Shockingly Successful

How AEDs are Expanding Field Treatment for Victims of Sudden Cardiac Arrest

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According to the American Heart Association (AHA), sudden cardiac arrest (SCA) strikes nearly 350,000 victims every year in the United States, and kills nearly 95% of them. This means that every day, nearly 1,000 U.S. citizens fall victim to SCA.

The figures are staggering when one considers that they represent only a fraction of the total number of SCA cases worldwide. The fact of the matter is simple: SCA is a sudden, severe condition that must be treated as quickly as possible in order to achieve any hope of patient survival.

However, the news is not all grim. Across the country, increased patient access to early defibrillation is expected to make a huge impact upon SCA survival, with automated external defibrillators (AEDs) playing a major role in that success.

SCA and Treatment

According to Taber's Cyclopedic Medical Dictionary, 18th Edition, SCA is often (though not always) caused by an electrical malfunction of the heart known as ventricular fibrillation, in which "organized electrical activity and synchronized mechanical pumping activity are absent." In SCA, the heart stops beating, resulting in a loss of blood flow to the brain, which, if left untreated, will lead to brain damage and certain death.

A crucial part of the standard treatment for ventricular fibrillation is to re-activate the heart's electrical system by restoring a heartbeat, and of equal importance, to restore the flow of oxygenated blood to the brain through this action. In order to do this in the most rapid, safe and effective manner, ventricular fibrillation must be terminated, or defibrillated.

To restore the heart's electrical activity, the patient is shocked with a defibrillator--a device that connects electrodes to the patient's chest, and depending upon the particular model used, either automatically assesses the correct energy level needed to shock the patient back into a normal heart rhythm, or allows a trained medical provider to manually or semimanually perform this function based on their own knowledge of the situation. Rapid treatment is essential for victims of SCA. According to the AHA, with each passing minute that a person is in SCA his survival rate drops an additional 10%. Thus, a patient in SCA for five minutes has only a 50% chance of survival.

Understanding that early access and treatment for SCA are crucial, in 1990 the AHA introduced a four-link chain of survival outlining four crucial steps that must be taken by responders (both the lay public and trained medical personnel) to give patients any hope at all of surviving SCA.

The four-link chain of survival involves: early access, which includes educating citizens to recognize cardiac arrest and having trained EMS providers respond to the scene with the appropriate equipment; early CPR, with bystanders (the lay public) performing cardiopulmonary resuscitation on the victim to provide circulation and respiration and buy time before EMS arrives; early defibrillation, ideally within a few minutes of the onset of the cardiac event; and advanced cardiac life support, including medications and immediate hospital care, both necessary after such an attack. SCA victims who are treated under such a plan stand the best chance of survival,
Defibrillation, the third step in the four-link chain, is thought to be the most critical step.

Defibrillators: A Brief History

Defibrillators have been around for years in one form or another. In the past, only manual, in-hospital defibrillators existed to shock a SCA patient back into a normal heart rhythm. According to David Rasumoff, MD, clinical assistant professor of emergency medicine for L.A. County-USC Medical Center in Los Angeles, CA, and an EMS Magazine editorial advisory board member, these machines are routinely used in emergency departments and are still crucial in the treatment of SCA even if a patient has already been defibrillated in the field, because patients may have multiple defibrillations during the course of time.

"Just because the heart got started doesn't mean it's not going to stop again," notes Rasumoff. "Whatever made it stop in the first place is still unaddressed, so that's why patients need to be monitored in the hospital," he adds.

Prior to the advent of portable defibrillators, the best treatment plan for a SCA victim was to at least receive CPR prior to EMS' arrival, be transported to the hospital and defibrillated by a trained emergency room physician. However, after the development of portable defibrillators, SCA victims could be defibrillated in the field by trained EMS providers (usually paramedics and advanced EMTs riding in an ALS unit). Field defibrillation often achieved the third link of the chain of survival in a much faster manner, no doubt increasing the odds of survival from SCA.

Along with the reality of field defibrillation came external manual defibrillators, which require extensive operator training. Portable manual defibrillators, which are used in most, if not all, ALS units, require the operator to determine whether defibrillation is necessary in the first place, and, if it is, to analyze the electrocardiogram, select an appropriate energy level, charge the machine and deliver the required shocks to the victim.

Semiautomated external defibrillators came next. Like portable manual defibrillators, the semiautomated models require operator training (though not as much). Although they assess the heart's rhythm and give voice prompts concerning the patient's condition and the electrical charge required to shock the patient, they still require operators to deliver the shock themselves, rather than the machine doing it automatically. The semiautomated units are still used solely by EMS providers.

The Rise of AEDs

As manual and semiautomated external defibrillators made their way into EMS agencies across the country and made an impact on the survival rate from SCA, various manufacturers began to explore means by which these devices could be made even lighter and easier to use. Fully automated external defibrillators became the natural result of the quest to build machines that required the least amount of training to deliver shock to a SCA patient.

According to Rasumoff, the main difference between the semiautomated units and the fully automated models is that the latter do everything for the operator--they do not require any decisions to be made regarding appropriate energy level of shocks to be delivered, how to read an electrocardiogram, etc. All the operator has to know is how to place the electrodes on the patient's chest and listen for clear voice prompts, which guide the user every step of the way in the correct operation.

The official protocol for AED use, established by the AHA, is to administer three shocks (if it is determined they are needed), followed by one minute of CPR, followed by three more shocks.
the machine advises not to shock, the protocol is to perform one minute of CPR, check a pulse and reanalyze, according to Paula Lank, program director for AED Product Development for Redmond, WA-based Physio-Control Corporation, whose first AED unit came to market just over 10 years ago, in 1986.

Lank says the AHA also made it clear that like any medical device, AEDs have to be used and sold under a medical authority's supervision, and that they should initially be targeted toward trained EMTs, first responders and firefighters, personnel whose jobs already require them to at least know CPR and other medical lifesaving techniques.

When the devices became available to EMS, there initially was much excitement, says Lank. "There was an expectation that AEDs in the EMS environment would take off and be used by the majority of providers in a relatively short period of time."

However, Lank adds, that didn't happen for a number of reasons. Legislation was the main sticking point, because many of the states differed according to who could use the device and how much training would be required.

As of this writing, most states have some form of legislation pending or in place to determine which level of EMS provider can use AEDs. However, AED training (which by itself often consists of no more than a half day to teach the device and then additional training in CPR, if necessary) is not a standard part of the national EMT curriculum, according to those involved in the industry.

While there are specific guidelines for who can use external semiautomated and manual defibrillators (mainly paramedics and advanced-level EMTs riding in ALS units), each state differs according to how it regulates use of the AEDs.

To date, at least 17 states and the District of Columbia have explicit guidelines for training personnel in AED use at the EMT-Basic and/or First Responder level, according to 1997 data submitted to EMS Magazine by state EMS offices. They are: Alaska, Arizona, California, District of Columbia, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Nebraska, North Carolina, Oregon, South Carolina, Tennessee, Vermont and Wisconsin. Most have placed AED training as an option to the standard EMT-B curriculum. It should be noted that other states may also have similar provisions or are in the process of developing them, but have not explicitly stated them as such. Thus, while advanced EMTs and paramedics clearly have the training to use semiautomated external defibrillators and/or manual versions and need not rely solely on fully automated means, beginning level EMTs and first responders, the very people who could best use AEDs, may not yet be able to train for them due to lack of state regulations (though training may be performed at the local level in some cases, in lieu of state regulations.)

Wayne Reval, EMS director of marketing for Zoll Medical Corporation in Burlington, MA, which manufactures a line of higher-end AEDs, says legislative hurdles are nothing new when it comes to who can use defibrillators.

"Back in the early days of the EMT-D, some of the states didn't allow EMTs to use defibrillators, and those issues had to be sorted out," says Reval. "They started out with EMTs using manual defibrillators and needing to interpret the ECG, and that didn't work really well. So some people were reluctant to go to AEDs for training purposes, and they also didn't trust the technology," he adds.

These problems are now being worked out, and they are unlikely to be an issue in the public access arena, says Reval.

**Cost Factor**
Another factor affecting placement of these devices in the hands of EMS agencies was (and still is) cost. On average, a typical AED still costs between $3,000-$4,000 (down substantially from the earliest versions). For most large metropolitan agencies, this is not a problem, but for the bread-and-butter volunteer agencies or smaller departments, costs can add up quickly if multiple units are purchased.

Because of this, some large corporations like Prudential Insurance Company, headquartered in Newark, NJ, have initiated grant programs to aid smaller and volunteer agencies in acquiring the units. Some of these companies match funds to help the small agencies purchase the devices, giving them leeway as to which manufacturer and unit to choose.

One small agency that has an AED unit on each of its two ambulances is the Seaford Fire Department's ambulance service, a volunteer operation in Seaford, NY.

Vinni Mangiolino, an EMT with the fire department-run agency, says the price of the units is small compared to what they can do. She says her agency, which trains EMT-Ds to use the devices, is trying to get them placed in medic cars, which could arrive sooner at a scene than an ambulance.

"Ambulances may take longer, so it would be good to get them into the medic cars," says Mangiolino. Of course, it will cost the department some money to place them in more vehicles.

Beyond cost, poor reliability, inconvenient weight and technological shortcomings of early machines affected AED penetration in EMS circles, according to SurVivaLink Corporation, a Minneapolis, MN-based company that manufactures the devices. However, as technology improved, weight and cost decreased, and organizations such as the AHA endorsed the devices, the market began to expand.

In 1995, total AED market sales were estimated at $50 million, according to a SurVivaLink representative. This figure is expected to increase in the years to come, particularly as a result of public access programs.

The Public Sector

As AEDs expanded into EMS, a second major market opened up: the lay public. This included flight attendants, police officers, security guards, lifeguards, sports trainers, corporate employees and anyone else who might be in a position to care for another person during the course of their daily duties. While lacking the medical training and knowledge of EMS providers, these people were still thought to be capable of operating AEDs, because the devices were now so easy to use.

According to Patricia Bower, AED project coordinator with the AHA, it is important to recognize the role that these so-called "targeted responders" may play in coming upon someone who experiences SCA.

"We feel it is important that we put defibrillators in the hands of targeted responders, people who are not medically trained, but who would have the potential to respond to a medical emergency possibly faster than EMS," says Bower.

Toward that end, the AHA wrote an official position paper on what has come to be known as public access defibrillation. The association, says Bower, also became active in pushing legislation that would change state laws that may restrict use of the devices by so-called laypersons. For example, Bower says most states are trying to change their existing Good Samaritan Laws to include the use of AEDs as legally allowable by nonmedical providers.
"A lot of our state organizations are involved in trying to get modifications in their legislation to allow more people to use the defibrillators and also to modify their training guidelines so that they're appropriate for the new defibrillators," says Bower.

She believes the existing 30-hour Department of Transportation-approved First Responder course, used in some circles as the standard for AED training, goes beyond what is necessary to operate the relatively easy-to-use machines. "It's outrageous. It's not something that is needed by a person who is just trying to prepare to use an AED," claims Bower.

According to Art Romano, EMT-P, a training officer with Greenwich EMS in Greenwich, CT, some public places have bypassed the First Responder requirement by allowing use of the devices under the license of an on-site physician. He says this is happening right now in Connecticut, a state that ordinarily requires anyone who uses the device to initially be licensed as a First Responder.

Under such an arrangement, Romano says, the physician would be responsible for ordering the AED and ensuring that training takes place for designated on-site personnel to use the device. Maintenance and placement of the device would presumably fall under the authority of the on-site physician, as well, according to Romano.

Notwithstanding these legal circumventions, Bower may be right when she claims the First Responder training is too much. According to a recent study conducted by the University of Washington in Seattle, laypeople who were trained to use an AED along with a traditional AHA Heartsaver CPR course had almost no difficulty retaining what they learned, even six months after their initial testing period.

Alidene Doherty, the University of Washington researcher who coordinated the study, says 149 normal citizens were analyzed as they took an ordinary walk-in CPR course and then were given either lecture material or hands-on instruction in the use of AEDs. According to Doherty, regardless of whether they received hands-on instruction or a lecture, the remaining group of people who agreed to retention testing were able to conduct CPR and use the AED device with almost no difficulty.

"What we found was, there is excellent learning of the psychomotor skills required to use an AED, and there was excellent retention, as well," says Doherty.

The only difficulty encountered, according to Doherty, was that some study participants had trouble using devices from different manufacturers the second time around (due to changes in pad and cable connections or instruction/voice prompt setups). However, this would easily be rectified if training were done on one device only. Doherty is currently working on an even larger study to cement these findings.

As to whether or not laypeople need to use AEDs, since EMS response times have improved in many areas, studies have shown that although SCA continues to occur most often in the home (in 75% of cases), the other percentage involves certain public sites that may be harder for EMS to reach during the critical treatment period for SCA (within the first few minutes).

Linda Becker, a researcher with King County Emergency Medical Services in Seattle, WA, analyzed the most common sites at which SCA occurred in the Seattle area from January 1, 1990 to December 1994.

"The biggest public site where SCAs took place during that four-year period was the international airport," notes Becker. Other public sites experiencing high rates of cardiac arrest were shopping malls, golf courses and casinos, according to the study.
Approximately 1,100 patients were tracked during the study, which also concluded that if the arrest was witnessed, the survival rate was 30%, as opposed to 15% if it was not witnessed.

Becker sums up what many believe about public access defibrillation: "It's a good thing. "Without a doubt, it is efficacious and highly useful in certain settings, and as time goes on, it will emerge as to what those locations are," says Becker.

**Public AED Programs: A Model**

What constitutes a good public access defibrillation program? According to Rasumoff, who has followed these programs, certain criteria should be included when developing an effective public access AED program. These include: effectively educating the public as to the safety and efficacy of the devices; solid education of the public in CPR, as well as operation of the device; universal precautions training; education regarding the most effective placement and maintenance of the device, as it will be used in the particular site; and finally, an effective means to call EMS during application of the device.

On the first note, Rasumoff says it is highly important that laypersons be effectively educated about the safety and efficacy of these devices, because they may feel reluctant to help others due to liability concerns.

"Part of the problem that people have in volunteering their services is the potential liability on them," says Rasumoff. "When you act on behalf of somebody who's in a medically life-threatening situation, you're really acting like a good Samaritan, and that's why the states have Good Samaritan Laws to reassure you that even though mistakes will be made from time to time, what matters is that what you do is reasonable."

Making people aware that the devices are safe and effective might also help them respond more quickly, says Rasumoff.

The second component is educating the public in not only knowing how to use the devices, but in understanding the nature of SCA and how CPR is a factor in its treatment. "While you're setting up the machine, you need to open the patient's airway and establish breathing, either by the patient or for the patient, and then perform some chest compressions," says Rasumoff. "So CPR training is important."

The third component, receiving universal precautions training, is key as well, says Rasumoff. "People need to be reminded of communicable disease precautions for their own safety," he says. "Most likely, you don't know the victim's health and medical background, unless you personally know them," he adds.

The fourth component is making sure that personnel being trained to use these devices know how to maintain them and place them in the most effective locations at the site. For example, in large high-rise buildings, personnel may have to sit down and figure out exactly where the devices would be most accessible, in much the same way as building managers determine where fire extinguishers are placed in each hallway.

As Rasumoff notes, having AEDs hidden doesn't help anyone. "It has to be easily found, otherwise no one will use it if they don't know it's at hand," he says. Finally, a good public access defibrillation program must be able to contact EMS during application of the device. AEDs are not a replacement for trained medical personnel, and any CPR program will train people on how to designate personnel to contact 911 in cardiac and other emergencies.
Casino Program

There are many programs across the country that are working well and that use all of the above guidelines in their operation. However, three programs stand out, not just for what they do, but for the cooperation required to get them off the ground in the first place.

Clark County Fire Department (Las Vegas, NV), Boyd Gaming Properties and Physio-Control Corporation's public-access defibrillation program in casinos has met with success and already has saved some lives.

Largely the result of studies that showed Las Vegas' SCA rate to be double that of many other cities, the program is notable for its emphasis on training, the sheer number of people involved and the cooperation of university researchers who are studying its efficacy as an ongoing project.

Richard Hardman, EMT-P, an EMS training coordinator for the Clark County Fire Department, is heading the project. According to Hardman, in 1995, after realizing that SCA rates were drastically high in Las Vegas casinos, he spoke to Boyd Gaming Corporation, which owns and runs many Las Vegas hotels, about establishing a casino-based AED program through which on-site security guards would be trained to use the devices.

"There was this perceived liability of inappropriately shocking somebody who should not receive a shock, but we finally worked that through with the Boyd Group," says Hardman. "They took out an extra insurance policy just to address some of their liability concerns, and since that time an assembly bill in Nevada placed AED use under the Good Samaritan Law, so that essentially eliminated liability concerns and explained why there's the proliferation of the program across the valley here."

In the Las Vegas program, the Clark County Fire Department provides 5-hour training to approximately 700 casino security guards. The training is broken down as follows: 3 1/2 hours of lecture and 1 1/2 hours in a practical, hands-on workshop, whereby students are taken through various scenarios requiring both CPR and the use of an AED. In the last half hour, students take a written exam to certify that they learned the material.

According to Hardman, 25 casinos are currently taking part in the program, and plans are underway to incorporate more properties both in Las Vegas and in other Boyd properties across the country.

Hardman says the main reason for getting AEDs into casinos is the sheer size of the properties. While EMS may arrive quickly at the curb of an establishment like Caesar's Palace, for example, having to find a patient who has arrested at the hotel's penthouse on the top floor, nearly a football field's length from the front door, can certainly be difficult.

"From the time that we have to go through the casinos to the elevators to the 30th floor and then walk down a long hallway, it would take on average 10 to 11 minutes to get to these people and deliver that first shock, and the survival rate at that point is almost zero," notes Hardman.

Through the program, says Hardman, the cardiac arrest survival rate in the selected casino properties has skyrocketed from a dismal 16% prior to implementation to 83% at the present time, thanks to five saves with the devices.

Asked to comment on the viability of AEDs, Hardman responded: "With the newer technology that currently exists out there by all the manufacturers, I am fully supportive of it. If you would have asked me the same question as little as two or three years ago, I don't know if I would have been
quite as supportive, because technology at that point in time was not as conducive for use of these devices by laypeople."

Terry Valenzuela, MD, professor of surgery at the University of Arizona in Tucson, is the principal investigator of the casino program and will be tracking the survival rate of SCA victims who were administered defibrillation from lay personnel in the casinos.

"I'm trying to show that nontraditional providers can successfully perform defibrillation and they can do so in much shorter times," notes Valenzuela. In order to do that, he needs about 90 cases of ventricular fibrillation. So far, the study has eight cases, so this will be ongoing.

**Calgary EMS/Fire Program**

Another program notable for its organization and liability checks is being run jointly by the City of Calgary (Alberta, Canada) Fire Department and the City of Calgary Emergency Medical Services Department, with assistance from select AED manufacturers (including Physio-Control of Redmond, WA; Heartstream of Seattle, WA; and Laerdal Medical Corp. of Wappingers Falls, NY), who have made their devices available for the project.

According to Doug Odney, EMT-P and public education officer with the Calgary EMS Department, the program was driven by the need to refine the city's early defibrillation program. Although Calgary has a high-performance EMS system (meaning it rates in the top 5% for all of North America), its weakest link, according to Odney, was its early defibrillation program.

"We realized our best direction was to tighten up our chain of survival, so we wanted to get AEDs into the public's hands," notes Odney.

Odney and others formed an AED Committee with support from various AED manufacturers to determine who would need to use the devices and how they would ultimately be trained.

"We said to the groups that were interested, 'Why don't we put on a course for you, free of charge?'" remembers Odney. "'The paramedic and fire department staff will come in and we'll train you in the course.'"

Odney says the course takes about three to four hours to complete. Those participating receive first-hand training on use of the devices, which they purchase from a manufacturer of their choice. The program also trains representatives from certain locations to train others at their sites.

"We don't have to go back," notes Odney. "We've trained one or two people in their facility to be the ongoing instructors, and they're trained to keep the machines up to date, the batteries charged, and that kind of information."

The classroom material includes an AHA Heartsaver CPR course, along with AED instruction and the underlying physiological reasons for using a defibrillator. Students who complete the program receive a certificate.

Currently, the Calgary program has installed AEDs in eight different locations: a sports aquatic center that has lifeguards; a high-rise office building in the downtown part of the city (in which security guards would be the first responders); a community college; the Calgary Exhibition and Stampede Park (a sports arena-type venue); Calgary City Hall (with its own stampede of daily traffic estimated at 8,000 people); a senior citizen recreation center; the city hospital (which was moved but retained its psychiatric wing in the old location); and the new city hospital location.
Notable not only for its variety of venues, the Calgary program also stands out for having a highly sophisticated way of tracking where AEDs are at any given moment.

"Say someone on the 10th floor of this high-rise building downtown calls and says, 'A guy tipped over in the boardroom and he's not breathing,'" explains Odney. "Well, not only do we activate EMS and respond quickly, but we also tell them we can see from our screen that there is an AED at the security desk and tell them to call their security guard to respond."

The system is expected to become even more sophisticated. "We just changed our database so that we in the dispatch center can actually see what number the person with the AED can be reached at," says Odney. "Another person in our dispatch center can call them right away and say, 'There's a man down on the 10th floor; please respond,' and we're on our way."

The only thing missing so far is a save, says Odney. Fortunately, they have not, as of this writing, had any SCA emergencies that necessitated use by the trained laypeople, but when they do, and if they involve saves, Odney forecasts that a predictable wave of media attention will result.

**Luhr Program in Houston**

Another effective program in place is run jointly by The Luhr Group, a safety and health consulting firm located in Houston, TX, and SurVivaLink Corporation. The program is spearheaded by Sherry Luhr-Hirk, EMT-B/FF, the principal owner of The Luhr Group.

"We started volunteering to educate the public in specific industrial and corporate sites about AEDs-what are they, why you would have one, where you would find one, and so on," says Luhr-Hirk. "After that, we got into a relationship with SurVivaLink, whereby if they go out to sell one of their units, and the company they're selling to wants education and training, we provide that component for them, sometimes free, and sometimes for a fee."

Luhr-Hirk says her company currently has about 700 clients in 25 different locations that it has trained, either directly or indirectly (through other employees) to use the devices. Before delivering a formal instruction, says Luhr-Hirk, her firm assesses each site location.

"We'll give them a general education review and, like an audit, tell them where the devices should go and how many they might need based on our professional recommendations," says Luhr-Hirk. "Then, we can actually do training, which involves basic cardiac life support, essential first aid and use of special equipment, most notably the defibrillator."

The training usually takes a minimum of four hours, but Luhr-Hirk prefers to do longer sessions to ensure that clients are given the most information they can use.

"Whenever possible, we do an 8-hour class, because we feel that while an AED is simple to use, there are some other things to consider, such as bloodborne pathogen issues, and lifting and carrying," she says.

Luhr-Hirk says that although the Houston area has an excellent EMS and hospital system, the city is so spread out that it might take time to reach a patient on the top floor of a high-rise and then transport them to the hospital. So, having a defibrillator inside an office building makes sense, she says. One of the corporate clients who has benefited from the AED program is Rio Energy, a large oil and gas firm with a suite near the top floor of a high-rise office building in downtown Houston.
"We went in and assessed their suite and said, 'Based upon what we saw, why don't you pick a core group of 15 or 20 people who would always be on site, and let's design some training to meet your needs,'" says Luhr-Hirk.

Before any formal instruction began, Luhr-Hirk's firm took a SurvivaLink AED and placed it next to an existing fire extinguisher. She told the assembled group they had a few minutes to open up the device and see if they could get it to work with no prior instruction. "They were able to do that within a minute and a half," she claims.

After this, each group member received hands-on instruction with the device in a variety of different scenarios.

"We made it change rhythms just to see if they could follow the directions, and of course they could," recalls Luhr-Hirk.

Luhr-Hirk says that part of the training package for every client involves a re-visit after six months to ensure that the training has been retained and to possibly re-train in the event the client has experienced a lot of employee turnover.

"In the two cases where we've been back, even the new folks caught on quickly because the other people were pretty enthused about it and they seemed to remember what they learned," she says.

"Some of the other things were a bit slower to come back, like how many chest compressions to use, but as far as the AED was concerned, they seemed to retain what they learned," adds Luhr-Hirk.

As AEDs continue to expand field treatment of SCA, it is expected that others will sing the praises of these devices as well.