



**Public Access
Defibrillation
Evidence Review**

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Submitted to:

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Executive Summary

Context Ltd. has been contracted by the Heart and Stroke Foundation to develop a model to enhance and increase access to automated external defibrillators (AEDs) in public places across British Columbia. As a step in developing this model, Context reviewed published evidence to determine the lifesaving effectiveness of AEDs, the cost effectiveness of AED placement, and considerations in the development of a public access defibrillation (PAD) program.

To develop this review, the team first focused on print materials supplied by the Heart and Stroke Foundation, and followed up on relevant references contained therein. Team members then searched for PAD and AED related articles in the medical literature which yielded a number of articles for review. The team also identified a number of specific medical journals which contained relevant publications. Special attention was paid to the Journal of the American Heart Association (Circulation), the Journal of the American College of Cardiology, the Journal of the European Resuscitation Council (Resuscitation), and the New England Journal of Medicine because of their frequent publication of AED and PAD related research.

The team also reviewed media articles and other publications available online and identified through Google keyword searches.

This review places emphasis on more recent studies, and acknowledges that studies vary in quality and scope. Whenever possible, rigorously-controlled studies reported in peer-reviewed articles were used to produce this review, but it also contains references to editorials published in medical journals and information published on credible websites.

The Context team is confident the evidence demonstrates defibrillation by AED is the definitive, life-saving treatment for the majority of SCA victims. The evidence also shows there are a number of specific public locations where AEDs can be placed and be cost-effective according to generally accepted guidelines.

The evidence confirms the importance of the Heart and Stroke Foundation's cardiac arrest Chain of Survival™. Like any chain, it is only as strong as its weakest link. To ensure a strong chain, AEDs must be integrated with other aspects of the chain, such as early CPR and early advanced care, to maximize their potential. Training incorporated in a PAD program should include not just AED training but also CPR training. The best PAD programs are integrated with EMS services, are built with financial sustainability in mind, and address legal and regulatory concerns.

A properly designed and implemented PAD program for public places that recognizes these requirements has the potential to save the lives of British Columbians.



The Heart and Stroke Foundation's Chain of Survival

1 Introduction

This evidence review provides information on the effectiveness of automated external defibrillators (AEDs) in increasing survival rates in victims suffering sudden cardiac arrest (SCA) in public locations. It also examines optimum strategies for AED placement, cost-effectiveness considerations, and regional issues related to increasing survival rates for SCA patients in British Columbia and Canada.

An **Automated External Defibrillator (AED)** is a portable device used in lifesaving emergency medical care. When retrieved and attached to a presumptive sudden cardiac arrest victim, AEDs provide instructions to lay-bystanders on how to shock (defibrillate) victims that are experiencing ventricular fibrillation or ventricular tachycardia. Defibrillation shocks the heart with the hope of allowing it to resume a normal contraction rhythm. (American Heart Association)

2 Rationale for implementing an AED strategy in public locations

While most cardiac arrests happen in the home, AEDs have not been shown to be effective at treating victims in residential locations.

SCA is a serious medical emergency. There are up to 45,000 SCAs in Canada every year. The current survival rate for out-of-hospital cardiac arrest (OHCA) in Canada is around 5%, which results in very few SCA victims surviving to hospital discharge.

This need not, however, be the case. Evidence shows that victims of SCA who are assessed and appropriately defibrillated immediately after the onset of a SCA event are more likely to survive. One study showed that a SCA victim who is in ventricular fibrillation (VF), the most common form of SCA, will have nearly a 75% chance of survival if defibrillated within three minutes of collapse. (Lalenzuela, Roe, Nichol, Clark, Spaite, & Hardman, 2000) Early defibrillation is the key to survival; another study showed that for every minute a patient in VF is not defibrillated, their chance of survival decreases by 7-10%. (American Heart Association, 2008)

Sudden Cardiac Arrest (SCA) is the sudden cessation of normal circulation of the blood due to failure of the heart to contract effectively. It is a serious medical emergency, and, if left untreated, will normally result in death. There are various forms of SCA, including “shockable” forms like ventricular fibrillation and ventricular tachycardia, as well as “non-shockable” forms like pulseless electrical activity and asystole (flatline). (National Heart Lung and Blood Institute, 2009)

Unfortunately in B.C., early defibrillation is seldom available to victims. Public AED placement is sparse, and median EMS response time is 9.3 minutes. (Vaillancourt, 2004)

While most cardiac arrests happen at home (Nichol, et al., 2008), these arrests are often not witnessed, and as a result bystander resuscitation is not an option. Additionally, those experiencing SCA at home are less likely to have a shockable rhythm as a result of other physiological factors. For instance, those experiencing SCA at home are on average older and more likely to have chronic diseases. These factors have been associated with lower survival rates with implanted defibrillators, suggesting AEDs may also be less effective in treating at-home SCAs (Resuscitation Outcomes Consortium Investigators, 2011).

A number of studies have found that AED placement in residential buildings is not generally an effective strategy for significantly decreasing death due to SCA. (The Public Access Defibrillation Trial Investigators, 2004) (Folke, et al., 2010) Another study found that placement right in high-risk patients’ homes did not reduce overall mortality. (Home Automated External Defibrillator Trial Investigators, 2008)

Because of the lack of evidence for effectiveness of AEDs in residential locations, this evidence review focuses on the evidence for placement in locations open to the public, where SCAs are most likely to be witnessed and promptly responded to.

3 Effectiveness of AEDs at increasing survival from SCA

Science and research demonstrate that AEDs are safe and effective lifesaving devices. Application of AEDs in public locations has been shown to significantly increase the chances of survival for victims of sudden cardiac arrest.

The algorithms used in AEDs to detect shockable rhythms are extremely accurate. A recent study discovered that AEDs deliver three times fewer inappropriate shocks than paramedics and resident physicians. (Kramer-Johansen, Edelson, Abella, Becker, Wik, & Steen, 2006) There was no evidence in any of the reviewed literature of an AED inappropriately shocking someone not experiencing SCA, with the only inappropriate shocks coming to victims who had

already been converted from VF to another rhythm by the AED. In these cases, the victims were no worse off than they had been before attachment of the AED.

Advanced AED technology enables conversion of VF to a stable sinus rhythm with a 90% success rate. (The American Heart Association, 2005) In the last ten years, there have been a number of studies examining the effectiveness of AEDs to increase survival rates. The results have been positive, with the largest, most recent studies showing significant improvements in survival rates for public OHCA treated by bystanders using AEDs.

While SCA is sometimes linked to myocardial infarction (heart attack), seemingly healthy individuals, including children, may experience SCA. (National Heart Lung and Blood Institute, 2009)

One study of 13,769 OHCA showed that survival rates increased to 35% if an AED was applied by a bystander compared to 20% if bystander CPR was performed in the absence of an AED. (Resuscitation Outcomes Consortium Investigators, 2010) Another large study of SCAs in England and Wales found that the survival rate for those receiving a shock by on-site AED was 30.5%. (Colquhoun, et al., 2008)

In Japan, investigators tracked survival rates for 312,319 out-of-hospital cardiac arrests, including 12,631 patients that had an initial VF rhythm in an event witnessed by bystanders. After implementing a strategy to increase the availability of AEDs in the public, they found that the percentage of shocked VF patients increased from 1.2% to 6.2% ($P < 0.001$ for the trend). Overall, 37% of patients who received a first shock from a public access AED survived, compared to 24% who were shocked by EMS and 12% who had a VF rhythm and received no shock. They also showed that survival rates for SCAs were correlated with AED density; areas that were best covered by AEDs had higher survival rates than those areas that had poor AED coverage. (Kitamura, Iwami, Kawamura, Nagao, Tanaka, & Hiraide, 2010)

Earlier studies of PAD programs had shown similarly promising increases to SCA survival rates. A 2004 prospective study of 993 community facilities found that implementing an organized emergency-response plan and training and equipping volunteers to provide early defibrillation with an AED doubled the number of survivors. (The Public Access Defibrillation Trial Investigators, 2004)

Other smaller studies examining specific application strategies for AEDs also showed the effectiveness of AEDs used in public settings. A study of SCAs in casinos that implemented a comprehensive SCA response strategy showed an overall survival rate of 35%, with a mean AED attachment time of 4.4 minutes, compared to an EMS response time of 9.8 minutes. The high priority that is placed on surveillance, along with the above-average ability of casino security guards to respond to high-intensity situations, led to quick response times for a number

of patients. Twenty-six out of thirty-five patients who received their first shock within three minutes of collapse survived, compared to twenty-seven out of fifty-five who received it more than three minutes after collapse. (Lalenzuela, Roe, Nichol, Clark, Spaite, & Hardman, 2000)

Positive results were also achieved by American Airline's AED program. Survival rates for SCAs on airplanes have historically been extremely low; this intervention resulted in six of fifteen patients shocked with AEDs surviving. Also of interest, AEDs were used more than 100 times by physicians on airplanes to monitor heart rhythms for patients experiencing other medical emergencies. In none of these cases did an AED recommend or deliver an inappropriate shock. (Page, et al., 2000)

Many of the published studies investigating the effectiveness of AEDs involved staff who had been trained in AED use and had strict response guidelines in place. However, even in a study of AED use in Chicago airports, where it was often left up to bystanders to respond, the results were positive. Out of the twenty witnessed SCAs of cardiac origin, eighteen had an initial VF rhythm. In all eighteen cases, an AED was successfully retrieved and operated before EMS arrival. Eleven of the patients survived. In four of the seven situations in which the patient did not survive, AEDs were not immediately available. For instance, two of the patients were on a plane at the time of arrest. The three other patients that died all had pre-existing medical conditions which may have contributed to their deaths. In six out of eleven of the successful resuscitations, the operators had no previous training in AED use. (Caffrey, Willoughby, Pepe, & Becker, 2002)

4 Cost-effectiveness of AED placement in public locations

The installation of AEDs in some public locations is cost-effective according to widely accepted medical intervention standards. The American Heart Association's guideline that suggest AED installation in venues expected to deal with at least one SCA every five years should be regarded as a minimum standard.

The research shows that AED placement in public locations can be effective in saving lives. To determine whether or not it is a cost-effective intervention, it must be compared to other life-saving treatments on which money could be, or is already being, spent.

When comparing one medical intervention to another, cost per quality-adjusted life year is generally the accepted metric that is used. This has been the case since at least the early 1990s, when guidelines were first introduced for deciding which interventions might be worth spending money on and which ones are not. (Laupacis, Feeny, Detsky, & Tugwell, 1992)

The cost-effectiveness of AEDs varies widely depending on where they are located. As expected, there is little evidence for the cost-effectiveness of AEDs in most private locations. (Pell, Walker, & Cobbe, 2007) With public locations, the density of SCAs in the area is the most critical factor. For instance, there is a strong argument for cost-effectiveness of AEDs placed in large airplanes, with an estimated cost per QALY of \$35,300. Placement in small airplanes however would be cost-ineffective, with costs per QALY of \$200,000 or more. (Gold & Eisenberg, 2007)

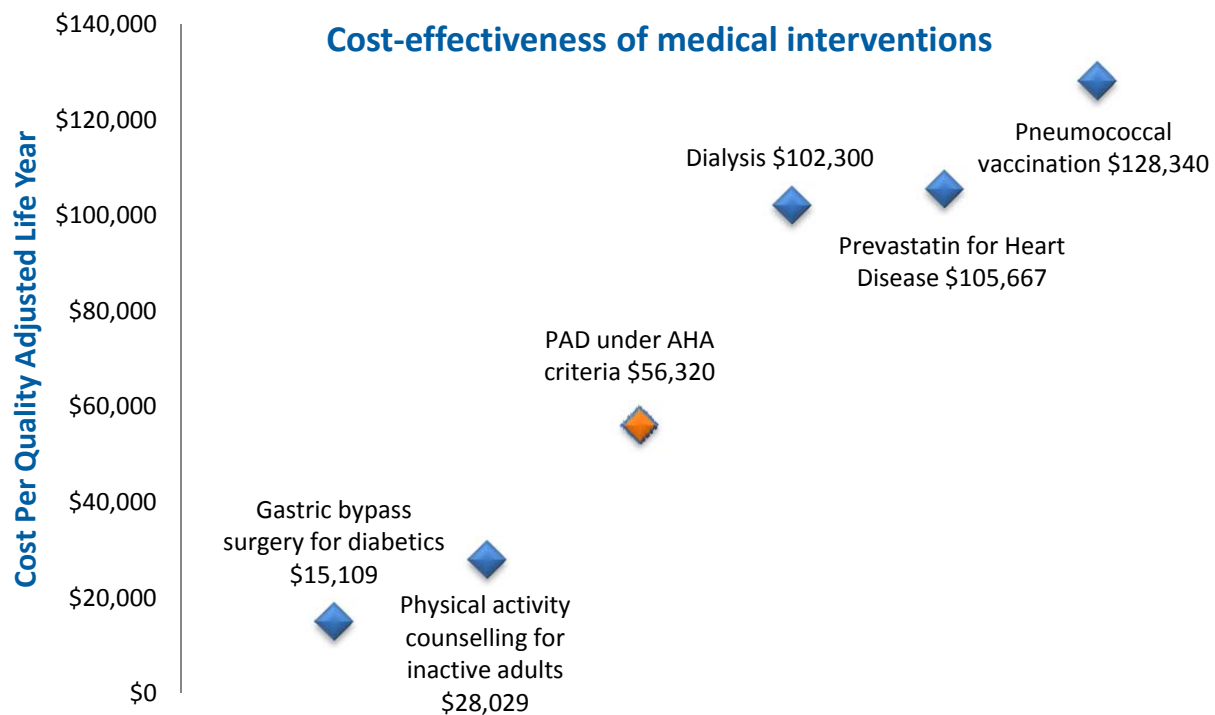
The Nichol et al study examined the cost-effectiveness of CPR+AED use compared to CPR only. It used the data from the Public Access Defibrillation Trial Investigators study that examined all SCAs in 993 community units over a three year period. (Nichol, et al., 2009) According to the study, the incremental cost of CPR+AED use as compared to CPR alone was \$46,700 per QALY. This incremental cost is less than that of pravastatin therapy for newly diagnosed diabetic patients with increased serum cholesterol levels but without a history of coronary artery disease, as well as less than the incremental cost of dual air bags compared with driver-side air bag. If the maximum society is willing to pay for a health intervention is \$100,000, a commonly used threshold for cost-effectiveness, then there is a 99.7% chance that defibrillation by a volunteer is cost-effective in some public locations. If dialysis, estimated at approximately \$93,000 per QALY, represents the maximal societal willingness to pay, then defibrillation by a volunteer has ~97.9% chance of being cost-effective. (Nichol, et al., 2009) (de Wit, Ramsteijn, & de Charro, 1998)

Another factor must be considered when calculating the cost-effectiveness of OHCA treated with public AEDs. Of the OHCA patients who eventually survive to discharge, those treated with AEDs tend to be in better condition when they arrive at the hospital than those who are not. (Lalenzuela, Roe, Nichol, Clark, Spaite, & Hardman, 2000) As a result of their decreased morbidity, they tend to be discharged from the hospital sooner, and are also more likely to be discharged home rather than to a long-term care facility. (Berdowski, Kuiper, Dijkgraaf, Tijssen, & Koster, 2010)

The American Heart Association (AHA) and the European Resuscitation Council (ERC) have both released recommendations for the placement of AEDs in areas of high incidence for cardiac arrest. However, they define these areas differently. The AHA defines a high-incidence area as one with a SCA expected at least once every five years, whereas the ERC defines it as an area with a SCA expected once every two years. A study of all OHCA in Copenhagen from 1994-2005 examined the implications of these guidelines. Assuming 80% use of AEDs to treat SCA in covered areas, the AHA's guidelines would have led to a cost of \$51,200 per QALY saved. (Folke, et al., 2009) This figure is well within the generally accepted cost that suggests a solid rationale for the implementation of life-saving medical technology. Graph 1 compares the

cost-effectiveness of implementing a PAD program using this criteria to a number of other medical interventions. The graph strengthens the point that this figure is quite a bit lower than the commonly-cited \$100,000 per QALY, which may mean that following AHA’s guideline would lead to too few AEDs being deployed. (Cram, Vijan, & Fendrick, 2003) The ERC’s guideline, being even more conservative than the AHA’s, should therefore not be used. The Folke et al. study discovered that implementing the AHA’s guidelines would cover 66.8% of all OHCA’s occurring in public. However, this figure cannot be applied to SCAs in B.C., as population density for the whole Province is lower than it is in Copenhagen. Because SCA survival rates in cities are not dramatically higher than rates in remote locations, AEDs are likely to be more cost-effective in high-density urban areas.

Graph 1



All numerical values above are the cost per QALY figures adjusted to 2009 Canadian dollars. (Folke, et al., 2009) (Nichol, et al., 2009) (Dalziel, Segal, & Mortimer, 2008)

5 Specific public locations where AEDs are cost-effective

High-traffic public areas should be targeted for AED installation. However, there is a paucity of data regarding cost-effectiveness of AEDs in specific public locations.

AEDs are cost-effective in some locations. Determining the specific locations where they should be placed however, can be difficult. Generally speaking, AEDs should be placed in locations where cardiac arrests are expected to occur relatively frequently, about once every five to ten years. However, just because a location has had one or more SCAs in the past, does not necessarily mean it will have more in the future.

The most common public locations for SCAs are casinos, medical offices, train stations, large shopping centers, central bus terminals, sports centers, and outdoor public locations including streets and sidewalks. (Folke, et al., 2009) (Fedoruk, Currie, & Gobet, 2002) However, one group of researchers recently attempted to identify exact locations for AED placement, and they found that they could not identify any specific location that would justify defibrillator placement over any other location. (Zeitz, Grantham, Elliot, & Zeitz, 2010)

There are a few studies examining the effectiveness in very specific public locations. One study examined twenty-two SCAs that occurred in southern Ontario health care clinics. In the SCAs studied, only 10% were treated with AEDs. Those experiencing symptoms preceding cardiac arrest may travel to a clinic for medical treatment, and as a result OHCA occur disproportionately in clinics. Because of this fact, and the fact that clinics should be equipped to deal with a variety of medical emergencies, expansion of an AED program in medical clinics should be considered. (Brooks, Lam, & Morrison, 2010)

There was recently a large push to get AEDs into schools in the United States. A similar program is currently being implemented in Saskatchewan. A study evaluating the American program with 1710 schools with at least one AED found an annual incidence rate of 4.4 SCAs per 100,000 student athletes. This translated into fourteen student SCAs in six months. In addition, there were twenty-two non-students (faculty, fans at events, janitorial staff etc) who experienced SCA in the schools. An AED applied a shock in 30/36 of the cases, and 23/36 survived. A total of 9/14 student athletes survived. (Drezner, Rao, Heistand, Bloomingdale, & Harmon, 2009)

There is no discussion of cost-effectiveness in the above-described article, but using the AHA guidelines this would not meet the criteria. The schools averaged 2.9 AEDs per school, which translates into only one cardiac arrest per AED every sixty-seven years. Indeed, at least eighty-three AEDs have been deployed in schools since the program in Saskatchewan began in 2007, and so far none have been used to treat an SCA victim.

Finally, when choosing locations for AED placement, some environmental factors need to be considered. For instance, while there are no recorded incidents of AED malfunction while treating a victim, controlled tests have discovered that the rhythm analysis function on some devices is susceptible to high-power lines such as those in metro terminals. This has raised concerns regarding whether current AED models should be used in certain public locations. (Einav, Weissman, Kark, Lotan, & Matot, 2005)

6 AED program integration with EMS and other systems

Venues with AEDs should be strongly encouraged to register their AEDs with a central database, and this database should be integrated with EMS dispatch to maximize their life-saving potential.

In some jurisdictions, dispatchers have access to databases that allow them to direct callers to the nearest AED. A common theme amongst studies analyzing the success of AED programs is the emphasis off this type of integration with EMS systems.

The Folke et al. study of SCAs in Copenhagen found that there were a number of situations in which a nearby AED may have been available to treat a victim but the lack of an AED registry integrated with EMS services meant the AED was never retrieved and applied. (Folke, et al., 2009)

A survey of EMS personnel, AHA trainers and local AED vendors in North Carolina discovered that fewer than 20% of all unique locations with at least one AED were included in the state EMS database, and only one county out of 100 had AED locations incorporated into their computer-aided dispatch. The researchers concluded that simple regulatory guidelines are an insufficient incentive for the registration of AEDs. Prior to recommending placement of additional AEDs in the community, EMS and public health leaders should locate AEDs already deployed and incorporate them into a comprehensive public access defibrillation plan. (Myers, French, & Webb, 2005)

To encourage registration of public AEDs, King County offers free pad replacement for AEDs that are registered in the county database. King County implemented this incentive after officials discovered that integration of an AED program with EMS can dramatically raise survival rates. In fact, by combining integration of AEDs with the EMS system and putting steps in place to make sure their EMS system is the fastest anywhere in North-America (Seattle EMS has an swift mean response time of 3.7 minutes), they have managed to increase overall public SCA survival rates to 29%. (Culley, et al., 2004)

A number of counties in Minnesota can be used as examples of how successful an integrated strategy can be for OHCA. Anoka county and St. Cloud county implemented all of the AHA's 2005 most highly recommended guidelines for resuscitation into one strategy, including CPR and AED training in schools and businesses as well as additional deployment of AEDs in public places. With their integrated strategy, they managed to increase survival rates in patients with initial VF from 17% to 41% (5/29 to 37/90, $P = 0.025$). (Lick, et al., 2011)

7 AED Training Requirements

A successful PAD Program includes AED training as part of a larger training program that includes all aspects of emergency life-saving cardiac care.

A number of studies have suggested that the actual use of an AED requires no training. As mentioned above, in six out of eleven of the successful resuscitations in the Chicago airport study, the operators had no previous training or experience in AED use. (Caffrey, Willoughby, Pepe, & Becker, 2002)

In another study, a group of fifteen sixth-grade school children and twenty-two EMS personnel participated in mock SCA events. None of the children had prior basic life support training or experience with an AED, nor were they prompted or prepared in any way by the investigators before the study. All fifteen children properly placed the pads and successfully shocked the mannequin while remaining clear of the shock. On average, they were only twenty-three seconds slower than the EMS personnel, with an average time from mock SCA to shock of ninety seconds vs sixty-seven seconds. Many point to this study as evidence that AEDs are easy to use and that no training is required for lay people to successfully operate AEDs. (Gundry, Comess, DeRook, Jorgenson, & Bardy, 1999)

However, another study showed different results. In this study, 1015 high school students were placed in different randomized groups with the goal of assessing different training methods for CPR and AED use. The groups were trained using a variety of methods including traditional hands-on training, video training, and interactive computer program training. The study found that, regardless of the type of training given, students who received some form of training were far more likely to use an AED properly upon two-month follow-up evaluation than those students in the untrained control group. Trained students were at least 29% more likely to turn the AED on properly, at least 32% more likely to place the pads properly, and at least 32% more likely to properly administer a shock if indicated by the AED. (Reder, Cummings, & Quan, 2006)

It should be noted that, even if it is determined that AEDs are easy to use without formal training, other factors need to be considered with respect to AED training. It is clear from many AED studies that the stress involved in a life or death situation is something that people may

need to be prepared for. In fact, one of the reasons that survival rates for SCAs occurring in private settings is so low may be that that, even if witnessed by a friend or family member with an AED at hand, panic may diminish the timeliness and effectiveness of treatment.

(Investigators for the Home Automated External Defibrillator Trial, 2008)

Another critical consideration is that virtually every study that has investigated AEDs and their role in resuscitation has found that defibrillation is but one part of the actions that should be taken to maximize survival in the event of a witnessed SCA. It is clear from the research that CPR and AED use together provide the best chance for SCA survival. (Caffrey, Willoughby, Pepe, & Becker, 2002) (Vaillancourt, 2004)

Considering these findings, it is unlikely that a training program for AED use alone would be an effective intervention. AED training should be part of a larger program that emphasizes all aspects of resuscitation best practices including CPR and AED use, as well as emergency situation management. The better prepared a bystander is, the more likely they will be to properly react to an OHCA.

8 Legal frameworks for AED implementation

An AED strategy should push for a clear law that exempts bystanders from liability when using an AED, as well as legislation that lays out requirements in oversight and maintenance.

The success of an AED program depends, to some extent, on the legal framework for AED ownership and use. Currently, the legal framework in B.C. is ambiguous, with many experts disagreeing on the extent of liability protection that the law provides. This is a situation which is certainly not ideal for a program intended to maximize lives saved by AEDs.

One major issue is that AED treatment in public settings is often administered by physicians. The highest risk areas for SCA are those where there are a lot of people around, and this means there will often be a physician present. In order to ensure that physicians and all bystanders are protected from liability in the event that they treat a patient with an AED in a public setting, Ontario passed the Chase McEachern Act. The Act explicitly states that all individuals, including health care professionals, are protected from all but gross negligence in the event they use a defibrillator outside of a hospital or other place having appropriate health care facilities and equipment for the purpose of defibrillation. Currently, no such law exists in B.C. (Ontario, 2007)

Additionally, a number of those facilities in B.C. that already have AEDs have indicated that they purchased them to comply with old WorkSafeBC regulations. Some of the language in these AED regulations was ambiguous and causing problems. Rather than amend the regulation, in

November 2010 WorkSafeBC withdrew it. This has left a void in AED regulation, although general first aid equipment regulations are still applicable to AEDs, including the provisions contained in Sections 3.16, 3.17, 4.3, 4.5 and 4.10 of the Occupational Health and Safety Regulation. (WorkSafe, 2010)

These are only a few examples of the problems with AED legislation and regulation in B.C. In order to maximize the success of an AED program, an AED strategy should push for a clear law that exempts bystanders from liability when using an AED, as well as legislation that lays out requirements in oversight and maintenance, and facilitates the installation of AEDs in public spaces. An example of AED legislation that addresses these concerns is the Manitoba legislature's Bill 20, The Defibrillator Public Access Act.

9 Resuscitation of trauma victims using AEDs

Trauma victims may benefit from wider deployment of AEDs.

Most AED research has studied only AEDs used to treat SCAs of a "cardiac origin". However, it is plausible that a bystander may attach an AED to a victim that has undergone SCA as a result of or in conjunction with a traumatic accident.

With no research studying expected survival for trauma victims treated with AEDs versus those who are not, it is impossible to know if AEDs are an effective way of saving these patients' lives. Unless the underlying cause of SCA due to trauma is treated, it is unlikely an AED will convert a patient back to a stable sinus rhythm. However, it is also unlikely that a patient in VF or VT due to trauma would be harmed by an AED shock. In fact, shocking VF or VT in a trauma victim is still considered medical best practice in a hospital setting.

Additionally, bystanders need to be aware that SCAs commonly cause trauma. A driver, for instance, may experience SCA and crash his or her car. In a case like this, application of an AED will almost certainly increase the chance of the patient's survival. (Willis, Cameron, Bernard, & Fitzgerald, 2005)

In general, if cardiac arrest is suspected in a trauma victim and an AED is available, it should be applied. However this application should not delay a call to EMS or delay transport of the patient to a trauma centre.

10 Concerns about AEDs harming bystanders or SCA victims

AEDs pose no risk to bystanders or those suffering from medical emergencies other than SCA. Any potential harm to an SCA victim is minute compared to the potential benefit of early defibrillation.

AEDs are incredibly effective at diagnosing and treating VF and VT. An AED is a semi-automatic device. In order to deliver a shock, the device must record VF or VT in a patient and the shock must then be initiated by a user. For this reason, it is very rare that a machine delivers an inappropriate shock. There are no known cases where an AED has delivered an inappropriate shock to a patient who did not present with an initial VF or VT rhythm that had already been converted by the AED. This means there were no cases in which a patient was worse off due to being treated by an AED. As was mentioned earlier, AEDs have been shown to deliver far fewer inappropriate shocks than EMS personnel or physicians using manual defibrillators. (Kramer-Johansen, Edelson, Abella, Becker, Wik, & Steen, 2006)

While some rare side-effects like contact burns occasionally occur, defibrillation is the definitive treatment for VT and VF. The alternative to early defibrillation for most SCA victims is death.

There are no documented cases in which an administrator has been injured by an AED shock. This includes cases of SCA in aquatic complexes, where electrical shock transferred through the water would likely provide the largest hypothetical threat to an administrator.

11 Conclusion

AEDs are effective, easy to use, and affordable medical tools that are extremely effective at saving lives. Most SCA victims in public locations present with an initial VF or VT rhythm, and for these patients their best chance for survival is early defibrillation. Proper implementation of AEDs has been shown to double survival rates for SCAs in some locations. Studies have shown that both trained responders and lay persons are able to safely and effectively treat SCA patients with AEDs. Additionally, AEDs can be used by medical professionals to monitor patients during other serious medical emergencies.

If implementation is guided by specific criteria, AEDs can be cost-effective. Generally speaking, their implementation will be cost-effective in public areas where there are a lot of people a lot of the time. These include locations like airports, train stations, casinos, and large public parks. AEDs in private locations (offices, homes) have generally been shown to not be cost-effective.

A successful PAD program should be comprehensive, in that it should include integration with EMS, training in all aspects of the "Chain of Survival", and must address the legal and

regulatory framework under which it is being implemented. Without this integration, a PAD program will not meet its maximum life-saving potential.

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