Automated External Defibrillator Use Among the General Population

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Abstract: Automated External Defibrillators (AED) are becoming more prominent in public locations within the mainstream of our society. They are marketed as providing the ability for a broader range of people, beyond clinicians and community emergency medical services personal, to successfully defibrillate a person in cardiac arrest. The objectives of this study were to determine whether or not a member of the general population, without previous exposure to an AED, could successfully operate an AED, thus delivering the necessary shock in ventricular fibrillation arrest. In addition, we analyzed the relationship between health care training and the time required to defibrillate a patient using an AED and investigated the overall success of operating an AED with respect to health care training. Utilizing an AED trainer, we conducted a timed trial study of five subject categories (general population; first-year dental students; third-year dental students; dentists, hygienists, and nurses; and anesthesiologists and surgeons) as each operator attempted to defibrillate a mannequin (n=50). Their times, success in defibrillation, and comments were recorded. The general population group experienced an 80 percent failure rate, while the other groups showed an inverse relationship between failure rates and the amount of health care training. Overall, only 58 percent of the subjects successfully performed the defibrillation, and comments were recorded. Operator speed in relation to the amount of health care training showed another inverse relationship as times decreased from group one (general population) to group five (anesthesiologists and surgeons). The findings suggest that prior exposure to an AED leads to a greater number of successful defibrillations. It remains unclear at this time as to whether a member of the general population can successfully operate an AED.

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In shopping malls and airports across the United States, signs with “AED” are popping up at a rapid pace. AEDs or Automated External Defibrillators are being marketed and reported as the best thing in basic life support since the advent of cardiopulmonary resuscitation (CPR). Studies have shown that untrained persons can successfully operate an AED in simulated emergencies, but it remains unclear how adequately such persons would perform in actual emergencies and how the lack of rescuer training affects patient outcomes.1

Studies confirm that AEDs have saved lives in the hands of trained experts, but these researchers questioned whether the average shopper or traveler could successfully operate an AED. Caffery et al. concluded that the “lack of training should not constrain attempts to use a defibrillator in emergencies.” The data did however indicate that, in their study, health care professionals made sixteen of eighteen defibrillation attempts.1

Studies evaluating the effectiveness of CPR and advanced cardiac life support (ACLS) have shown that the most effective way to save a cardiac arrest victim’s life is to use a defibrillator as early as possible.2 The complete interval from collapse to first countershock is a key variable in determining the outcome from cardiac arrest. Data shows that mortality increases by 4 percent for each minute of delay to first shock. Additionally, it was shown that early cardiopulmonary resuscitation in conjunction with prompt defibrillation doubles the number of survivors over early cardiopulmonary resuscitation alone. The data demonstrated that defibrillating within five minutes would increase the proportion of cardiac arrest survivors by 10-11 percent.1

As our society and profession advance into the twenty-first century, the proximity and ability to use an AED will be the cornerstone in the standard of care. One manufacturer’s catalog description of the AED reads: “This innovative easy-to-use device en-
ables a broader range of people—beyond clinicians and community EMS professionals—to provide life-saving defibrillation therapy. According to ACLS training and the ABCs of life support, after the Airway, Breathing, and Circulation have been evaluated, Defibrillation analysis should be performed—that is, the AED assesses the need for a defibrillating shock.

Typical AEDs on the market range in price from $2,000 to $4,000 and usually weigh less than ten pounds, or five kilograms. These devices have the ability to measure chest impedance and deliver the appropriate shock based on the patient’s physical requirements for countering ventricular fibrillation. The AEDs have the capacity to recognize a shockable rhythm and advise the operator whether the rhythm is shockable via voice and lighted prompts. All AEDs must charge before delivering a shock, with some automatically doing so upon recognition of ventricular fibrillation. Each device has the ability to charge from zero to 150 joules in less than three seconds and deliver an accurate, appropriate shock. If the delivered shock is ineffective, the AED will recharge itself from 200 to 300 and finally to 360 joules until defibrillation has been accomplished. Originally designed to be used by those certified in ACLS or basic life support (BLS) for patients in transport, these machines, with their “error proofing” features, seem to have brought the option of rapid, accurate defibrillation into mainstream society. The purpose of this study was to test the assumption that the general public as well as the health care provider can actually operate an AED appropriately.

The American Heart Association (AHA) recognizes four Universal Steps of AED Operation. These steps, in order, are: turn on the AED; place the pads on the patient’s bare chest; stand clear for patient analysis; push the shock button if indicated (while clear of the patient). These steps should be taken if a victim with signs of cardiac arrest is unresponsive, not breathing, or has no pulse or signs of circulation. It should be noted that standing clear of the patient when analyzing and shocking is critical. Touching the patient during the analysis phase could alter the AED’s ability to read the patient’s electrical activity. Touching the patient while administering a shock could shock the rescuer, potentially rendering him or her unconscious. The incorrect placement of the defibrillation pads could also result in an ineffective or inadequate shock. These universal steps thus provided the criteria to evaluate the success of each operator in our study.

Methods

An exploratory study was performed at the University of Pittsburgh School of Dental Medicine’s (UPSDM) Department of Anesthesia to investigate whether the general population can use AEDs successfully. Five categories of individuals were identified as subjects. The categories were established to represent varying degrees of health care training, ranging from the general population to highly trained anesthesiologists and surgeons. The differences among these categories, with regard to their ability to successfully use an AED, were explored. The Laerdal AED Trainer 2 (Laerdal Medical Corporation, Wappingers Falls, NY) was utilized with the testing mode of U2. U2 is an arbitrary name assigned by Laerdal to a specific mode of the Laerdal AED Trainer 2. This mode forces the operator to reposition the defibrillating pads and add a fifteen-second delay if the placement was incorrect. If the defibrillating pads were placed correctly, the U2 testing mode did not penalize the operator.

A CPR mannequin was used as the fibrillating patient. The mannequin was furnished with five Velcro® patches placed on the bare chest under a T-shirt (Figure 1). The AED pads were also fit with Velcro®, so the same costly pads could be used throughout the study while still forcing the operator to place them correctly on the patient’s chest. AED electro pads function to sense a cardiac electric signal and send it to the device as well as deliver a shock through the electrodes if indicated. The testing room was set up with the mannequin lying on top of a table, T-shirt on, and the AED lying, in full sight, adjacent to the mannequin (Figure 2). The instructions given to the testing subjects were: “Here is an unresponsive victim with signs of cardiac arrest. The victim is not breathing and has no pulse or signs of circulation. Next to the victim is an automated external defibrillator; save the victim.” A stopwatch was started once these instructions were given. The stopwatch was only stopped when the AED sounded, “It is now safe to touch the patient.”

Several statistical methods were used. The following tests were applied to the recovered data. They were the one-way analysis of variance (ANOVA),
the Student-Newman-Keuls procedure, the Kruskal-Wallis test, and the Post Hoc Mann-Whitney U test.

The researchers divided subjects into five categories based on health care experience and training. These categories, each consisting of ten subjects, were 1) general population; 2) first-year dental students; 3) third-year dental students; 4) dentists, registered nurses, and registered dental hygienists; and 5) anesthesiologists and surgeons. Times, outcomes, and comments were recorded. Category one, general population, was comprised of subjects from a broad spectrum of ages and educational backgrounds, including students, teachers, secretaries, and laborers. The subjects of category one had a mean age of thirty-three years, and their average education was two years of post-high school training/education. None of them had ever seen or operated an AED prior to this study. Category two, first-year dental students, consisted of ten students from UPSDM with a mean age of twenty-three years. Each of these students had little or no knowledge of and may or may not have had experience with an AED. The third-year dental students of category three, each from UPSDM, had all been certified in CPR. In addition to their certification, category three subjects had attended lectures on the use of an AED, but were not given the opportunity to operate the device during their training prior to this study. The mean age of category three was twenty-six years. Category four consisted of dentists, registered nurses, and registered dental hygienists. These subjects, with a mean age of forty years, claimed to be knowledgeable about or certified in the use of an AED. No category four subjects reported having an AED in their place of practice. ACLS certification with AED training was required of subjects in category five. This category consisted of subjects with a mean age of forty-two years, and nine out of the ten subjects were certified ACLS and AED instructors.

Results

According to the Phillips Medical Systems Products and Services Catalog 2002, “True 1-2-3 operation makes defibrillation intuitive for all users. Voice and possibly text guide users through the defibrillation process. The bright LCD display makes it easy to use in noisy or dark settings.” Contrary to such industry advertisements, this study found that a significant inverse relationship exists between training and failure. Two third-year dental students at UPSDM assessed each subject. Subjects that did not successfully follow the written, pictured, and verbal prompts of the AED in compliance with the AHA universal steps, as stated in the above literature, defined failure.
Category one, the general population, showed an 80 percent failure rate, while categories two, three, four, and five had failure rates of 60 percent, 30 percent, 20 percent, and 10 percent, respectively (Figure 3). Of the fifty operators tested, twenty-one (42 percent) failed to successfully defibrillate the patient (Figure 4). Of those failing, 52.4 percent (eleven out of twenty-one) did not remove the patient’s T-shirt and attempted to defibrillate through the shirt. Due to the fact that the AED was a trainer, after the above-mentioned fifteen-second delay, it continued to walk the operator through the steps toward defibrillation, even with the shirt in place. Another 28.6 percent (six out of twenty-one) did not place the defibrillating pads correctly on the patient’s chest, thus resulting in failure. The remaining 14.3 percent (three out of twenty-one) failures were a result of the operator touching the patient while defibrillating.

The operator speed in defibrillation was analyzed to test for significant mean differences among the five experience categories using an independent means one-way analysis of variance (ANOVA). After rejection (p=.0004) of the equality of means hypothesis, a test for trends resulted in a significant linear effect (p=.004). Only the test for a linear trend was significant. Pair wise comparisons using the Student-Newman-Keuls procedure at p=.05 found the category one mean to be significantly different from

![Pass vs Failure with Regard to Training](image1)

**Figure 3.** Pass-fail rates by category of operator

![Total Pass vs Failure](image2)

**Figure 4.** Total pass-fail rate for all operators
of the four other category means, none of which differed from each other. The pass-fail performance score data was tested for significant mean rank differences among the five categories using the Kruskal-Wallis test. They were significant at $p=.007$. Post Hoc Mann-Whitney U tests at the .05 level found category one to significantly differ from categories four and five. None of the other pair wise mean tests were significant.

Operator speed in defibrillation was also recorded and analyzed in this study. The data showed a direct correlation between operator training and a decrease in time required to defibrillate (Figure 5). Category five was the fastest, averaging a time of 1:06.7 minutes. The shorter average time for category five is due to turning on the AED immediately, as prescribed in the first step of the Four Universal Steps of AED Operation. Category four averaged 1:21.1 minutes, category three averaged 1:25.1 minutes, and category two averaged 1:27.1 minutes. Category one showed the greatest variation from the other categories, averaging 1:41.6 minutes. Success with regard to age again demonstrated the direct relationship between years of training and ability to operate the AED appropriately (Figure 6).
Discussion

The data collected in this research strongly suggests that a person in the general population may not be able to successfully operate an AED, especially in a stressful situation. Some literature underestimates this issue by stating, “A brief training course should be helpful.” 6 The primary comment of those unsuccessful in defibrillation was that the volume of the voice prompt was not loud enough. Additionally, the researchers recognized that the automated instructions only told operators once to “apply the pads to the patient’s bare chest.” Attempting to defibrillate through clothing constituted a failure in properly following the specific instructions given by the AED. Two separate drawings on both the written instructions and defibrillating pads showed pad placement on a bare chest. However, realizing that 52.4 percent of those failing did not perform this task correctly, the researchers believe that further product analysis should focus on emphasizing the removal of the patient’s shirt. Another frequent comment was that the machine was too slow, especially for the highly trained category five. Brillhart et al. suggested that a one-minute goal and a ninety-second minimum standard for time to first shock are appropriate for EMT AED defibrillation in the field. 7 In appreciating that all categories of operator averaged less than two minutes in performing the defibrillation, the advantage of having an on-site defibrillator surpasses any other basic methods that could be executed in the initial stages of a cardiac emergency.

It is also essential to understand that CPR would be administered concurrently with AED therapy. The researchers experienced some problems associated with operators wanting to shock before the AED had been charged. Operators were not instructed by the AED unit to wait until the yellow shock button was illuminated before attempting to administer the shock; therefore, many operators pushed the shock button prematurely. This caused confusion among the operators as to whether the shock had been delivered or not since the AED trainer did not actually deliver a shock. The operators questioned why the AED was telling them to deliver the shock after they had attempted to do so. As a result of this finding, we hope that the future development of AED devices includes better and more detailed instructions for those operators with little or no health care training.

One general population operator said, “I have seen signs in rest areas with AED on them, but I had no idea what that meant or what it was for.” As AEDs become more commonplace, the public must be educated on their purpose. According to Woollard, “It has not been conclusively shown that public access defibrillators are less effective than bystander cardiopulmonary resuscitation or first responder defibrillation schemes.” 3 Opportunities for public training, such as through the media, on the use of AEDs could provide some insight into the use of these devices for the general population. Study subjects, in general, were very appreciative for the lesson on the correct use of an AED following their testing. Each failing operator, after instruction, felt he or she could use the device with accuracy and safety. Another operator commented that the only reason he knew how to place the pads was from watching television shows such as ER where manual defibrillation is often dramatized. It should also be noted that each operator who failed the defibrillation attempt had never seen an AED.

Conclusion

We believe that further studies need to be performed on the successful use of AEDs in the general population. Based on the results reported in this study, it appears that the general population may not even recognize an AED in a public place. We hope that, in the future, data will be available to the public illustrating the value of having AEDs placed in public places. To maximize an AED’s lifesaving potential, further public exposure and education are crucial. Data on the cost to benefit ratio of having AEDs accessible to the general population would provide further insight into public use of them.

Furthermore, we challenge dental educators to expand emergency curriculums to include intensive AED training. It is very probable that AEDs soon will be the standard of care in every dental office. Currently, health care providers are required to be CPR certified biannually with AED instruction incorporated. This study has raised questions about whether the majority of trained operators can perform an emergency defibrillation under stressful conditions, which suggests that more intensive planning is necessary.
REFERENCES