Report to the Maryland General Assembly

Regarding the Placement of

Automated External Defibrillators

SB427 (Chapter 34) 2017

HB522 (Chapter 35) 2017

December 2017

The Maryland Institute for Emergency Medical Services Systems

653 W. Pratt Street

Baltimore, MD 21201

410-706-5074

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Background

Senate Bill 427 (Chapter 34, 2017) and House Bill 522 (Chapter 35, 2017) "Maryland Institute for Emergency Medical Services Systems-Automated External Defibrillators-Study (The Joe Sheya Act)" required the Maryland Institute for Emergency Medical Services Systems (MIEMSS) to (1) conduct a study and make recommendations, in consultation with interested stakeholders, about locations where automated external defibrillators (AEDs) could be most beneficial; (2) compile AED pricing information, including installation and training costs; and (3) provide a summary of the immunity from liability provisions in State law regarding the use of AEDs. As part of this study, MIEMSS was required to use any available, relevant data from calendar years 2015, 2016, and 2017 to conduct the requested study[1].

This report contains information and results from analyses conducted on out of hospital cardiac arrest data in Maryland[2]. Information on the plan for the study and results from the analysis component of the study were presented to the MIEMSS Cardiac Arrest Steering Committee at August, September and October 2017 meetings. The full report was reviewed by the EMS Board at its December 12, 2017 meeting. A listing of representatives on the Cardiac Arrest Steering Committee and individuals who attended the meetings is included in Appendix A.

[1] MIEMSS also conducted a similar study in 2007 as a result of the passage of Senate Bill 742 (Chapter 349, 2007) "Swimming Pools-Automated External Defibrillators-Study" that required the Maryland Institute for Emergency Medical Services Systems, in consultation with interested stakeholders, to study whether automated external defibrillators (AEDs) should be provided on-site at swimming pools in Maryland and to examine: 1) which swimming pools should be required to provided AEDs; 2) whether the presence of individuals trained in the use of automated external defibrillators should be required by swimming pools; and 3) the safety of providing AEDs at a swimming pool. In addition, the statute required MIEMSS to make recommendations on locations, other than swimming pools, where AEDs should be required.

[2] The data analysis was conducted by Rebecca Piasecki, a Research Data Analysis Assistant contracted to MIEMSS, with the assistance of John New, Director of Quality Management at MIEMSS. Ms. Piasecki worked on this study under guidance from her mentor, Dr. Nisha Chandra-Strobos, Professor of Medicine at Johns Hopkins School of Medicine and Chief of Cardiology at Johns Hopkins Hospital Bayview Medical Center.

Executive Summary

In accordance with Senate Bill 427 (Chapter 34, 2017) and House Bill 522 (Chapter 35, 2017) "Maryland Institute for Emergency Medical Services Systems-Automated External Defibrillators-Study (The Joe Sheya Act)", MIEMSS analyzed available cardiac arrest records to identify locations where placement of AEDs could be most beneficial; compiled pricing information for AEDs, including installation and training costs; and summarized of the immunity from liability provisions in State law regarding the use of AEDs. As discussed herein, this report contains the following information.

AED Location

- The location type with the highest rate of cardiac arrest is BWI Thurgood Marshall Airport, approximately 7 per year. This finding is consistent with the high number of passengers who travel through the airport every day. BWI has its own Fire and EMS system on site and maintains AEDs throughout the airport, as do most large airports.

- Skilled nursing facilities are the next highest ranked location occurrence. Over the 30-month period of the study, 541 cardiac arrests occurred in 227 skilled nursing facilities, yielding a cardiac arrest rate per year per facility of 0.95.

- The remaining rates at identified locations are significantly less and appear to be randomly distributed across location types which compares similarly with the data provided in the 2007 report[1].

- AEDS may be considered for placement in high traffic areas where large numbers of people are present for significant periods of time, or in locations where individuals at high risk may be present. While cardiac arrest can occur at any age, risk of cardiac arrest increases with age, especially after age 50 and in individuals who have suffered a previous cardiac arrest or who have been diagnosed with conditions that may trigger an event.

AED Costs

- Generally, the cost of a new AED ranges from $880 to $1,696. The cost of certified pre-owned AEDs generally ranges from $500 to $850.

- Training in CPR and AED usage can be obtained throughout the state at an approximate cost of $55 – 90 per person. Training courses, which typically take between two (2) and three (3) hours to complete, must be repeated every two (2) years.

AED Immunity

- Maryland's Public Access AED Program statute provides specific immunity for facilities if they are registered with MIEMSS, have a valid certificate to provide PAD defibrillation, and comply with other requirements, as long as the actions taken were not willful or grossly negligent.

- Individuals who use an AED under the same provision are also protected. Individuals may also be able to claim immunity under Maryland's Good Samaritan law.

- The Court of Special Appeals recently held that Maryland businesses that opt to have a defibrillator on-site have no legal obligation to use it in case of a cardiac emergency.

Introduction

Cardiac arrest is the sudden loss of heart function that occurs when the heart's electrical system malfunctions. Cardiac arrest may be caused by abnormal or irregular heart rhythms (called arrhythmias).[3] When cardiac arrest occurs, blood stops flowing throughout the body, and if left untreated, can rapidly lead to multiple organ failure and death, often within minutes of onset. Cardiac arrest occurring outside the hospital ("out-of-hospital cardiac arrest" or "OHCA") is a leading cause of death in North America and Europe, with an estimated 295,000-326,000 OHCAs occurring in the United States annually [4] [5] [6]. Nationally, reported median rates of survival to hospital discharge for OHCA are dismal at 7.8% and have remained unchanged for the past 30 years[7].

Research has shown that outcomes of cardiac arrest improve with early initiation of cardiopulmonary resuscitation ("CPR") and early defibrillation using automated external defibrillators ("AEDs")[8] [9]. An AED is a portable device that checks the heart rhythm and sends an electric shock to a heart that is in ventricular fibrillation or pulseless ventricular tachycardia[10] to restore a normal rhythm; AEDs are widely considered to be the key tool in treating SCA[11]. Defibrillation by an AED is most effective if provided within 3-5 minutes of cardiac arrest. AEDs can be used to treat a cardiac arrest only if the arrhythmia causing the arrest is a shockable rhythm (ventricular fibrillation/pulseless ventricular tachycardia); AEDs are not effective in treating cardiac arrest from other types of arrhythmias.

According to the most recent *American Heart Association Guidelines for CPR and Emergency Cardiovascular Care* ("the Guidelines") published in 2015, because OHCA has an annual incidence of 132/100,000 population, communities should establish a system of care that prepares laypersons to provide bystander CPR and early defibrillation to offer the best chance

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[3] What is sudden cardiac arrest? www.nhbli.nih.gov. https://www.nhlbi.nih.gov/health/health-topics/topics/scda. Updated June 22, 2016. Accessed October 25, 2017.

[4] Jorgenson DB, Yount TB, White RD, Liu PY, Eisenberg MS, Becker LB. Impacting sudden cardiac arrest in the home: A safety and effectiveness study of privately-owned AEDs. *Resuscitation*. 2013;84(2):149-153. doi:10.1016/j.resuscitation.2012.09.033.

[5] Schober P, van Dehn FB, Bierens JLM, Loer SA, Schwarte LA. Public access defibrillation: Time to access the public. *Ann Emerg Med*. 2011;58(3):240-7. doi: 10.1016/j.annemergmed.2010.12.016. Epub 2011 Feb 3.

[6] *Sudden cardiac arrest: Meeting the challenge*. Oakbrook Terrace, IL: The Joint Commission; 2011. Reprint number 630/792-5631.

[7] McNally B, Robb R, Mehta M, et al. Out of hospital cardiac arrest surveillance-cardiac arrest registry to enhance survival (CARES), United States, October 1, 2005-December 31, 2010.*Centers for Disease Control and Prevention Morbidity and Mortality Weekly Report Surveillance Summaries.* 2011; 60(8):2-3.

[8] Sudden cardiac arrest: A healthcare crisis. sca-aware.org. http://www.sca-aware.org/about-sca. Updated 2017. Accessed October 24, 2017.

[9] A race against the clock: Sudden cardiac arrest. www.heart.org/policyfactsheets. https://www.heart.org/idc/groups/heart-public/@wcm/@adv/documents/downloadable/ucm_301793.pdf. Published 2013. Accessed October 24, 2017.

[10] See https://www.resus.org.uk/resuscitation-guidelines/adult-advanced-life-support/

[11] What is an automated external defibrillator? www.nhbli.nih.gov. https://www.nhlbi.nih.gov/health/health-topics/topics/aed. Updated December 2, 2011. Accessed October 24, 2017.

for survival in the initial minutes following an OHCA, and health surveillance to measure the incidence and outcomes of OHCA. Other important system components include emergency medical dispatcher recognition of sudden cardiac arrest with telephone assisted CPR to the caller, community Public Access Defibrillation (PAD) programs, and use of social media to summon rescuers prior to the arrival of EMS[12].

In an effort to improve outcome from sudden cardiac arrest through early initiation of CPR and early use of AEDs, many areas of the United States have implemented PAD programs [8,13,14,15]. First proposed in the 1990s, PAD programs consist of the placement of AEDs and training laypersons in CPR and the use of AEDs so that both are easily accessible in a community[16]. PAD programs have been implemented throughout the United States, and many studies have reported improved outcomes for patients experiencing sudden cardiac arrests in areas where PAD programs have been implemented[8, 13, 14]. Some have noted, however, that while these programs have great potential to continue to improve outcomes in communities, their effectiveness may wane over time without legislation that helps to support, maintain, and improve these programs[12].

One element of PAD programs that seems essential for their success is to target the implementation of PAD programs to public areas that are highly accessed in the community[12, 13]. Airports and school are examples of such high-traffic areas where PAD programs appear to have been successful at improving cardiac arrest outcomes, and many governments, including the federal government, have passed legislation requiring AEDs in municipal buildings, large public venues, airports, casinos, and schools[6, 13, 11]. Ease of access to the AED itself is important, with the American Heart Association recommending public access AEDs be within a 1.5 minute walk of a potential SCA victim[14]. The type of location where a cardiac arrest initially occurs (e.g., "home" compared to "public building") also seems to impact patient outcome in certain populations[17]. Additionally, important to community-wide strategies for AED deployment are

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[12] Kronick SL, Kurz MC, Lin S, et al. Part 4: systems of care and continuous quality improvement: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation.*2015; 132(suppl 2):S402-S403.

[13] Gilchrist S, Schieb L, Mukhtar Q, et al. A summary of public access defibrillation laws, United States, 2010. *Prev Chronic Dis*. 2012; 9:E71. Epub 2012 Mar 15. http://dx.doi.org/10.5888/pcd9.110196.

[14] Valdes SO. Public access defibrillation programs: Improving outcomes worldwide. *J Am Heart Assoc*. 2015;4(10):e002631. doi: 10.1161/JAHA.115.002631.

[15] Hazinski MF, Idris AH, Kerber RE, et al. Lay rescuer automated external defibrillator ("public access defibrillation") programs: lessons learned from an International Multicenter Trial. *Circulation*. 2005;111(24):3336-3340. http://search.ebscohost.com/login.aspx?direct=true&db=cin20&AN=106371240&site=ehost-live.

[16] Weisfeldt ML, Kerber RE, McGoldrick RP, et al. Public access defibrillation: A statement for healthcare professionals from the American Heart Association Task Force on Automatic External Defibrillation. *Circulation*. 1995;92(9):2763. doi:10.1161/01.CIR.92.9.2763.

[17] Reinier K, Stecker EC, Vickers C, Gunson K, Jui J, Chugh SS. Incidence of sudden cardiac arrest is higher in areas of low socioeconomic status: A prospective two year study in a large United States community. *Resuscitation*. 2006 70(2):186-92. Epub 2006 Jun 30. doi:10.1016/j.resuscitation.2005.11.018.

socio-economic and geographic disparities as some research suggests higher incidence and poorer outcomes in communities with low-socioeconomic status[17].

Maryland's Public Access Defibrillation (PAD) Program

The Maryland Institute for Emergency Medical Services Systems (MIEMSS) is an independent state agency that oversees and coordinates all components of the statewide EMS system in accordance with Maryland statute and regulation, including planning, operations, evaluation, and research[18].

In 1999, Senate Bill 294 established the Maryland Public Access Automated External Defibrillator (PAD) Program which permits a business, organization, association, etc., that meets certain requirements, to make automated external defibrillators (AEDs) available for individuals suffering sudden cardiac arrest on the premises prior to the arrival of emergency medical services personnel. Examples include offices, government buildings, churches, schools, health clubs, pools, and golf courses. Entities exempt from registering in the Maryland PAD Program include healthcare facilities, physician's offices, dentist's offices, federal government agencies, jurisdictional EMS operational programs, and commercial ambulance services.[19]

While having an AED is voluntary for most locations, Maryland laws have been passed requiring placement of AEDs at high schools, middle schools, and county or municipally operated pools[20]. Additionally, some counties have passed ordinances requiring AEDs at certain locations within their jurisdictions. For example, Montgomery County requires AEDs at all commercial health clubs and fitness centers, and several counties have additional requirements for types of pools beyond what the state law requires.

MIEMSS oversees the Maryland PAD Program and, as such, approves entities meeting the necessary requirements to participate in the Program. Specific requirements have been developed for entities that wish to set up an AED program, including registration with MIEMSS, training of expected AED operators, and the ability to access 9-1-1 immediately. A certificate issued by MIEMSS to a registered entity is effective for three (3) years if compliance with the program requirements is maintained.

Beginning in FY 2016, MIEMSS implemented PAD program registration using an online Maryland AED registry. The registry provides automated notifications regarding battery and electrode expirations, program renewals, and AED recalls. The program also has an optional feature, an application called "AED Link" that, for a fee, allows an interested EMS Operational Program (EMSOP) to see all the AED locations within their jurisdiction that are registered with the program, without having to manually enter the AED site addresses into the their 9-1-1

[18] Education Article 13-501 et seq., Ann Code MD

[19] Education Article 13-517(d)(2) Ann Code MD.

[20] HB 1200 (Chapter 203) 2006; Education-High Schools or Secondary Schools-Automated External Defibrillator Program. HB 812 (Chapter 616) 2014; Education-Middle Schools-Automated External Defibrillators. HB 364 (Chapter 107) 2013; Swimming Pools-Automated External Defibrillator Programs (Conner's Law).

center database. Registration in the new AED registry, www.marylandaedregistry.com, can be accessed from the MIEMSS website.

Currently, there are 5,615 actively registered PAD locations in Maryland with AEDs onsite, with thousands of individuals trained in CPR and AED use. This figure includes the 328 applications MIEMSS received and approved in FY2017.

Since its inception, the Maryland PAD Program has had 202 (25.0%) successful AED uses out of 809 reported incidents. Success is measured by the patient having a return of pulse at EMS arrival, during EMS arrival, or during EMS transport. Of the overall arrests, 459 were witnessed, and 148 of those witnessed arrests regained a pulse at the time of EMS arrival for a 32.2% save rate for witnessed cardiac arrests.

Public Policy Development

Public policy considerations regarding improving cardiac arrest survival and the response to out-of-hospital SCA can be guided by national guidelines. The Institute of Medicine of the National Academies report, entitled "*Strategies to Improve Cardiac Arrest Survival: A Time to Act,"* includes the following recommendations that describe the placement of AEDs in public locations based on specific criteria, which include any combination of the following:

- More than 250 adults over the age of 50 accessing the location more than 16 hours per day
- The presence of high-risk individuals or a high-risk location
- Health Clubs with more than 2,500 members
- A cardiac arrest event at the location at least once every few years

The report goes on to say further work on determining the optimal locations for strategically placing AEDs could help with evaluating these recommendations and developing guidelines for locations adopting PAD[21].

AED Location Study Description

Data Selection and Analysis

The best available data resource to identify the incidence and characteristics of Maryland's out of hospital sudden cardiac arrest population is eMEDS®. The electronic Maryland EMS Data System (eMEDS) is a 3rd generation system, hosted by MIEMSS, which enables Maryland's EMS providers to document, submit, and produce an electronic patient care record. Additionally, it serves a primary resource to query entered data to answer questions on EMS demand, response, and outcome.

[21] Institute of Medicine of the National Academies: Strategies to Improve Cardiac Arrest Survival. National Academy Press, Washington, D.C., June 2015.

The eMEDS® database was queried for all cardiac arrests submitted for the time period of January 1, 2015 through June 30, 2017, per the specifications of the report request. The query parameters included any EMS encounters where the enclosed variables conditions were met:

- Cardiac Arrest (E11.1) was equal to "Yes" **or**
- Provider Primary Impression (E9.15) was equal to "Cardiac Arrest" **or**
- Provider Secondary Impression (E9.15) was equal to "Cardiac Arrest" **and**
- EMS service was not equal to "Commercial Services"[22].

After accounting for and eliminating duplicate records, the resulting file identified 29,382 unique patient records[23].

Not all of the 29,382 patients who experienced arrests between January 1, 2015 and June 30, 2017 in Maryland, could be included in the analysis, however. This is because the study followed the Utstein guidelines for reporting cardiac arrest data, Figure A outlines how data was selected for analysis in this report[24, 25]. First published in 1991, the Utstein template was adopted as a standard for use by researchers and clinicians for tracking cardiac arrest. Utstein stratifies arrests by witness status, etiology, and initial cardiac rhythm, to identify those patients that are most likely to respond to CPR or defibrillation and survive a sudden cardiac arrest[7]. Individuals whose cardiac arrests are not witnessed, are caused by a non-medical/cardiac origin, or are not in a shockable rhythm are very unlikely to respond to CPR or defibrillation and survive. Therefore, current research focuses on the utility of AEDs for witnessed arrests.[14, 26, 27, 28].

[22] Commercial services do not respond to public safety 9-1-1 calls, except in unusual circumstances.

[23] Duplicate patient records can arise due to database structure and reporting characteristics. Also, multiple EMS units may be dispatched to a single patient event, with each responding unit completing a report. For this study, only the transporting EMS unit record was use and if the patient was not transported, the record from the provider in charge was used.

[24] Jacobs I, Nadkarni V, Bahr J, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: Update and simplification of the Utstein templates for resuscitation registries. A statement for healthcare professionals from a task force of the International Liaison Committee on Resusci. *Circulation*. 2004;110(21):3385-3397. doi:10.1161/01.CIR.0000147236.85306.15.

[25] Perkins GD, Jacobs IG, Nadkarni VM, et al. Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Templates for Out-of-Hospital Cardiac Arrest. *Resuscitation*. 2015;96:328-340. doi:10.1016/j.resuscitation.2014.11.002.

[26] Weaver WD, Cobb LA, Hallstrom AP, Fahrenbruch C, Copass MK, Ray R. Factors influencing survival after out-of-hospital cardiac arrest. *J Am Coll Cardiol*. 1986;7(4):752-757. doi:10.1016/S0735-1097(86)80332-1.

[27] Sasson C, Rogers MAM, Dahl J, Kellermann AL. Predictors of survival from out-of-hospital cardiac arrest: a systematic review and meta-analysis. *Circ Cardiovasc Qual Outcomes*. 2010;3(1):63-81. doi:10.1161/CIRCOUTCOMES.109.889576.

[28] Lee M, Demirtas D, Buick JE, et al. Increased cardiac arrest survival and bystander intervention in enclosed pedestrian walkway systems. *Resuscitation*. 2017;118:1-7. doi:10.1016/j.resuscitation.2017.06.013.

Therefore, application of the Utstein guidelines excluded the following from the analysis:

- 6,623 exclusions based on patient etiology. Arrests with the following suspected etiologies were excluded: drowning, electrocution, ingestion/overdose, respiratory, SIDS, and trauma. This is because, following Utstein guidelines, those types of arrests were not caused by a medical/cardiac etiology. Arrests of presumed medical/cardiac etiologies were included for analysis, in keeping with related peer-reviewed research[29, 30, 31]. Arrests of unknown etiology were also included in analysis in order to allow for comparability of these findings to those in a previous report regarding the incidence of SCA and the placement of AEDs, which also included both arrests of unknown and presumed cardiac etiologies for analysis[1].

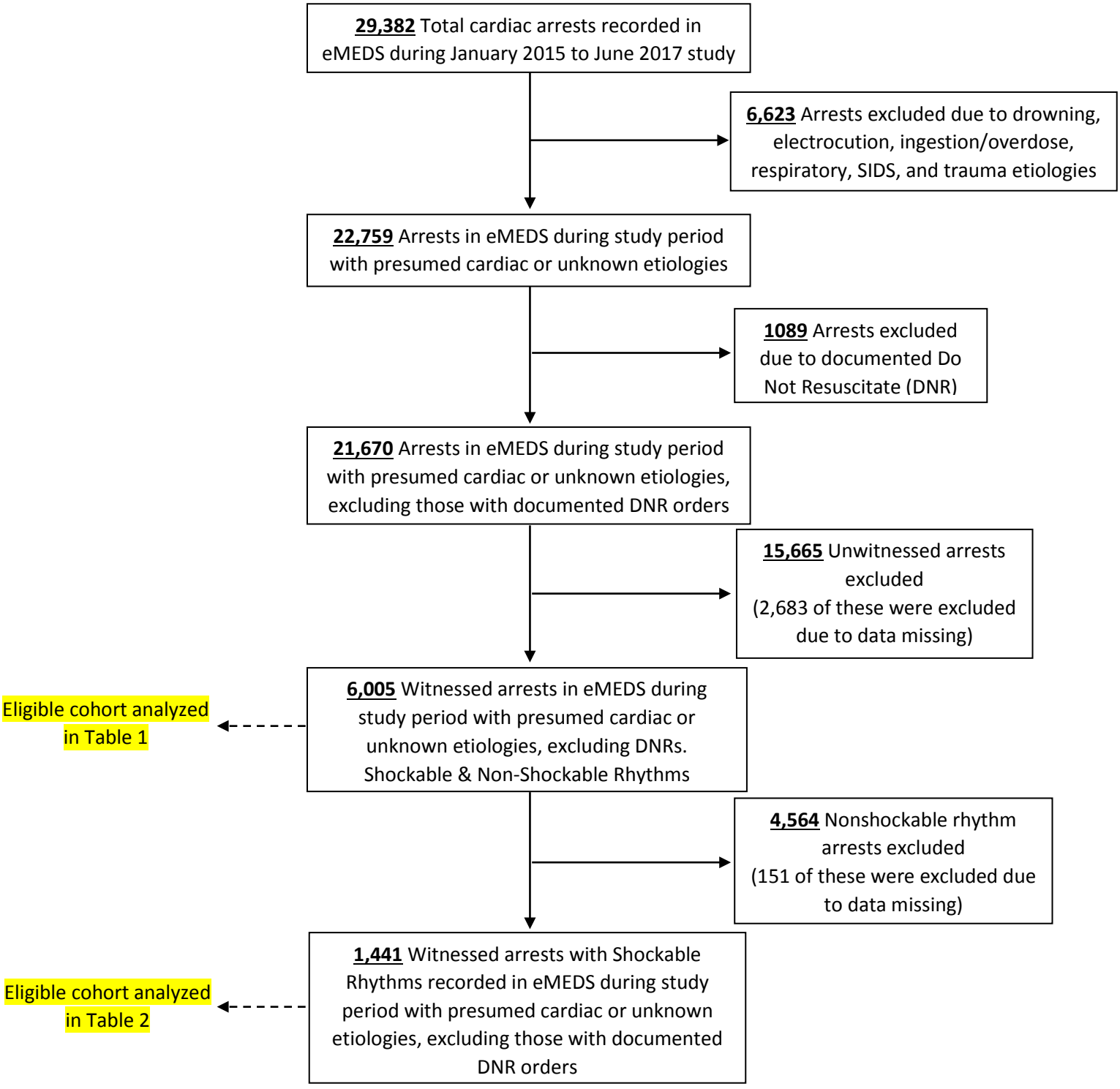
- 1089 patients were excluded from analysis who had documented Do Not Resuscitate ("DNR") orders in place at the time of their arrests that directed health care workers not to attempt resuscitation in the event of cardiac or respiratory arrest. Since resuscitations attempts are not started on patients with DNR orders, they would not receive resuscitative treatments such as CPR or use of AEDs; consequently, these patients were excluded from analysis.

- 15,665 patients were excluded from analysis in this study because their arrest was either unwitnessed or the status of whether or not the arrest was witnessed was unknown,

See Figure A: Utstein Guidelines Applied to Maryland Cardiac Arrest Data.

[29] Daya MR, Schmicker RH, May S, Morrison LJ. *Current burden of cardiac arrest in the United States: Report from the Resuscitation Outcomes Consortium*. Institute of Medicine; 2015.
[30] Malta Hansen C, Kragholm K, Pearson DA, et al. Association of Bystander and First-Responder Intervention With Survival After Out-of-Hospital Cardiac Arrest in North Carolina, 2010-2013. *JAMA*. 2015;314(3):255. doi:10.1001/jama.2015.7938.
[31] Boland LL, Formanek MB, Harkins KK, et al. Minnesota Heart Safe Communities: Are community-based initiatives increasing pre-ambulance CPR and AED use? *Resuscitation*. 2017;119:33-36. doi:10.1016/j.resuscitation.2017.07.031.

Figure A: Utstein Guidelines Applied to Maryland Cardiac Arrest Data



Witnessed Cardiac Arrest – AED Shockable **and** Non-Shockable Arrhythmias

Table 1 includes the descriptive statistics of 6,005 patients who experienced witnessed arrests of presumed cardiac/medical or unknown etiologies during the study period, excluding those patients with documented DNR orders. In keeping with the aforementioned report[1], Table 1 includes OHCA with all types of presenting cardiac rhythms, i.e., AED shockable and non-shockable arrhythmias. Table 1 includes arrests with all types of presenting rhythms in order to allow some measure of comparison to the table from a similar report previously submitted to the Legislature in 2007[1] and to account for individuals who may have been in a shockable rhythm prior to EMS arrival.

The first column in Table 1 lists the location types used by EMS personnel to define where the arrest occurred for each patient. The second column gives the number of OHCAs that happened during the 30 month study period for each location type. The third column gives the number of sites in Maryland for each type of location; location types with a "u" for this column indicate that it was not possible to find a reliable source to provide the number of sites for those location types.

Incidence is a measure of probability of an occurrence that is expressed as a proportion or rate using a denominator. The fourth column, which is highlighted, gives the rate or probability of arrests per the number of sites per year for each location type. These numbers are ranked from highest to lowest and are shown in order to help determine the distribution of arrests within each location type. Knowing how probable it would be to experience an arrest while in a given location type is important to consider when trying determining where to install and provide education for the use of AEDs. In order to evaluate this probability, it is necessary to know how the arrests for a given location type are distributed throughout all of the possible sites in the state for that location type. For example, how likely an individual would be to experience an arrest in any home in Maryland would be dependent on how many arrests happened in homes over the study period and how many homes there are in the state; the resulting figure would identify the rate of cardiac arrest in a home. The highlighted column in Table 1 shows the estimated rate of arrest for each location type over the study period, and the table is organized from location types with the highest arrest rates to the lowest arrest rates. Location types with a "u" for number sites are unranked since they are missing this key number used to determine an arrest rate. The last column gives the percentage of the total arrests that occurred in each location type during the study period to offer context of the breakdown of overall volume.

Witnessed Cardiac Arrest – AED-Shockable Arrhythmias Only

Because Utstein focuses on only those individuals whose initial cardiac rhythms are shockable by an AED, Table 2 further shows a breakdown of only shockable rhythms of witnessed arrests with presumed cardiac or unknown etiologies; these patients would have had the highest

likelihood of responding to CPR and AED and, therefore, survival. Table 2 includes the descriptive statistics of 1,441 patients who experienced witnessed arrests of presumed cardiac or unknown etiologies during the study period **who also presented with AED-shockable rhythms**, excluding those patients with documented DNR orders. Table 2 excludes 4,564 of the patients included in the data analysis in Table 1, who presented with either shockable or non-shockable rhythms. While the number and rank based on arrest rates are slightly different in Table 2, the general description of each column and order of columns are identical to Table 1. Sites that had no arrests were not included in either table.

Table 1: Ranked Out-of-Hospital Witnessed Cardiac Arrests with Medical or Unknown Etiology
(All Ages), Shockable and Non-Shockable Rhythms (CY15, CY16, and first half of CY2017)

Location Types	30 Month Total	# of Facilities	Rate of Arrests per Facility per Yr.	Percent of Total
Airport (B.W.I.)	18	1	7.2000	0.30
Skilled Nursing Facility	541	227	0.9533	9.01
Dialysis	89	134	0.2657	1.48
Jail/Correction Facility	26	68	0.1529	0.43
Convention Center	2	6	0.1333	0.03
Retail Store (enclosed mall)	10	32	0.1250	0.17
Hospital	18	61	0.1180	0.30
Racetrack (Horse or Vehicle)	4	15	0.1067	0.07
Metro/Light Rail Station	5	47	0.0426	0.08
Urgent Care	19	184	0.0413	0.32
Assisted Living Facility	140	1,580	0.0354	2.33
Bay	4	60	0.0267	0.07
Rehabilitation (Substance Abuse)	20	333	0.0240	0.33
Golf Course (Public and Private)	8	148	0.0216	0.13
Public Beach	2	37	0.0216	0.03
Hotel/Motel	48	942	0.0204	0.80
Courthouse	3	65	0.0185	0.05
Theatre/Cinema	6	166	0.0145	0.10
Park	27	1,291	0.0084	0.45
School, College/Community College	5	244	0.0082	0.08
Health Club	17	928	0.0073	0.28
River	1	67	0.0060	0.02
Market/Store (Grocery/Other Community)	55	3,751	0.0059	0.92
School, Elem. through HS, Pub./Non-Pub.	23	2,844	0.0032	0.38
Industrial	23	3,110	0.0030	0.38
Restaurant	64	11,000	0.0023	1.07
Church	29	5,336	0.0022	0.48
Bus Station	8	3,964	0.0008	0.13
House/Apartment/Dorm (Housing Unit)	3,907	2,159,525	0.0007	65.06
Swimming Pool (Public or Semi-Public)	1	2,900	0.0001	0.02
Farm	3	12,300	0.0001	0.05
Daycare	5	u		0.08
EMS or Fire Station	26	u		0.43
Other Building/Premises	88	u		1.47
Public Building (Government)	16	u		0.27
Public Building (Non-Government)	32	u		0.53
Retail Store (not in enclosed mall)	42	u		0.70
Physician/Dentist	58	u		0.97
Other Medical Facility/Premises	41	u		0.68
Forest/Trail/Wilderness	14	u		0.23
Gymnasium	16	u		0.27
Other Recreation	27	u		0.45
Stadium	4	u		0.07
Other Residential	54	u		0.90
Senior/Independent Living Facility	120	u		2.00
Other Transportation	11	u		0.18
Parking Lot/Parking Garage	78	u		1.30
Street/Highway/Road	239	u		3.98
Other Water Related	3	u		0.05
"*blank*"	5	u		0.08
State Total	6,005			100.00

Table 2: Ranked Out-of-Hospital Witnessed, Cardiac Arrests with Medical or Unknown Etiology, Shockable Rhythms Only (All ages)

(CY15, CY16, and first half of CY17)

Location Types	30 Month Total	# of Facilities	Rate of Arrests per Facility per Yr.	Percent of Total
Airport (B.W.I.)	8	1	3.2000	0.56
Retail Store (enclosed mall)	7	32	0.0875	0.49
Skilled Nursing Facility	47	227	0.0828	3.26
Racetrack (Horse or Vehicle)	3	15	0.0800	0.21
Jail/Correction Facility	11	68	0.0647	0.76
Dialysis	19	134	0.0567	1.32
Hospital	7	61	0.0459	0.49
Metro/Light Rail Station	3	47	0.0255	0.21
Golf Course (Public and Private)	7	148	0.0189	0.49
Urgent Care	8	184	0.0174	0.56
Bay	2	60	0.0133	0.14
Courthouse	2	65	0.0123	0.14
Public Beach	1	37	0.0108	0.07
School, College/Community College	4	244	0.0066	0.28
Park	20	1,291	0.0062	1.39
Assisted Living Facility	20	1,580	0.0051	1.39
Theatre/Cinema	2	166	0.0048	0.14
Hotel/Motel	11	942	0.0047	0.76
Health Club	10	928	0.0043	0.69
Market/Store (Grocery/Other Community)	22	3,751	0.0023	1.53
School, Elem. through HS, Pub./Non-Pub.	14	2,844	0.0020	0.97
Industrial	13	3,110	0.0017	0.90
Restaurant	27	11,000	0.0010	1.87
Church	10	5,336	0.0007	0.69
House/Apartment/Dorm (Housing Unit)	874	2,157,089	0.0002	60.65
Bus Station	1	3,964	0.0001	0.07
EMS or Fire Station	9	u		0.62
Other Building/Premises	36	u		2.50
Public Building (Government)	11	u		0.76
Public Building (Non-Government)	17	u		1.18
Retail Store (not in enclosed mall)	25	u		1.73
Physician/Dentist	10	u		0.69
Other Medical Facility/Premises	7	u		0.49
Forest/Trail/Wilderness	7	u		0.49
Gymnasium	12	u		0.83
Other Recreation	15	u		1.04
Stadium	3	u		0.21
Other Residential	11	u		0.76
Senior/Independent Living Facility	20	u		1.39
Other Transportation	3	u		0.21
Parking Lot/Parking Garage	16	u		1.11
Street/Highway/Road	82	u		5.69
Water Related - Other	3	u		0.21
"blank"	1	u		0.07
Total	1,441			100.00

Data Results

Reading from top to bottom, Table 1 ranks location types in order of rates of arrest from highest to lowest, leaving location types unable to be ranked at the bottom of the table. Table 2 is similarly ranked for those arrests with only shockable presenting rhythms, as previously discussed. While the majority of all arrests by volume alone appear to occur in homes (approximately 65% of all arrests per Table 1, and 61% per Table 2), the rate or probability of a cardiac arrest at home is low compared to other public places, such as BWI Thurgood Marshall Airport which has the highest rate at seven per year during the study period. These findings align with other findings published in peer-reviewed studies, although the findings of this study should be interpreted with caution given study limitations[32, 33, 34, 35, 36].

Study Limitations

The current study and its findings should be considered in light of the following limitations. While the number of sites per location type was determined using the most recent data available from federal, state, local, academic, and reputable non-profit sources, these numbers are best estimates and may not be exact representations of the number of sites of each location type. For future data collection and analysis, it may be helpful to include exact definitions of what constitutes a site for each location type so that data collection regarding the location type is more systematic and enumeration of the number of sites for each location type are more precise.

Secondly, missing data or data marked with an "other" response accounted for approximately 13% of responses for witnessed vs unwitnessed and initial rhythm and were excluded (see Figure A). It is unknown how completed responses for these may have affected the findings of this study; however, there is no reason to assume the additional missing data would not be randomly distributed among the location types. For future, data collection and analysis, it may be helpful to discuss improving or streamlining data collection methods in order to facilitate the completion of more responses in the EMS records. To that end, MIEMSS began participating in The Cardiac Arrest Registry to Enhance Survival (CARES), which is a national database designed to help communities assess their response to and outcomes from OHCA by allowing them to compare patient populations, interventions, and hospital discharge outcomes to local, state,

[32] Bardy GH, Lee KL, Mark DB, et al. Home use of automated external defibrillators for sudden cardiac arrest. *N Engl J Med*. 2008;358(17):1793-1804. doi:10.1056/NEJMoa0801651.

[33] Folke F, Gislason GH, Lippert FK, et al. Differences between out-of-hospital cardiac arrest in residential and public locations and implications for public-access defibrillation. *Circulation*. 2010;122(6):623-630. doi:10.1161/CIRCULATIONAHA.109.924423.

[34] Mark DB, Anstrom KJ, McNulty SE, et al. Quality of life effects of automatic external defibrillators in the home: Results from the Home Automatic External Defibrillator Trial (HAT). *Am Heart J*. 2010;159(4). doi:10.1016/j.ahj.2010.01.013.

[35] Mozaffarian D, Benjamin EJ, Go AS, et al. Heart Disease and Stroke Statistics—2016 Update. *Circulation*. 2016;133(4):e38-e360. doi:10.1161/CIR.0000000000000350.

[36] Fordyce CB, Hansen CM, Kragholm K, et al. Association of public health initiatives with outcomes for out-of-hospital cardiac arrest at home and in public locations. *JAMA Cardiol*. 2017; 2(11):1226-1235. doi: 10.1001/jamacardio.2017.3471.

and national statistics. Maryland will have its first full year of robust data from all EMS operational programs, including hospital discharge outcomes at the end of calendar year 2017.

Study Conclusions

By far, the location type with the highest rate of cardiac arrest is BWI Thurgood Marshall Airport which is logical given the number and variability of passengers that travel through the airport every day. BWI has its own Fire and EMS system on site and maintains AEDs throughout the airport, as do most large airports. The remaining rates in Tables 1 and 2 are randomly distributed across location types which compares similarly with the data provided in the 2007 report[1].

After BWI Thurgood Marshall Airport and skilled nursing facilities, there were no sites during the study period that had a remarkably high rate of cardiac arrest. Nonetheless, AEDS may be considered for placement in high traffic areas where large numbers of people are present for significant periods of time, or in locations where individuals at high risk may be present. While cardiac arrest can occur at any age, risk of cardiac arrest increases with age, especially after age 50 and in individuals who have suffered a previous cardiac arrest or who have been diagnosed with conditions that may trigger an event.

AED and Supplemental Equipment Cost

MIEMSS obtained quotes from three vendors on new AEDs which ranged from $880 to $1,695 and include adult pads, batteries, and carrying cases. The new AEDs all have eight-year warranties. The Maryland Public Access AED Program requires two sets of adult pads be kept with the AED. Batteries and pads are required to be checked monthly to be sure the batteries are charged and the pads have not expired. Replacement batteries and adult pads for new AEDs are sold together and are necessary every 2-4 years at a cost from $103 to $150. For locations with large numbers of young children on-site (under 8 years of age), a pediatric dose attenuator or pediatric pads are also recommended although adult pads may be used if a pediatric dose attenuator is not available. They range in price from $68 to $116.

Subject to availability, certified pre-owned (CPO) AEDs also may be an option. Currently, three makes/models are available from one of the vendors that provided quotes and range in price from $500-$850 which includes adult pads, battery, and carrying case. There is a one year warranty and trade back options toward purchase of a new or another pre-owned AED. Replacement batteries and pads must be purchased separately every 2-4 years.

Wall mount cabinets are an additional charge and range in price from approximately $130 to $330 which does not include actual installation. The Philips AEDs also can be mounted directly to the wall in the carrying case on a bracket which costs $64. None of the vendors provide installation but indicate the cabinets are very easy for the customer to mount themselves. Wall

mounted cabinets are not a requirement of the Maryland Public Access AED Program but AEDs must be visible and accessible to anyone willing to use them. State tax and shipping fees are not included in the quotes.

AED Equipment Pricing Information –

New Units

Vendor Name	AED Make/Model (New)	AED unit Price*	REPL Batt/Pad Pack	Wall Cabinet
Physio-Control	LIFEPAK CR Plus	$1,698.00	$123.00	$330.00
Philips Healthcare	Heartstart HS1	$880.00	$102.70	$164.00
Philips Healthcare	Heartstart FRX	$1,268.80	$117.00	$164.00
Enerspect Medical Solutions	Heartsine samaritan 350P	$899.00	$150.00	$130.00
Enterspect Medical Solutions	Heartsine samaritan 360P	$999.00	$150.00	$130.00

* Unit price includes battery, adult pads, and carrying case

Certified Pre-Owned

Vendor Name	AED Make/Model (CPO)	AED Unit Price*	REPL Batt/Pad Separate	Wall Cabinet
Enerspect Medical Solutions	Lifepak 500	$500.00	$278.00/$50.00	$130.00
Enerspect Medical Solutions	Cardiac Science G3	$650.00	$305.00/$50.00	$130.00
Enerspect Medical Solutions	Philips Heartstart FRX	$850.00	$110.00/$50.00	$130.00

* Unit price includes battery, adult pads, and carrying case

CPR & AED Training

Entities wishing to participate in the Public Access AED Program are required to have an AED Coordinator, as well as individuals who are expected to operate the AED, who must complete CPR and AED training and subsequent refresher training in accordance with their training course requirements. These courses must, at a minimum, include content consistent with the recommendations for layperson CPR and AED training in the most current publication of the American Heart Association Guidelines for CPR and Emergency Cardiovascular Care. The courses typically take two and a half to three hours to complete and include cognitive learning, as well as hands-on demonstration of skills proficiency. The courses are instructor-led and teach adult and child CPR and AED use, infant CPR, and how to relieve choking in adults, children, and infants. Space is limited as there is a maximum instructor-to-student ratio. The cost

information provided includes courses where the student goes to the facility where the course is being taught but does not include the cost of an instructor(s) coming to a facility that wishes to train its employees on-site. One of the options includes an online component of the classroom part of the training followed by a hands-on demonstration of skills. MIEMSS found courses ranging in price from $55 to $90 per person, and all require renewal every two years.

CPR/AED Training Information

Vendor Name	Course	Method of Instruction	Cost PP	Renewal
American Red Cross	Adult/Pediatric CPR/AED	Classroom	$90	2 years
KTB Training	Heartsaver CPR/AED	Classroom	$60	2 years
St. Agnes Hospital	Heartsaver CPR/AED	Classroom	$55	2 years
Anne Arundel Medical Center	Heartsaver CPR/AED	Classroom	$75	2 years
Howard County General Hospital	Heartsaver CPR/AED	Classroom	$55	2 years
Chesapeake AED Services	Heartsaver CPR/AED	Online/Classroom	$85	2 years

Immunity from Liability Provisions in Maryland law

Maryland law has several statutory provisions regarding immunity for facilities that purchase AEDs and make them accessible for use in the event of a cardiac emergency through the Maryland Public Access AED (PAD) Program and individuals using an AED.

The PAD statute, Education Article Section 13-517, Annotated Code of Maryland, provides specific immunity for individuals who use an AED, as well as the facility providing the AED. In addition, regional council AED committee members are also provided immunity.

The statute provides:

> (j)(1) In addition to any other immunities available under statutory or common law, a registered facility is not civilly liable for any act or omission in the provision of automated external defibrillation if the registered facility:
>
> (i) Has satisfied the requirements for making automated external defibrillation available under this section; and
>
> (ii) Possesses a valid certificate at the time of the act or omission.

(2) In addition to any other immunities available under statutory or common law, a member of the regional council AED committee is not civilly liable for any act or omission in the provision of automated external defibrillation.

(3) In addition to any other immunities available under statutory or common law, an individual is not civilly liable for any act or omission if:

(i) The individual is acting in good faith while rendering automated external defibrillation to a person who is a victim or reasonably believed by the individual to be a victim of a sudden cardiac arrest;

(ii) The assistance or aid is provided in a reasonably prudent manner; and

(iii) The automated external defibrillation is provided without fee or other compensation.

(4) The immunities in this subsection are not available if the conduct of the registered facility or an individual amounts to gross negligence, willful or wanton misconduct, or intentionally tortious conduct.

(5) This subsection does not affect, and may not be construed as affecting, any immunities from civil or criminal liability or defenses established by any other provision of the Code or by common law to which a registered facility, a member of the regional council AED committee, or an individual may be entitled.

Under these immunity provisions, a facility which is registered with MIEMSS, has a valid certificate to provide public access defibrillation, and complies with the requirements found in COMAR 30.06 is not civilly liable for damages as the result of the provision of the AED, as long as the actions were not willful or gross negligence. The individual using the AED is provided immunity protections under this provision as well. In addition to the immunity provided in the AED statute, an individual who uses an AED may be able to claim immunity under the "Good Samaritan" law found in Courts and Judicial Proceedings Article, Section 5-603 which provides:

(a) A person described in subsection (b) of this section is not civilly liable for any act or omission in giving any assistance or medical care, if:

(1) The act or omission is not one of gross negligence;

(2) The assistance or medical care is provided without fee or other compensation; and

(3) The assistance or medical care is provided:

(i) At the scene of an emergency;

(ii) In transit to a medical facility; or

(iii) Through communications with personnel providing emergency assistance.

(b) Subsection (a) of this section applies to the following:

(1) An individual who is licensed by this State to provide medical care;

(2) A member of any State, county, municipal, or volunteer fire department, ambulance and rescue squad, or law enforcement agency, the National Ski Patrol System, or a corporate fire department responding to a call outside of its corporate premises, if the member:

(i) Has completed an American Red Cross course in advanced first aid and has a current card showing that status;

(ii) Has completed an equivalent of an American Red Cross course in advanced first aid, as determined by the Secretary of Health and Mental Hygiene; or

(iii) Is certified or licensed by this State as an emergency medical services provider;

(3) A volunteer fire department or ambulance and rescue squad whose members have immunity; and

(4) A corporation when its fire department personnel are immune under paragraph (2) of this subsection.

(c) An individual who is not covered otherwise by this section is not civilly liable for any act or omission in providing assistance or medical aid to a victim at the scene of an emergency, if:

(1) The assistance or aid is provided in a reasonably prudent manner;

(2) The assistance or aid is provided without fee or other compensation; and

(3) The individual relinquishes care of the victim when someone who is licensed or certified by this State to provide medical care or services becomes available to take responsibility.

An individual administering an AED or a facility providing an AED may raise these immunity provisions as a defense to any civil claim brought as a result of the use of an AED or the failure to use the AED. Neither of these two statutory sources of liability protection is limited to

individuals who are trained to use the AEDs and would apply to untrained lay rescuers who use an AED in a cardiac emergency.

Additionally, the Court of Special Appeals recently held that Maryland businesses that opt to have a defibrillator on-site have no legal obligation to use it in case of a cardiac emergency. The Court stated that the statute is "designed to encourage the installation of AEDs in places of business and public accommodation" but does not impose a duty to use an AED.[37]

[37] *Valerie TRIM, et al. v. YMCA OF CENTRAL MARYLAND, INC.* 233 Md.App. 326, 2017.

Appendix A

Cardiac Arrest Steering Committee Membership and Meeting Attendees

American Heart Association
Michaeline Fedder, MA
Government Relations Director, Maryland
Amanda Davani, MS
Director, Quality and Systems Improvement, MD & DC
217 East Redwood Street
Baltimore, Maryland 21202

Maryland Department of Health
Albert J Romanosky MD PhD
Medical Director / State Emergency Preparedness Coordinator
Office of Preparedness and Response
300 West Preston Street, Rm 202
Baltimore, MD 21201

Maryland State Department of Education
Alicia Mezu, MSN/Ed, BSN, BS, RN
Health Services Specialist
Student Services and Strategic Planning Branch
200 W. Baltimore Street
Baltimore, MD 21201-2595

Maryland Resuscitation Academy
Kevin Seaman, MD, FACEP (Committee Chairman)
Medical Director Maryland Resuscitation Academy/Medical Director Charles County EMS
Charles County EMS
10425 Audie Lane
La Plata, MD 20646

Maryland State Firemen's Association
William Dousa, CRT-I
Abingdon Volunteer Fire Company
3306 Abingdon Road
Abingdon, MD 21009

Chestnut Ridge Volunteer Fire Department
Beth Philipson, RN, BSN, CEN, NRP
12020 Greenspring Avenue
Owings Mills, MD 21117

Frederick 9-1-1 Center
Karlea Brown, EMD
110 Airport Drive East
Frederick, MD 21701

Harford County Fire and EMS
Linda Dousa, CRT-I
Abingdon Volunteer Fire Company
3306 Abingdon Road
Abingdon, MD 21009

Baltimore County Fire and EMS
Captain Steve Adelsberger, NRP
700 E. Joppa Road
Towson, MD 21286

Howard County Fire and EMS
Matthew Levy, MD
Medical Director
6751 Columbia Gateway Dr
Columbia, MD 21046

Montgomery County Fire and Rescue
Captain Bob Lindsey, NRP
Office of Quality Improvement
100 Edison Park Drive, 2nd Floor
Gaithersburg, MD 20878

Prince George's County Fire and EMS
Jorge Pacaur, NRP
FF/PM PP – CPR Coordinator/CODE STAT/QA-QI
6820 Webster Street
Landover Hills, Md. 20784

BWI Thurgood Marshall Airport Fire and Rescue
Robert Reynolds, NRP
Program Manager, Public Access Defibrillation
CPR Training Coordinator
Designated Infection Control Officer
Fire Department Quartermaster
PO BOX 8766
BWI Airport, MD 21240

August 15, 2017

Kevin Seaman, MD (Chair), Maryland Resuscitation Academy

Jen Anders, MD; Johns Hopkins Hospital

Jorge Paucar; Prince George's County Fire & EMS

Linda Dousa; Harford County Fire & EMS

Bill Dousa; Maryland State Firemen's Association

Al Romanosky, MD, Maryland Department of Health

Rob Reynolds; BWI Thurgood Marshall Fire & EMS

Beth Philipson; Chestnut Ridge Fire & EMS

Bob Lindsey; Montgomery County Fire & Rescue

Chris Dew; Annapolis Fire & EMS

Karen O'Connell, MD, Children's National Medical Center

September 13, 2017

Kevin Seaman, MD (Chair), Maryland Resuscitation Academy

Beth Philipson, Chestnut Ridge Volunteer Fire Department

Matt Levy, MD, Howard County Fire & EMS

Steve Adelsberger, Baltimore County Fire & EMS

Amanda Davani, American Heart Association

Michaeline Fedder, American Heart Association

Becky Piasecki, Johns Hopkins University

Kristin Roller, Maryland State Department of Education

Alicia Mezu, Maryland State Department of Education

Bill Dousa; Maryland State Firemen's Association

Linda Dousa; Harford County Fire & EMS

Jorge Paucar, Prince George's County Fire & EMS

Gil Genn, Esq., Representing Maryland American College of Cardiology

October 16, 2017

Kevin Seaman, MD (Chair), Maryland Resuscitation Academy

Al Romanosky, MD, Maryland Department of Health

Robert Reynolds, BWI Thurgood Marshall Airport Fire & EMS

Steve Adelsberger, Baltimore County Fire & EMS

Karlea Brown, Frederick County 9-1-1

Joe Leake, Baltimore County Public Schools

Beth Philipson, Chestnut Ridge Volunteer Fire Department

Matt Levy, MD Howard County Fire & Rescue

Becky Piasecki, Johns Hopkins University

Gil Genn, Esq., Representing Maryland American College of Cardiology

Michaeline Fedder, American Heart Association

Amanda Davani, American Heart Association

John Tutt, American Heart Association

Bob Lindsey, Montgomery County Fire & Rescue

Nisha Chandra-Strobos, MD, Johns Hopkins Bayview

Melvin Thompson, Maryland Restaurant Association

Alicia Mezu, Maryland State Department of Education

Jorge Pacaur, Prince George's County Fire & EMS