retrospective review of past Naperville Fire Department response records to cardiac arrest situations over a three-year period,
- An evaluation of patient care reports for cardiac arrest patients treated by Naperville Fire Department personnel in 1999,
- A survey of selected agencies and organizations in the Chicago metropolitan area that had implemented a PAD program.

The first study consisted of a retrospective review of patient care records (EMS Report Forms) to identify two parameters; the location of cardiac arrest incidents within the community requiring Fire Department emergency response and the underlying medical nature of the call as identified by the responding paramedics. This evaluation reviewed documents for the years 1997, 1998 and 1999. In accordance with the Illinois Department of Public Health rules, Naperville Fire Department personnel must complete an approved EMS Report Form for each patient contact. This consists of a hand-written report on a standardized form. A copy of the standard EMS Report Form utilized by Naperville Fire Department paramedics is found in

Appendix A. Paramedics leave copies of this report at the receiving hospital of final destination and retain the original for Fire Department records. The original copies, served as the basis for review and evaluation. Requirements regarding the confidentiality of patient medical records were strictly observed.

Besides relevant patient information, the report form requires emergency care providers to identify the occupancy type of the location where the incident occurred. The report writer notes by checking off one of five choices on the report form. As defined by the Naperville Fire Department, those choices include the following.

- Residential: Responses to residences such as single or multi-family structures,
- Industrial: Responses to manufacturing and processing type occupancies not open to the public, including factories, warehouses, garages, body shops, and construction work sites,
- Commercial: Business occupancies open to the general public for the purchase and distribution of goods and services, encompassing structures housing restaurants, retail sales, hotels, medical offices, and general office activities,
- Institutional: Occupancies providing a structured setting for the provision of specific types of services in a residential or non-residential environment such as schools, hospitals, and skilled nursing facilities.
- Highway: Incidents occurring on public roadways or within the public way.

In order to satisfy data collection requirements, dictated by the Illinois Department of Public Health, the EMS Report Form lists a number of data fields at the bottom of the form. These data fields permit the coding of a variety of incident information for subsequent computer entry and statistical analysis. For the purposes of this review, Data Field #2-Nature of Call, was

evaluated in order to document the specific nature of the illnesses or medical complaints associated with cardiac arrest incidents.

As defined by the Edward Hospital Emergency Medical Services System, the local oversight agency for the Naperville Fire Department, the data category "Nature of Call" refers to a generic categorization of the medical basis for the call. EMS personnel completing the EMS Report Form are required to categorize the nature of call by selecting an appropriate data code from one of six general fields. Further specificity is gained by subdividing the six fields into 22 related sub fields. For purposes of this project however, nature of call entries were documented in accordance with whichever one of the six general fields were recorded on the EMS report. The six "Nature of Call" data fields include the following.

- Cardiac
- Respiratory
- Medical
- Trauma
- Obstetric
- Pediatric

The second survey involved a more in-depth evaluation of EMS report form data. Using the Utstein method (Cummins, 1993, p. 37) for reporting cardiac arrest information, a retrospective review of patient care reports for cardiac arrest patients treated by the Naperville Fire Department was conducted for the year 1999. Appendix B contains an outline of the Utstein criteria. Key criteria for selection required that only cardiac arrest patients treated with full resuscitative measures, including but not limited to CPR, be considered. This exercise attempted to quantify the number of sudden cardiac arrest resuscitations attempted by Naperville Fire

Department personnel, the number of patients defibrillated, and the number of patients discharged from the hospital. Table 1 outlines the specific Utstein criteria tabulated.

The final survey conducted in conjunction with this project consisted of distributing a questionnaire to a selected group of agencies and organizations, which had successfully implemented a PAD program. For this survey, the study population was composed of organizations and agencies from the Chicago metropolitan area that had placed AEDs in their workplace. A listing of 52 agencies was obtained from the Chicago office of the American Heart Association, 208 S. LaSalle Street, Suite 900, Chicago, IL 60604 (312-346-4675). In order to validate information on the list, attempts were made to contact the identified agencies and organizations by telephone to confirm agency name, contact information, AED placement, and the name of the program coordinator. This effort yielded a list of credible contacts (n=43) for a survey sample. Agencies and organizations represented included 21 private corporations or groups, 13 police organizations, and 9 other governmental agencies. No fire departments were surveyed. The results of specific agency responses were kept confidential.

Questionnaire Design

The survey instrument used in evaluation of the sample population consisted of a one page, 14 point questionnaire mailed to all 43 agencies and organizations. The questionnaire, developed to gather data from the study population on AED placement and program implementation, is reproduced in Appendix C. Survey questions prompted respondents to answer a series of close-ended questions by ether choosing an answer from a list of selections or by providing specifically requested information. Besides asking two questions for the purpose of identifying agency contact personnel for possible follow-up purposes (responses optional), the instrument confined questions to inquiry about certain operational practices of the agencies or

organizations of the study population relative to the placement of AED units in the workplace. Questions related to the following.

- Year of AED implementation
- Type of setting
- Number of units deployed
- Area protected
- Placement methodology
- Primary users
- Number of personnel trained
- Training curriculum used
- Number of uses, defibrillations, and successful resuscitations

Limitations

The two retrospective studies conducted as part of this project attempt to gather data relative to the organizational experience of the Naperville Fire Department in responding to and treating victims of sudden cardiac arrest. Information gleaned from these evaluations depicts circumstances specific to the Naperville Fire Department as influenced by unique community conditions. They provide a limited view of the experience of one specific agency, affording a limited opportunity for generalization to the experiences of the fire service as a whole in the treatment of sudden cardiac arrest. Accuracy of the results of both internal reviews depended upon the proficiency of Naperville EMS personnel in completing the EMS Report Form.

The definitions for the five listed occupancy types serve only as broad definitions when considering the various permutations of homes, businesses, government agencies, and

commercial enterprises in a community the size and diversity of Naperville. The chance for overlap in categorizing of occupancy types exists to a limited degree.

The time parameters recorded for the Utstein comparison, specifically for response times and times to defibrillation, come directly from the EMS Report Form filled out by Naperville Fire Department personnel. Actual response times encompassing the period from the time of 911 center notification until unit arrival on the scene are taken directly from the computer aided dispatch data recorded in the PSAP and copied to the EMS Report by ambulance personnel. Recording space on the written EMS report only permits documentation in the hour and minute format. As a result, these times are accurate only up to the minute, allowing for up to a 59-second variance in recording. Likewise, Naperville Fire Department paramedics manually transfer times for defibrillation events from the data recorder of the cardiac monitor/defibrillator utilized to assist in completion of the written report. The internal clock of these units is synchronized with the CAD time stamp to allow for consistent reporting. Unfortunately, this time recording is also only tallied on the written report in hour and minute format as well.

Several procedural considerations limit the effectiveness of the survey questionnaire. One consideration concerns dropout bias. "Questionnaires sent through the mail often have a very low response rate . . . A dropout bias (that is a distortion caused by nonreturned questionnaires) is always possible, but is even more likely with a low response rate." (Katzer, Cook, and Crouch, 1991, p.183) Another limitation deals with the nonrandom selection of the survey population. The purposive sampling method utilized, though straightforward and effective, provides a weak basis for generalized conclusions beyond the identified study population.

RESULTS

This project endeavored to gather information relative to the development of public access defibrillation programs, the primary goal being to determine the need for implementing such a program in Naperville. This needs analysis was based on information gained through a literature search, an evaluation of community conditions, and a survey of successfully implemented public access defibrillation programs. Study efforts undertook to answer four research questions in an attempt to identify change forces driving the needs and desires for public access defibrillation. Questions attempted to quantify cardiac arrest survival data, distinguish structural elements of public access defibrillation, determine target populations, and describe characteristics of successful PAD programs. Once documented, the answers to these questions will form a basis for future planning efforts.

Research Question 1: What is the prevalence of sudden cardiac arrest patients treated by the Naperville Fire Department? An examination of current conditions is paramount to any evaluative process. An adequate assessment of change needs requires a thorough description of the present state of being. In this instance, the extent of the threat of sudden cardiac arrest to residents of Naperville and the community's success in dealing with that threat provides an appropriate benchmark for analyzing the need for change. The two retrospective reviews of Naperville Fire Department EMS Report Forms attempted to provide the necessary answers.

The initial review of these reports served to quantify the number of cardiac arrest patients, the location of onset, and the medical nature of calls associated with sudden cardiac arrest. As documented in Table 1, the Naperville Fire Department attempted 196 resuscitations of sudden cardiac arrest patients from 1997 through 1999. This figure represents just 1.13 percent of the 17,196 patients treated by Naperville EMS responders during that same time

period or a ratio of 1 cardiac arrest resuscitation for every 88 patients seen. Cardiac events, accounted for the vast majority of all resuscitations. Responding paramedics documented cardiac related conditions as responsible for 85.20 percent (167) of all calls associated with sudden cardiac arrest. Medical emergencies at 6.12 percent (12) were listed as the next most common, followed by trauma related causes (4.6%/9), respiratory problems (3.06%/6), and pediatric patients (1.02%/2).

Further review of the data in Table 1 shows that most cardiac arrest events occurred in the home. During the three-year period reviewed, 62.24 percent (122) of all cardiac resuscitations occurred in single or multiple family residences. Institutional settings, at 26.02 percent (51) proved to be the second most common location. Cardiac arrests occurred on the highways (6.63%-13), in commercial settings (4.60%-9), and in industrial occupancies (0.13%-1) with much less frequency.

TABLE 1

OCCURRENCE OF SUDDEN CARDIAC ARREST

Year	**1997**		**1998**		**1999**		**Total**	
Patients Treated	5552		5563		6081		17,196	
SCA Resuscitations	73		54		69		196	
Nature of Call								
Cardiac	58	79.45%	51	94.45%	58	84.06%	167	85.20%
Respiratory	2	2.74%	0		4	5.80%	6	3.06%
Medical	10	13.10%	0		2	2.90%	12	6.12%
Trauma	3	4.11%	2	3.70%	4	5.80%	9	4.60%
Obstetric	0		0		0		0	0.00%
Pediatric	0		1	1.85%	1	1.44%	2	1..02%
Location of Call								
Residence	50	68.49%	32	59.26%	40	57.97%	122	62.24%
Institutional	17	23.29%	12	22.22%	22	31.88%	51	26.02%
Commercial	3	4.11%	4	7.41%	2	2.90%	9	4.60%
Industrial	1	1.37%	0		0		1	0.51%
Highway	2	2.74%	6	11.11%	5	7.25%	13	6.63%

A second retrospective review of EMS Report Forms was conducted to elicit cardiac arrest survival data. This more in depth evaluation consisted of a one-year look back of cardiac arrest patients. Applying the Utstein criteria for the uniform reporting of cardiac arrest data, this review documented information for the period of January 1, 1999 through December 31, 1999. Only cardiac resuscitation attempts were evaluated. Obviously dead patients, such as those with evident signs of long term death, injuries inconsistent with life (decapitation), or patients with "do not resuscitate" orders, who received no resuscitative measures were documented, but not counted in the survey analysis. Table 2 documents the data gathered from this evaluation.

Survey data demonstrates that the Naperville Fire Department responded to a total of 116 cardiac arrest patients in 1999. Of these incidents, emergency responders initiated resuscitation efforts on 69 patients (59%). The mean average response time from the initiation of the 911 request for assistance until the arrival of advanced life support care on the scene was 3:52 minutes. The mean average age of cardiac arrest patients treated was 62 years. Further analysis of age data shows patients in age range of 71-80 years as having the highest incidence of sudden cardiac arrest (29 %/20) of patients treated, while patients 0-20 years (2.89%/2) had the lowest. As a whole the occurrence of sudden cardiac arrest increased dramatically for patients aged 51 and older, accounting for 78.27 percent (54) of all sudden cardiac arrests treated.

With respect to sex of the patient, males suffered nearly a two times greater incidence of sudden cardiac arrest than females, 63.77 percent versus 36.23 percent. Information tabulated from EMS Report Forms indicated the overwhelming majority sudden cardiac arrests resuscitated resulted from a cardiac etiology as opposed to a non-cardiac etiology (84.06% to 15.94%). The initial onset for most sudden cardiac arrest events evaluated from the study

population were unwitnessed (53.62%/37). Bystanders witnessed 31.89 percent of the cardiac arrests (22), while emergency response personnel observed the remaining 14.49 percent (10).

TABLE 2
Cardiac Arrest Survival Data for 1999

Population Served by EMS		145,838	
Confirmed Cardiac Arrests		116	
Resuscitations Not Attempted		47	
Resuscitations Attempted		69	
Average Response Time		3:52	Minutes
Age (Average)			62.25
Ages (Fractile)	Ages 0-20	2	2.89%
	Ages 21-30	5	7.24%
	Ages 31-40	4	5.80%
	Ages 41-50	4	5.80%
	Ages 51-60	12	17.39%
	Ages 61-70	12	17.39%
	Ages 71-80	20	29.00%
	Age $\geq$ 81	10	14.49%
Female		25	36.23%
Male		44	63.77%
Cardiac Etiology		58	84.06%
Noncardiac Etiology		11	15.94%
Arrest Witnessed (bystanders)		22	31.89%
Arrest Witnessed (EMS)		10	14.49%
Arrest Unwitnessed		37	53.62%
Initial Rhythm V-Fib		16	23.19%
Initial Rhythm VT		1	1.45%
Initial Rhythm Asystole		25	36.23%
Initial Rhythm Other		27	39.13%
Bystander CPR		30	43.48%
No Bystander CPR		39	56.52%
Return of Circulation		12	17.39%
No Return of Circulation		57	82.61%
Resuscitation Efforts Ceased			
	In Field	7	10.14%
	In ER	53	76.82%
Patient Admitted		9	13.04%
Patient Discharged Alive		4	5.80%

Paramedics noted asystole as the most common initial EKG rhythm seen upon their arrival at the side of the patient (36.23%/25). Ventricular fibrillation accounted 23.19 percent

(16) of the initially observed EKGs, with only one case of ventricular tachycardia being observed. While the remaining EKG category tallied, "Other Initial Rhythm," accounted for 39.13 percent (27) of the patients treated, further breakdown of this field shows it included a variety of viable and nonviable rhythms. Twenty of these patients presented in cardiac arrest with an EKG of pulseless electrical activity or idioventricular rhythm, while 6 others presented with a variety of viable EKG rhythms prior to suffering a sudden cardiac arrest witnessed by the EMS providers.

Upon their arrival, EMS responders found bystanders administering CPR to these patients in 43.49 percent (30) of the cases. As a result of resuscitation efforts, 12 patients (17.39%) had a return of spontaneous circulation during the resuscitation effort. Nine of these patients were hospitalized to the cardiac care/intensive care unit for further definitive care resulting in an admission rate of 13.04 percent. All had a sustained heart beat and intact blood pressure. Four of these 69 patients (5.80 %) survived their sudden cardiac arrest through to hospital discharge.

Research Question 2: What are the essential components of a public access defibrillation program? Information gleaned from the literature review adequately clarifies the requirements of a PAD program. Any PAD program implemented by the City of Naperville using AEDs must comply with the requirements of Illinois Statutory Law. The Illinois Automated External Defibrillator Act (410 ILCS 4/) and the administrative rules required by this act as promulgated by the Illinois Department of Public Health through the Illinois Administrative Code (Automated External Defibrillator Code; Title 77, Chapter 1, Subchapter f, Part 525) specifically address the use of AEDs by medical and non-medical personnel. The Illinois AED Act (effective 1/1/2000) addresses the following components of AED use; training, equipment maintenance, medical oversight, Illinois Department of Public Health responsibilities, and exemption from civil

liability. The more comprehensive Automated External Defibrillator Code enumerates the following requirements.

1. Approval of Training Programs
    a) Curriculum shall include instruction in CPR in accordance with nationally recognized guidelines.
    b) Instructors shall successfully complete an AED instructor training program approved by IDPH.
    c) Instructors shall renew qualification every two years.
2. Recognition of AED Users
    a) Users shall successfully complete a course of instruction in accordance with standards of the American Red Cross or the American Heart Association or,
    b) Users shall be licensed to practice medicine in all its branches.
    c) Users shall renew recognition as an AED user no later than every two years.
3. Incident Reports
    a) Each use of an AED shall be reported to the EMS System Resource Hospital.
    b) Reports shall include information on the following.
        i. Date
        ii. Time
        iii. Name of person who determined unresponsiveness
        iv. Time 911 notified
        v. Initial heart rhythm
        vi. Number of times patient was defibrillated
        vii. Name of the person who defibrillated

viii. Final EKG rhythm at the time of arrival of the first emergency response vehicle

- Was the patient breathing?

-Did the patient have a pulse?

c) Reports shall be forwarded monthly to the local EMS System Resource Hospital.

4. Maintenance and Oversight

a) Persons acquiring AEDs shall take reasonable measures to ensure that;

i. The AED is used only by trained users,

ii The AED is maintained and tested according to manufacturer's guidelines,

iii The AED is registered with the local EMS Resource Hospital,

iv Persons who use an AED shall activate the EMS system (call 911) as soon as possible.

b) Persons possessing an AED shall notify the local emergency communications or vehicle dispatch center of the existence, location, and type of AED.

c) The local EMS System shall notify local ambulance providers of AEDs in the provider's service area.

5. Quality Assurance

a) The EMS System Resource Hospital shall submit information on the use, outcome, and adverse effects of AED use to IDPH on a quarterly basis.

b) Tapes of conversations recorded by an AED shall be confidential.

Beyond compliance with statutory requirements of AED use, a PAD program should address the model program components noted by Spivak (1998, p. 23). Programs should take into account; effective education for users on the safety and efficacy of AEDs, intensive public

CPR training, training on infection control and universal precautions, and effective integration with the EMS system. Education efforts should consider the type of AED user contemplated in accordance with the four user levels identified by the second AHA Public Access Defibrillation Conference held in 1997. Users might range from traditional first responders such as trained public safety personnel (firefighters and police), non-traditional responders (flight attendants, lifeguards, or security personnel), volunteer lay persons, and individuals with no formal training who witness an event. Each level of user will have unique requirements for training, application, and integration into the EMS System.

Research Question 3: What community groups should be included in an implementation program? PAD implementation for Naperville should be broad based in terms of inclusion. Efforts should begin with the most obvious agencies; whose involvement is required by law and those who traditionally provide emergency medical services to the community. This would include the Illinois Department of Public Health, the Edward Hospital Emergency Medical Services System, and the Naperville Fire Department. Furthermore, because of the training requirements imposed by law, involvement from appropriate standards and educational organizations such as the American Heart Association or American Heart Association should be elicited.

Analysis of where sudden cardiac arrest incidents historically occur provides another means of identifying potential participants in a public access program in the community and perhaps a prioritization for contact and involvement. Information listed in Table 2 on the location of cardiac arrests showing incidence by location gives an indication of where PAD efforts might effect outcome most. With the majority of cardiac arrests occurring in residences, efforts should seek ways to reduce response times. It is beyond the scope of this project to

provide a resource deployment analysis for emergency medical response units, the addition of which typically requires the expenditure of considerable capital sums. Program efforts should, however, seek to utilize available non-medical responders such as Naperville police officers. Because of their presence on the street 24-hours per day and their deployment throughout the community, they may provide a means to cost-effectively reduce response times in lieu of proposing the deployment of additional EMS units. Their involvement could potentially enhance Fire Department response to cardiac arrest incidents not just in residences, but to commercial occupancies and highway occurrences as well.

With more than 26 percent of cardiac arrests occurring in institutional settings such as skilled nursing facilities and assisted elderly living centers, implementation efforts should seek the support of these facility administrators and the involvement of their medical and custodial staffs.

The character of the community should also be considered when implementing a PAD. Due to a favorable economic climate and location along major transportation corridors, Naperville is home to a considerable business community including numerous retailers, large hotels, and high volume employers operating from large office buildings and expansive corporate campuses. This commerce community has an intense interest in maintaining the safety of their customers and employees. Efforts should seek to involve them as well, either individually or through the Naperville Chamber of Commerce or the Downtown Business Association.

Research Question 4: What have other organizations done to successfully implement public access defibrillation programs? In order to garner feedback on the experiences of other organizations that have implemented their own AED programs, a survey questionnaire was sent

to 43 different agencies listed by the Chicago Office of the American Heart Association as currently supporting active AED programs. The make up of this small sample population consisted of 21 organizations from the private sector and 22 from the public sector.

Response to the survey questionnaire yielded a 60.47 percent (26) return rate. Further breakdown of these responses showed a return rate of 52.38 percent (12/21) from private sector respondents and a 63.67 percent (14/22) rate from public sector participants. Representation from the private sector respondents varied greatly but included a major utility company, a nationally renowned research laboratory, a casino, several large corporate offices, and three golf courses. The population of public sector respondents consisted of 9 municipal police agencies and 5 other government agencies including a park district fitness center, a junior college campus, a municipal zoo, and a major metropolitan airport authority.

Table 3 details the tabulated results of the survey data, giving total survey outcomes as well as breaking down responses into three individual groupings for private sector, police organizations, and other government agencies.

Concordant with the development of present generation AED technology, none of the participants surveyed had implemented AED programs prior to 1996. One questionnaire did not identify a date of implementation. Most agencies (11/26) indicated having placed AED units during 2000. The overwhelming majority of private sector respondents (10/12) stated their placements took place during this year while most public sector organizations (10/14) implemented programs between 1998-1999.

Deployment settings varied greatly among survey participants. This was not suprising considering the diversity of employment environments represented. Result totals found the most common placement for AED units to be in agency vehicles (11), followed by placement in public

areas (10), office settings (7), industrial occupancies (3), and commercial spaces (2). Placement settings among the private sector agencies showed the most variety with breakdowns fairly evenly split between public access, offices, industrial workplaces, and commercial settings. None of the private sector users utilized agency vehicles for AED deployment.

TABLE 3

AED Survey

Agency Type	Private	Police	Other Govt.	Total
Year AED Implemented				
2000	10	1	O	11
1999	1	4	1	6
1998	0	2	2	4
1997	1	0	0	1
1996	0	1	3	3
Setting Deployed				
Public Access	5	1	4	10
Office	5	1	1	7
Industrial	3	0	0	3
Commercial	2	0	0	2
Agency Vehicles	0	9	2	11
# of AEDs Deployed	42	85	99	226
AED:Population	19,659	435,500	474,500	929,659
Intended Users				
Trained Employees	6	2	3	11
Police Officers	0	9	0	9
Security	1	0	1	2
Trained 1st Responders	3	0	2	5
Public	1	0	1	2
Training Curriculum				
AHA	8	5	4	16
ARC	2	2	0	4
Other	1	3	1	5
# of Uses	1	38	23	62
# of Cardiac Arrests	1	33	16	50
Patients Defibrillated	1	27	14	42
Successful Resuscitations	1	5	9	15

All 9 police agencies uniformly related placement in squad cars as their primary method for deployment of AED units, though one agency noted placement in a jail setting while another provided a unit within the office area the agency. Other government participants utilized

placement within public access areas (4) as the most common means of deployment with two indicating usage of agency vehicles and one in an office setting.

The number of AED placements was somewhat staggering. From the 26 organizations represented by the survey respondents, a total of 226 AED units were utilized; 42 within the private sector, 85 among police agencies, and 99 by other government agencies. Of the 5 other government agencies participating, one provider had noted placing 80 AED units within their two facilities. The estimate of daily populations served by these AED programs varied between the types of agencies. While the overall total equaled 929,659 persons, the private sector providers protected the smallest population at 19,656 while the governmental providers served much larger populations of 435,500 for police departments and 474,500 for other government agencies.

Private sector populations ranged from a low of 20 to a high 1900. The mean average ratio of persons protected per AED unit was 1:408. Police agencies tended to protect much larger populations with the smallest being 6,500 persons to a high of 100,000. Among police departments the mean average ratio of AEDs to population was 1:5,335. This average encompassed a range of 1:2,142 on the low end to 1:25,000 on the high side. Ranges for population served by other government agencies varied from 2500 to 300,000 daily. The mean average ratio for units to population equaled 1:4,792 and ranged from 1:833 to 1:14,545.

All respondents indicated that the primary users of AEDs would be trained employees. Two agencies, one in the private sector and one in the government sector, also identified members of the public as intended users as well. The most common users identified included trained non-medical employees (11), police officers (9), trained first responders (5), and security personnel (2).

Survey participants indicated the American Heart Association training curriculum as the most common program used (16), followed by some type of custom designed program (5), and the American Red Cross program used most infrequently (4).

Taken together, the 26 respondent agencies reported a total of 62 AED uses. Of these, 50 involved cardiac arrest patients with 42 patients receiving defibrillation from the AED users. Rescue efforts resulted in 15 successful resuscitations equaling a save rate of 30 percent for all cardiac arrests and a rate of 35.71 percent for patients with electrically treatable rhythms.

DISCUSSION

Limitations of this study concern the survey methodology and the size of the sample survey. The two retrospective studies dealt only with an evaluation of data from EMS Report Forms generated by the Naperville Fire Department, the goal of this research being to document the historical experience of the Naperville Fire Department in responding to and treating patients suffering from sudden cardiac arrest. As such, the results should not be construed as representative of the experiences of other fire service EMS agencies.

Likewise, the survey questionnaire, sent to agencies using AEDs, was a non-random type survey of a selected population. It was distributed to elicit information on the experiences of these specific organizations. The prospective nature of the population surveyed, the small size of the sample, and the low response rate (26/43 – 60.47%) limits the ability to draw generalized conclusions from data gathered to observations of the respondent population only.

Having noted the above limitations, study results appear to indicate a potential benefit to promoting public access defibrillation within the community. Data on the occurrence of sudden cardiac arrest in Naperville, showing nearly two-thirds of all cases occurring in the home, appears consistent with the research experience of Seattle (Litman) reported earlier. Ornato and

Hankins (1999) cite that three-fourths or more of cardiac arrests occur in the home. They identify this as one of the arguments foisted against implementing PAD programs. The mere fact that most cardiac arrests do not occur in public places severely limits the potential impact of such programs. This represents an important consideration. While it does not detract from the need to address defibrillation availability in public venues, it does identify the area of most need and a priority for effort. Based upon the historical location data presented in Table 2 and due to the lack of high volume public places in Naperville such as airports, enclosed shopping malls, or large sports arenas, efforts to concentrate the placement of AEDs in publics spaces are unlikely to have a significant impact on cardiac arrest survival outcomes. This could potentially produce unsatisfactory results at variance with the raised public expectations commonly generated by the publicity that accompanies the implementation of a major public health initiative.

Initial efforts for a PAD program should focus on improving the American Heart Association chain of survival by reinforcing the grid of first responders capable of providing defibrillation. While all Naperville Fire Department response vehicles including ambulance, engine, ladder, and squad companies have defibrillation capability, the Naperville Police Department has yet to embrace this technology. The addition of police responders equipped with AEDs and available 24 hours per day could contribute to reduce response times to sudden cardiac arrest events in residences as well as on the highways. This effort would require the Fire Department to partner with the Police Department in eradicating a long-standing line of demarcation between traditional roles. Establishing such a relationship with the police would be consistent with one of the recommendations of the 1994 American Heart Association Public Access Defibrillation Task Force.

Location data appears to indicate that the second priority location for AED placement should concentrate on institutional settings that include skilled care nursing homes and elderly assisted living centers. With in residence staff available 24 hours per day, AED availability could reduce the time from onset of cardiac arrest to defibrillation considerably. This represents another opportunity for the Fire Department to advocate the cause of PAD.

Promoting AED use by police responders and institutional nursing staff provides two potential advantages. One, it addresses the issue by educating a population individuals already trained as emergency responders or possessing some degree of medical training. Secondly, it focuses efforts toward reducing response times for defibrillation availability in occupancies (residences, institutional, and highway) where more than 94 percent of sudden cardiac arrests have historically occurred in the Naperville community.

Study results attributing more than 85 percent of sudden cardiac arrests to cardiac causes is consistent with AHA statistics showing heart disease in general and sudden cardiac arrest specifically as a leading cause of death in Americans. These results however could be questioned to some degree as they are based on the subjective impressions of paramedics, as noted in their written patient care reports, and not on objective post morteum examinations. Nevertheless, they do highlight the need for the Fire Department to promote increased awareness to the public of the risks of heart disease and sudden cardiac arrest as well as the benefits of early 911 access, early CPR, and early defibrillation.

Results for the study on cardiac arrest survival data for 1999 also appear to be consistent with the broader national experience, which shows the average survival rate of victims of sudden cardiac arrest as being 1 in 20. Despite moderately good mean average response times of less than 4 minutes (3:52 minutes) to sudden cardiac arrest events, prehospital care efforts in

Naperville produced a success rate for victims to hospital admission slightly more than 13 percent and only 5.8 percent for patients discharged from the hospital alive. While this may indicate unacceptable results on the part of a highly capable advanced cardiac life support provider, limitations of the study cannot account for the successes of preventative aspects of prehospital care provided. It cannot identify the number of cardiac arrests prevented through the rapid response to and aggressive case management of cardiac complaints. This represents a significant point as the data shows that EMS responders witnessed more than 14 percent (10) of the resuscitated sudden cardiac arrests evaluated in the study. Perhaps more importantly, it stresses the importance of not judging EMS systems solely on the outcome of the treatment of patients who suffer a terminal event such as cardiac arrest prior to the arrival of emergency responders. Nonetheless, model programs exist, such Seattle, which has demonstrated more dramatic success in the resuscitation of sudden cardiac arrest. These should continue to serve as a benchmark not just for judging performance, but for outlining a strategy for improvement.

The high number of patients recorded as having an initial EKG rhythm of asystole (25 – 36%) no doubt had an effect on the low percentage of patients discharged alive. When combined with the relatively small number of patients, 23 percent (16 of 69), identified with an initial EKG of ventricular fibrillation by paramedics, this suggests a possible benefit to decreasing the time from cardiac arrest to defibrillation through AED use. It is plausible to surmise that reduced response times could result in more patients being reached before their EKG deteriorated from ventricular fibrillation to asystole, though no direct evidence in the study indicates this to be the case.

Information generated from the AED survey questionnaire distributed to agencies managing active programs shows a dramatic rise in the number of programs implemented in

2000 particularly among the private corporations. This increase in interest coincides with enactment of the Illinois AED ACT, which effectively lowered the legal barriers for AED program implementation by permitting use by non-medical personnel and providing specific exemptions from civil liability for trainers, users, and owners of AEDs. This rise in AED popularity indicates a need for the Fire Department to anticipate a continued increase in interest on the part of the business community for information, training, and assistance in implementing AED programs within their facilities. For the Fire Department, this represents an opportunity for interaction with the business community, for promoting PAD and citizen CPR, and for spreading public education messages about fire and life safety.

Overall, the 26 survey respondents documented a total of 15 successful cardiac resuscitations with AED use by their employees. Though questionnaire responses indicated successes with AED use in both the private and public sector organizations, the public sector agencies appeared to have much greater success rate (14:1) over the private sector. This most likely had to do with the significantly greater population served by the public sector agencies and with the unique nature of the essential services they provide, which includes emergency response duties particularly for the police departments. Although the category for other government agencies showed the most cardiac resuscitations (9), only one of the 5 respondent organizations documented all 9 saves. This particular agency, a municipal agency managing two major airports, also accounted for more than 80 percent of the AEDs deployed by “other government agencies” and more than 63 percent of the population served.

Besides this one uniquely successful respondent, police agencies as a group appeared to have the most opportunity to utilize AEDs in the treatment of cardiac arrest patients. Police departments demonstrated the most uses of AEDs (38), encountered the highest number of

cardiac arrest patients (33), defibrillated the most patients (27), and documented a successful resuscitation rate of 18 percent (5). Survey data did not indicate whether respondents interpreted successful resuscitations as patients admitted to the hospital or patients discharged from the hospital. Though not a true correlation, the success rate for police resuscitations of 18.52 percent with AED use and CPR appears to better the Naperville Fire Department success rate of 13.04 percent to patient admission to the hospital using advanced cardiac life support. At the very least this indicates a need to further consider and evaluate police use of AEDs in Naperville.

RECOMMENDATIONS

The intent of this project was to analyze the need for implementing a PAD program for the City of Naperville, Illinois. In so doing it attempted to identify internal conditions, distinguish external influences, and determine potential organizational change requirements. Research efforts examined the prevalence of sudden cardiac arrest in the community, looked into the essential components of a PAD program, described community groups to be involved in an implementation plan, and gauged the experience of other organizations that have successfully implemented PAD programs. Based on the analysis provided, the following recommendations derive from this project associated with developing a proposal for implementing public access defibrillation in Naperville.

1. Identify areas for potential deployment of AED units among City of Naperville agencies to increase the availability of defibrillation in the community.
2. Examine the economic impact of AED deployments for public access defibrillation on the City budget.
3. Elicit support from senior Fire Department staff.

4. Seek the involvement of other allied City departments such as the Police Department and the City Manager's Office.
5. Develop a core group of AED/CPR instructors.
6. Promote public access defibrillation to the private sector.

Acknowledging that public access defibrillation offers potential benefits for improving survival rates for cardiac arrest, initial efforts at implementation should seek to identify those City agencies or properties that serve to broaden the availability of defibrillation to the public or help to promote the benefits of AEDs to the community. This should include a recommendation to place AED units in police patrol units to strengthen the response network and shorten response times to cardiac emergencies. It should also seek to deploy AEDs in highly utilized public buildings such as the Municipal Center, the Public Libraries, and Park District facilities. Installment in these buildings offers two advantages. One, it makes early defibrillation available in highly utilized public spaces and two, placement makes the units highly visible helping to promote and advertise PAD to the public.

As a prelude to developing plans for implementation, information on the economic impact associated with PAD programs should be developed for evaluation. Review must include not only the price tag for the AED units themselves, but the costs for training, installation, maintenance, and program promotion as well. This permits a thorough assessment of costs vs. benefits.

As the lead City agency involved in the delivery of emergency medical services to the community, the Fire Department must take the lead role in promoting a PAD initiative. Efforts to implement PAD will fail unless strongly supported by senior Fire Department staff as well as the rank and file membership of the organization. Such support cannot be taken for granted.

Information regarding the virtues of PAD, the safety and efficacy of AEDs, and the limitations of deployment should be distributed to all employees. Training and orientation presentations must address irrational fears about loss of status or changes in operational procedure. Since the deployment of AEDs for public access cuts across traditional lines of service delivery, efforts need to garner support from involved agencies such as the Police Department and most especially, the City Manager's Office to promote the initiative from within.

In order to effectively promote and control the message of PAD, the Fire Department should develop a core group of instructors for AED training. Not only will they provide instruction to Fire Department personnel and other City staff, but they may serve as ambassadors for PAD to private sector organizations seeking to develop their own programs.

Once the City has identified the overall need for PAD and implemented specific responses to satisfy those needs, then efforts should turn to active promotion in the private sector. Promotional efforts will carry greater weight if the City can demonstrate credible evidence of commitment by having its own house in order. Most likely, with the current availability of and interest in AEDs on the increase, the efforts to provide greater availability of defibrillation through public sector providers will coincide with the desires of private sector organizations to secure the same benefits for their own employees and customers. The Naperville Fire Department should prepare itself for this probability.

REFERENCES

American Heart Association. (2000). Cardiovascular Disease Statistics. www.americanheart.org

American Heart Association. (October 28, 1992). Guidelines for cardiopulmonary Resuscitation and Emergency Cardiac Care: Recommendations of the 1992 National Conference. Journal of the American Medical Association. Vol. 268, No. 16. (p. 2171-2274).

Bardy, G. H. (1996). Multicenter Comparison of Truncated Biphasic Shocks and Standard Dampened Sine Wave Monophasic Shocks for Transthoracic Ventricular Defibrillation. PACE. 19. (p. 678).

Communicore. (1996). Sudden Cardiac Arrest: A Treatable Public Health Crisis. Seattle, WA

Cummins, R. O. (1993, January). The Utstein Style for Uniform Reporting of Data from out of Hospital Cardiac Arrest. Annals of Emergency Medicine, 22:1. 37/49.

Cummins, R. O., Chesemore, K., and White, R. D. (1990). Defibrillator Failure: Causes of Problems and Recommendations for Improvement. Journal of the American Medical Association. 264. (p. 1019-1025).

Cummins, R. O. (1988, January). A New Rhythm Library for Testing AEDs: Performance of 3 Devices. Journal of American Cardiology. (p. 597).

Drake, J. W. (2000). Automated External Defibrillation. Brady/Prentice Hall. Upper Saddle River, NJ

Eisenberg, M. S., Horwood, B. T., and Cummins, R. O. (1990) Cardiac Arrest and Resuscitation: A Tale of 29 Cities. Annals of Emergency Medicine. 19 (p. 179-186).

Eisenberg, M. S., Hallstrom, A. P., and Copass, M. K. (1984). Treatment of Ventricular Fibrillation: Emergency Medical Technician Defibrillation and Paramedic Services. Journal of the American Medical Association. 251. (p. 1723-1726).

Eisenberg, M. S., Copass, M. K., Hallstrom, A. P., Blake, B. Bergner, L., Short, F. A., and Cobb, L. A. (1980) Treatment of Out of Hospital Cardiac Arrests With Rapid Defibrillation By Emergency Medical Technicians. The New England Journal of Medicine. 302. (p. 1379-1383).

Fletcher, G. F. and Cantwell, J. D. (1977). Ventricular Fibrillation in a Medically Supervised Cardiac Exercise Program: Clinical, Angiographic, and Surgical Correlation's. Journal Of the American Medical Association. 238. (p. 2627-2629).

Ginsburg, W. (1998, May). Prepare To Be Shocked: The Evolving Standard of Care in Treating Sudden Cardiac Arrest. American Journal of Emergency Medicine. Vol. 16, No. 3. (p. 315-319).

Green, H. L., DiMarco, J. P., Kudenchuk, P. J., Scheinman, M. M., Tang, A. S. L., Reiter, M. J. Ehct, D. S., Chapman, P. D., Jazayeri, M. R., Chapman, F. W., Ahmed, M., Johnson, J. L., and Niskanen, R. A. (1995). Comparison of Monophasic and Biphasic \ Defibrillating Pulse Waveforms for Transthoracic Cardioversion. American Journal of Cardiology. 75. (p. 1135-1139).

Hossack, K. F. and Hartwig, R. (1982). Cardiac Arrest Associated with Supervised Cardiac Rehabilitation. Journal of Cardiac Rehabilitation. 2. (p. 402-408).

Illinois Administrative Code. (2000). Automated External Defibrillator Code. Title 77, Chapter I, Subchapter f, Part 525.

Illinois Compiled Statutes. (2000) Automated External Defibrillator Act. 410 ILCs 4/.

Katser, J., Cook, K. H., and Crouch, W. W. (1991) Evaluating Information: A Guide for Users Of Social Science Research. McGraw-Hill. New York, NY. 183

Kerber, R. E., Becker, L. B., Bourland, J. D., Cummins, R. O., Hallstrom, A. P., Michos, M. B., Michol, G., Ornato, J. P., Thies, W. H., White, R. D., Zukerman, B. D. (1997). Automatic External Defibrillators for Public Access Defibrillation: Recommendations for Specifying And Reporting Arrhythmia Analysis Algorithm Performance, Incorporating New Waveforms, and Enhancing Safety. Circulation. 95. (p. 1677-1682).

Kellerman, A. L., Hackman, B. B., Somes, G., Kreth, T. K., Nail, L., and Dobyns, P. (1993, October). Impact of First-Responder Defibrillation in an Urban Emergency Medical Services System. Journal of the American Medical Association. 270:14. (p. 1708-1713).

Litwin, P. E., Eisenberg, M. S., Hallstrom, A. P., and Cummins, R. O. (1987). The Location of Collapse and its Effect on Survival From Cardiac Arrest. Annals of Emergency Medicine. 16. (p. 787-791).

Mead, W. F., Pyfer, H. R., and Thrombold, J. C. (1976). Successful Resuscitation of Two Near Simultaneous Cases of Cardiac Arrest With a Review of Fifteen Cases Occurring During Supervised Exercise. Circulation. 53. (p. 187-189).

Mercer, S. (1993, February). Automated External Defibrillation: An Easier,Cheaper, and Faster Way to Save Lives. Emergency. 25. (p. 36-39).

Morgan, C. B. (1997, January) Advances in AED Technology. Journal of Emergency Medical Services. 22. (p. S 12-S 15).

Murphy, D. M. (1987, December). Rapid Defibrillation: Fire Service to Lead the Way. Journal of Emergency Medical Services. (p. 67-71).

Newman, M. (1997, January). Early Defibrillation: Making Waves Across America. Journal of Emergency Medical Services. 22. (p. S 4 – S 8).

Ornato, J. P. and Hankins, D. G. (1999, October/December). Public-Access Defibrillation. Prehospital Emergency Care. 2. (p. 297-302).

Ornato, J. P., Caren, E. J., and Gonzales, E. R. (1988, June). Cost-Effectiveness of Defibrillation by Emergency Medical Technicians. American Journal of Emergency Medicine. (p. 108-112).

Sanders, M. J. (2000). Paramedic Textbook. Mosby. St. Louis, Mo. (p. 877).

Sedgwick, M. L., Dalziel, K., Watson, J., Carrington, D. J., and Cobbe, S. M. (1993). Performance of an Established System of First Responder Out-of-Hospital Defibrillation. The Results of the Second Year of the Heartstart Scotland Project in the 'Utstein Style'. Resuscitation. 26. (p. 75-88).

Shuster, M. and Keller, J. L. (1993, April). Effect of Fire Department First-Responder Automated Defibrillation. Annals of Emergency Medicine. 22. (p. 106-112).

Spivak, M. (1998, February). Shockingly Successful: How AEDs are Expanding Field Treatment for Victims of Sudden Cardiac Arrest. Emergency Medical Services. 27. (p. 19-24).

Sweeney, T. A., Runge, J. W., Gibbs, M. A., Raymond, J. M., Schafemeyer, R. W., Norton, H. J., and Boyle-Whitesel, M. J. (1998, February). EMT Defibrillation Does Not Increase Survival From Sudden Cardiac Death in a Two-Tiered Urban-Suburban EMS System. Annals of Emergency Medicine. 31. (p. 234-240).

Valenzuela, T. D., Bjerke, H. S., Clark, L. L., Hardman, R., Spaite, D. W., and Nichol, G. (1998, May). Rapid Defibrillation by Nontraditional Responders: the Casino Project. Academy of Emergency Medicine. (p. 414-415)

Weaver, W. D., Hill, D., Fahrenbruch, C. E., Copass, M. K., Martin, J. S., Cobb, L. A., and Hallstrom, A. P. (1988). Use of the Automatic ExternalDefibrillator in the Management

of Out-of-Hospital Cardiac Arrest. The New England Journal of Medicine. 319. (p. 661-666).

Weaver, W. D. (1987, October). Importance of Field Testing To Evaluate Performance. Journal of American Cardiology. (p. 1259).

Weaver, W. D., Copass, M. K., and Hill, D. L. (1986). Cardiac Arrest Treated With A New Automatic External Defibrillator By Out-of-Hospital First Responders. American Journal of Cardiology. 57. (p. 1017-1021).

Weigel, A. and White, R. D. (1994, July). AED Algorithms: The Shocking Truth. Journal of Emergency Medical Services. 19. (p. 53-57).

Weisfeldt, M. L. (1995). American Heart Association Report on the Public Access Defibrillation Conference, December 8-10, 1994. Circulation. 92. (p. 2740-2747).

Weidfeldt, M. L. (1995). Public Access Defibrillation: A Statement for Healthcare Professionals From the American Heart Association Task Force On Automatic External Defibrillation. Circulation. 92. (p. 2763).

Wolbrink, A. and Borrillo, D. (1998, Summer) Airline Use of Automatic External Defibrillators: Shocking Developments. Federal air Surgeon's Medical Bulletin.

APPENDIX A

APPENDIX B

RECOMMENDED UTSTEIN-STYLE TEMPLATE FOR REPORTING DATA ON OUT-OF-HOSPITAL CARDIAC ARREST

1. Population served by EMS system N=___

2. Confirmed cardiac arrests considered for resuscitation N=___

3. Resuscitations not attempted N=___

4. Resuscitations attempted N=___

6. Noncardiac etiology N=___

5. Cardiac etiology N=___

8. Arrest not witnessed N=___

7. Arrest witnessed (bystanders) N=___

9. Arrest witnessed (EMS personnel) N=___

12. Initial rhythm asystole N=___

10. Initial rhythm VF N=___

11. Initial rhythm VT N=___

14. Other initial rhythms N=___

14. Determine the presence of bystander CPR

16. Never achieved ROSC

15. Any return of spontaneous circulation (ROSC) N=___

17. Efforts ceased
a. expired in field N=___
b. expired in ED N=___

18. Admitted to ICU/ward N=___

19. Expired in hospital
a. total N=___
b. within 24 hours N=___

20. Discharged Alive N=___

21. Expired within one year of discharge N=___

22. Alive at one year N=___

APPENDIX C

NAPERVILLE FIRE DEPARTMENT
Automated External Defibrillator Survey

*Agency Name (optional):*_____

Contact Person (optional): _____ *Telephone:* _____

What year did your organization begin using Automated External Defibrillators? _____

In what type of setting have you deployed AEDs?

☐ *Industrial* ☐ *Commercial* ☐ *Office* ☐ *Public Areas* ☐ *Agency Vehicles*

How many AEDs has your organization deployed? _____

List the average daily population of your area protected by AEDs? _____

If limited to specific structures or properties, what is the square foot area protected by AEDs?

What methodology, if any, was used to determine placement of AEDs? _____

Who are the intended primary users of your AEDs? _____

How many personnel have you trained in the use of AEDs? _____

What training methodology do you employ?

☐ *American Heart Assn.* ☐ *American Red Cross* ☐ *Other* _____

How many times have your AEDs been used? _____

Indicate the number of: Cardiac Arrest Patients _____ *Patients Defibrillated* _____

Successful Resuscitations: _____
(return of spontaneous circulation to hospital admission)

Please return this survey by
September 21 via mail or fax to:

District Chief Patrick Mullen
Naperville Fire Department
1380 Aurora Avenue
Naperville, IL 60540
Phone: 630-305-5901
FAX: 630-420-4094