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Paragem cardiorrespiratória: os cardiodesfibrilhadores
automáticos externos podem mesmo ajudar?

Sudden cardiac arrest: can automatic external
defibrillators really help?

FEVEREIRO, 2020

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Faculdade de Medicina da Universidade do Porto, 05/02/2010

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DESIGNAÇÃO DA ÁREA DO PROJECTO

Ciências da Saúde

TÍTULO DISSERTAÇÃO/MONOGRAFIA (riscar o que não interessa)

Paragem cardiorrespiratória: os cardiodesfibriladores automáticos externos podem mesmo ajudar?

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Faculdade de Medicina da Universidade do Porto, 05/02/2020

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Dedicatória

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Título: Paragem cardiorrespiratória: os cardiodesfibriladores automáticos externos podem mesmo ajudar?

Title: Sudden cardiac arrest: can automatic external defibrillators really help?

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(PT) Resumo:

A doença cardiovascular é uma das principais causas de morte no mundo. A primeira manifestação de doença cardiovascular é frequentemente a paragem cardiorrespiratória. É já conhecido que a taxa de sobrevivência a uma paragem cardiorrespiratória diminui com o aumento do tempo entre o reconhecimento desta e a chegada da emergência médica. O reconhecimento precoce, a ressuscitação cardiopulmonar e desfibrilhação atempada são cruciais para um prognóstico favorável. Para aumentar as taxas de sobrevivência à paragem cardiorrespiratória, quando esta ocorrer em locais públicos (como aeroportos, centros comerciais, estádios, escolas), afastados dos serviços de emergência médica próximos (mais do que 5 minutos de acordo com as recomendações da *American Heart Association*), é crucial uma intervenção rápida após reconhecimento de uma possível paragem cardiorrespiratória. Estes locais devem definir um plano de emergência estratégico para responder a estas situações, que inclua um cardiodesfibrilhador automático externo, disponível para uso imediato aquando a apresentação da vítima com um ritmo desfibrilhável. Inúmeros países introduziram nas suas leis programas de desfibriladores acessíveis ao público leigo, de modo a aumentar significativamente as taxas de sobrevivência após paragem cardiorrespiratória em espaços públicos, promovendo um acesso mais rápido e eficaz a estes dispositivos, assegurando o desenvolvimento concomitante de planos de emergência e o treino de funcionários locais, principalmente, mas também da comunidade em geral.

Embora a legislação portuguesa já tenha sofrido alterações neste âmbito, este país ainda está bastante atrasado em termos de desenvolvimento e aplicabilidade de programas de desfibrilhação em espaços públicos, não sendo estes, infelizmente, acessíveis ao público em geral.

Palavras-chave: Paragem cardiorrespiratória; desfibriladores automáticos externos; programas de acesso público a desfibriladores; planos de emergência.

(EN) Abstract:

Cardiovascular disease is one of the main causes of death all over the world. The first manifestation of cardiovascular disease is frequently a sudden cardiac arrest. It is well known that the survival rate of sudden cardiac arrest decreases dramatically with a longer time between its recognition and the arrival of emergency medical services. Early recognition, cardiopulmonary resuscitation maneuvers and defibrillation are crucial to a good outcome. To improve the survival rates of sudden cardiac arrest, when it occurs in crowded public places (such as airports, shopping centers, sports venues or big schools), far from emergency medical services (more than 5 minutes according to American Heart Association guidelines), it is crucial to quickly help the victim after the recognition of sudden cardiac arrest. Public places must have a defined emergency plan in order to respond effectively to these situations and it must include access to an automated external defibrillator, easily available to use when the victim presents with a shockable rhythm (such as ventricular fibrillation). A great number of countries have introduced in its laws public access defibrillator programs in order to improve survival rates of witnessed sudden cardiac arrest in public places, providing a faster access to defibrillators, ensuring the development of emergency plans and training of lay people as well as community in general.

Although some modifications in law have been already done by Portuguese legislators in the past, Portugal is still far behind other countries in terms of development of public access defibrillator programs and its application.

Keywords: sudden cardiac arrest; automated external defibrillators; public access defibrillator programs; emergency action plans

Abbreviations

English	Abbreviation	Português	Abreviatura
Sudden Cardiac Arrest	Paragem Cardiorrespiratória	SCA	PCR
Public Access Defibrillator	Cardiodesfibriladores de acesso público	PAD	Sem abreviatura
Automated External Defibrillators	Cardiodesfibriladores automáticos externos	AED	Sem abreviatura
Emergency action plans	Planos de ação de emergência	EAP	Sem abreviatura
Out-of-hospital cardiac arrest	Paragem cardiorrespiratória fora do hospital	OHCA	Sem abreviatura
Cardiopulmonary resuscitation	Ressuscitação cardiopulmonar	CPR	Sem abreviatura
Emergency medical services	Serviços de emergência médica	EMS	Sem abreviatura

Introduction

Across Europe, more than 4 million deaths each year are attributed to cardiac death (45% of all deaths)¹, particularly in Portugal, cardiovascular disease is also the main cause of death. A recent study showed in Portugal that stroke is still the leading cause of death and just below it is ischemic heart disease².

The first manifestation of cardiovascular disease is frequently sudden cardiac arrest (SCA), with a global average incidence of 55 out-of-hospital cardiac arrests (OHCA) per 100 000 person-years, according to *Berdowski, et al*³. SCA is the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation by the standard Utstein definition⁴. Nearly half of sudden cardiac death subjects do not have a previous diagnostic of heart disease and the predictability of this event is poor⁵.

Early defibrillation (within 3-5 minutes of collapse) after SCA is the most effective intervention affecting survival rates (50-70%)⁶. Automatic external defibrillators (AED) are devices that provide an electrical shock to a victim's heart when placed in the chest and notice a shockable cardiac rhythm, such as ventricular fibrillation. Other rhythms, such as asystole and pulseless electrical activity, are considered non shockable, so in these cases, AED will not work. AEDs should work automatically, emitting voice prompts to the user, making this instrument easily usable for the general population, even without previous appropriate training in emergency first-aid⁷.

The American Heart Association identifies 4 steps to implement a "chain of survival" for ventricular fibrillation sudden cardiac arrest victims: in first place, after a prompt recognition of SCA, it should be available an early access to emergency medical services - EMS (which means making a call or somehow activate them); in second place, start bystander cardiopulmonary resuscitation (CPR) as soon as possible; then, if available, early delivery of defibrillation shock with AEDs; and finally, early advanced cardiac life support when EMS arrives⁸ (figure 1).

Bearing in mind that most SCA cases occur in an out-of-hospital setting, a great number of countries have developed programs to place AEDs in public places (named public access defibrillators – PAD - programs). This measure is recommended^{6,9} and considered cost-effective as long the AEDs are available in places like airports, casinos, fitness facilities, sports venues, shopping centres, colleges, high schools, among other places used by a considerable number of people, in which is probable to have at least one SCA each 5 years^{7,10}.

In this work, some of the actual recommendations for AEDs use and PAD programs regulation will be reviewed and discussed, particularly its use in schools and athlete setting, as well as in a specific population like younger SCA victims.

Actual international recommendations for automated external defibrillators use

In 2004, after verify the importance of using AEDs in the management of sudden cardiac arrest and the impact on public health, the European Society of Cardiology (ESC) along with European Resuscitation Council (ERC) developed European recommendations for legislation on defibrillation, AED use training and AED community programmes ¹¹. They define that AED programs should be a goal to every European country; not only within the EMS but also expanding its placement in public places. It will allow bystanders and laypeople to participate in the “chain of survival”, reducing the time-to shock and increasing the survival rate of SCA victims. They also recommend a cost-effectiveness analysis in order to determine the appropriate sites of AED implementation.

In these guidelines, this group recognized that European countries had a heterogeneous legislation concerning AEDs and defibrillation act. Moreover, they recommended that defibrillation “should be lifted from the list of actions “reserved to doctors”” and supporting the implementation or change of healthcare legislation should be a goal of all European governments, making AEDs access and use a widely spread lifesaving strategy.

In order to implement a PAD program, it should be considered epidemiological data of sudden death in the area of displacement. It is also recommended to have a protocol that includes access to EMS in a short time; also, it is important to identify potential responders, based on local conditions, and that first responders should have some training in first aid and defibrillation. General community training is also recommended. It's also necessary monitoring of the programme, obtaining data to quantify its efficacy and quality.

The most updated European recommendation on this matter came from European Resuscitation Council, in 2015 ^{6, 12}. These guidelines highlight the importance of prompt defibrillation by bystanders in increasing the survival rate by improving the time of shock and the communication with the emergency medical services.

The importance of including bystanders in the “chain of survival” described in this document is crucial. It includes early recognition and call for help (dialling 112 in Europe); early CPR; early defibrillation; and post resuscitation care. The probability of survival to discharge reduces 10-12%

per each minute of delay to defibrillation. But, if someone, a bystander for example, recognizes an SCA and start CPR right away, per each minute of delay in defibrillation process the survival only declines 3,2% ¹³.

ERC guidelines also value the education and training of laypeople in public places to immediately recognize SCAs and to perform basic life support, not only CPR but also defibrillation using AEDs ¹². The advantages of providing some training are increasing general awareness of use of AEDs and its availability, providing opportunities to dispel some myths about its use, and improve the performance of the trainees (recognition of these situations, correct CPR, AEDs use speed and correct pad placement).

Public Access Defibrillator Programs

Public access defibrillation can be described as the use of an AED by persons other than medical personnel and other trained people. Public Access Defibrillator (PAD) programs aim to make AEDs available for laypersons, in places that will be probably stage of out-of-hospital cardiac arrest (OHCAs). The main goal is to reduce time-to-shock, allowing AED use before EMS arrival. They include also the standard training of first responders, usually staff working in these places, but they also aim to achieve a general basic life support training to the community around these locations.

PAD programs are very heterogeneous: they include static AED provision in public places; mobile AED provision by identifiable first responders such as community volunteers, policemen or firefighters; or both in the same program ¹⁴.

Marenco et al., in 2001, predicted the future evolution of AEDs, making them more accurate, lightweight, affordable and intuitive and that they should become available to public access ¹⁵. Several studies in the last few years tried to demonstrate that PAD programs significantly improve survival rates in case of OHCA and other healthcare outcomes and these programs can be cost-effective. For instance, in a large community-based trial, patients with OHCA, in places where

laypeople were trained and had available AEDs and use it before EMS arrival, had a greater survival rate compared to those trials where laypeople only performed CPR ¹⁴.

In the *EuReCa* analysis, investigators were able to assess community involvement in OHCA, determining an increasing number of CPR attempts (by bystanders and EMS staff) after the recognition of SCA ¹⁶. Witness a SCA is an important step to improve survival to hospital discharge, once that bystanders may at least call for help and execute CPR in the moment. According to some evidence, in theory at least 30% of lives could be saved if targeted members of the public could have early access to an AED and its use ⁷. *Holmberg et al* ¹⁷ in their work also collected some evidence that AEDs use by bystanders improved survival to hospital discharge and neurological outcomes when applied in out-of-hospital cardiac arrest victims with an initial shockable rhythm. They also found that AED use may be useful in non-shockable rhythms, for example, using voice prompts by the device to guide a correct and CPR.

Bochum project data recognizes the efficacy of the training of several first-responders within the city, identifying the high-risk places to OHCA to place AEDs ¹⁸. Other German study point in the same direction, advising the development of PAD programs ¹⁹. The results of PAD trial in North America, counting with 622 public or residential locations where AEDs were placed, also show similar results, concluding that places where EMS response times are very long, the presence of trained lay responders and the availability of AEDS may increase the survival after OHCA ¹⁴.

Kitamura et al, accessing data from public-access defibrillation in Japan, from 2001 to 2015, suggests that there was an increased availability of AEDs and its use, which led to an improvement in survival at one month with minimal neurological deficits ²⁰.

Although previous studies often refer trained laypeople, it has been questioned if AEDs training should be mandatory to the effective use of AEDs. Reasonable evidence support that no training is needed to AED use ^{21, 22}, but even a brief training (and it doesn't need to be an instructor-led training course) can improve the speed of shock delivery and electrode pad placement ²². Other evidence points out that even children can be taught how to appropriate use AEDs after some video training ⁷. *Gundry et al* studied untrained sixth-grade children using AEDs versus EMS AED trained staff and observed small and not clinically relevant differences between the groups and

the untrained lay subjects, children, demonstrated a proficient electrode placement and followed the safety precautions with the AED system used (indicated by the voice prompts) ²³.

When setting a PAD program, a cost-effectiveness evaluation is an important tool to verify the importance of placing AEDs in a specific location.

AEDs can have a wide range of costs, depending upon the features of the device. Adding this cost, it also requires human monitoring and often training programs.

To produce a cost-effective PAD, *Winkle* showed that the actual evidence implies the placement of AEDs at sites where there is a high density of both potential victims and resuscitators, such as aircraft, large airports and casinos, some large sports venues and shopping malls. He also mentions that put AEDs in golf courses, health clubs/gymnasiums and places like these is not a cost-effective action, but it can be helpful in improving public awareness of the SCA occurrence and what to do after witnessing it ¹⁰. Additionally, *Moran et al* refer that national PAD programs that include widespread deployment of AEDs are unlikely to be cost-effective and advice the placement of these devices in target locations with highest incidence of OHCA, in order to improve the cost-effectiveness of this measure. Nevertheless, efforts should be made to increase AED utilisation, improving public awareness and increasing CPR and AED training ²⁴. Both refer that it is quite relevant in a cost-effectiveness context to develop a clear regulation to AEDs implementation in certain places.

Indeed, it should not be forgotten the relevance of public education and mass media support in a PAD program, as a mean of spread AEDs availability and its use recommendations ²⁵.

Once PAD programs become widely spread, strategies to improve AEDs use by trained laypeople should be considered. *Nichol et al* described several strategies including a mobile phone-based AED program, in which a bystander calls the EMS and dispatchers notify local first responders about the location of the event and send them via text message the location of nearby AEDs. Other possible strategy is encouraging trained people to have personal AEDs, and these ones will be notified about the occurrence of a SCA. They also suggest deployment of AEDs to the scene by drones ²⁶.

Specific Population – Children and adolescents

Cardiac arrest is much less common in children, and among this age group around 50% happens in infants less than 1-year-old. The range of causes is diverse, but major causes usually are sudden infant death syndrome and respiratory disease. Injuries and drowning also represents important causes of SCAs ²⁷.

Some studies show that when ventricular fibrillation is the initial rhythm, a ready defibrillation leads to higher initial resuscitation rate and good neurological outcomes at discharge time. But it is also known that VF is not the most common rhythm found in children less than 17 years old (asystole and pulseless electrical activity are more commons) ²⁸.

The overall rate of survival after pediatric OHCA is poor. An early recognition of SCA in the young with an immediate use of CPR and AED can improve survival rate ²⁹. Moreover, in this age group, collapse may be accompanied by seizure-like activity and agonal respirations, which may delay the diagnosis of SCA and resuscitation maneuvers ³⁰.

AEDs available in the market usually deliver energy doses that exceed the recommended monophasic dose of 2-4 J/kg in children less than 8 years old. AHA advises that future studies are needed to improve a current AED algorithm sensitivity and specificity to detect SCAs rhythm in children ^{29, 31}.

Children also have an important paper as AEDs users. *Fuchs* defends that children can effectively learn how to perform CPR and use an AED. Her study advocates that educating and certifying children in CPR and AED use skills and providing a periodic re-training will result in a subsequent more informed and effective population ³².

Specific Cases – Schools and Sports settings

- ***Schools setting***

American Heart Association recommends the placement of AEDs in schools with a reasonable probability of at least one cardiac arrest over the next 5 years, those with any student at high risk for cardiac arrest, or those with an emergency call to shock time more than 5 minutes ⁷. It is also recommended a medical emergency response plan annually practiced, a coordinated communication system, staff and student CPR training ³³.

There is evidence that the presence of AEDs in high schools is clearly associated with better overall survival outcome after SCA ^{34, 35}. *Drezner et al* studied SCA occurring in USA high schools with AED programs with a survival to hospital discharge rate of 78% when the school has an AED program and used it. It also showed an 87% survival rate when victims had on-site defibrillation, suggesting SCA among students can be a survivable event if prompt treatment and AED access and use ³⁴. In this study 2/3 of SCA cases occurred at an athletic venue, so it may be wise to place AEDs near these locations if resources are limited.

Schools reported that funding is an obstacle to include AEDs in the school emergency plan ^{34, 35}. 13-20% of the schools analysed in these studies had no AED and among these schools about half had no emergency action plan. The presence of AEDs was associated with schools more likely to have an emergency plan for SCAs.

However, *Lear et al* study has controversial results. 4400 Ohio schools were provided with AEDs and staff were trained to AED use. Of those, only 53% reported to have an emergency action plan, although staff training of staff and devices maintenance had been successful in around 90% of the schools. The survival rate after SCA in this schools was about 60% when an AED was deployed. Only 16% of the schools fulfilled all the AHA recommendations that were stated in the Ohio legislation ³⁶.

Meredith et al found that schools with enrolments of 1000-1499 and 1500 or more students are more likely to have SCA, suggesting that AED deployment may be particularly relevant in these cases ³⁷. Cost-effectiveness analyses may be positive in these settings, given the higher rate of SCAs, compared with small schools.

Besides the improvement in survival rates after SCA in school setting, AEDs placement and development of an emergency response plan may be the trigger to engage all the scholar

community, including students, in an educational program for basic life support and AED use, increasing the pool of individuals with the ability to become lay rescuers ³⁸.

To exemplify the above mentioned: *Project ADAM* (automated defibrillators in Adam's memory) started in 1999. It had 3 aims: education to SCA recognition and identification of warning signs as primary prevention; advocacy for high school student education and CPR training before graduation; and establishment of CPR-AED programs in Wisconsin schools. A preliminary review on this project showed a 93% adherence by schools and a survival rate of 46% after SCA, higher than the poor OHCA survival rate in children and adolescents previously reported ³⁹.

- ***Sports setting***

Sudden cardiac arrest is one of the major causes of death in young athletic setting. Usually there is a structural cardiac abnormality causing this manifestation, such as hypertrophic cardiomyopathy or coronary arteries anomalies. In a small percentage, it can be caused by other pathologies for instance, myocarditis, channelopathies, arrhythmogenic right ventricular dysplasia, Marfan syndrome, among others ⁴⁰. SCA prevention includes cardiac screening (medical history, with a family history of cardiac diseases and risk factors, focused physical examination and 12-lead resting ECG) in competitive athletes. This screening is quite important and it should exclude all the diseases above ⁴¹.

On the other hand, commotio cordis is a blunt, non-penetrating injury in the chest, resulting in a fatal ventricular arrhythmia, usually in a normal structure/electric heart (figure 2). It is also a cause of sudden death in athletes, occurring during competitive sports activities, representing in some settings, a common cause of sudden cardiac death in young athletes ⁴². It occurs mostly in men, about 50% with ages between 11 and 20 years old ⁴³.

The American Heart Association had alerted to the need of public awareness to recognize commotio cordis in any athlete after a blow to the chest from a solid projectile. They also recommended rapid initiation of CPR and defibrillation, considering that ventricular fibrillation often occurs immediately after the chest wall impact and it is always a shockable rhythm ⁴⁴.

A shorter time between collapse and resuscitation along with available defibrillation by on-site AEDs can significantly influence survival rate after commotio cordis, since it occurs in the absence of heart disease ⁴⁵. This condition has been known to have a very low survival rate, around 25%, according to data from 1996 to 2004 ⁴⁶, but more recent data showed that survival following commotio cordis is now around 58% ⁴⁵. This crucial improvement in the last years was associated with increased awareness and recognition of the phenomenon and prompt resuscitation efforts along with increased availability of AEDs in the community, including sports events ^{45, 47}.

In a sports setting, not only the athletes can be victims of SCAs, but spectators, trainers and other staff working in that sports venue can also become victims even in a greater percentage than young athletes ⁴¹ (67-77% of the SCA cases in NCAA Division I and NCAA Division II and III universities, according to *Drezner et al* ^{48, 49}).

There is still a limited research available regarding early defibrillation programs in athletic setting, but recent data show an improvement in survival rate: *Aschieri et al* found an overall neurologically intact survival rate of 58%; moreover, having an AED on-site was associated with favourable neurological outcome - 93% in SCAs occurring in sports centres with on-site AED, versus 9% in centres without on-site AED, because on-site AEDs resulted in a lower time to first shock compared to EMS-delivered AED ⁵⁰.

Early defibrillation is always the crucial strategy to improve survival rates. *Drezner* recommends that a high suspicion of SCA should be maintained in any collapsed and unresponsive athlete. AED should be applied as soon as possible in order to analyse the cardiac rhythm and deliver a shock if indicated ⁵¹.

It is known that sports venues are still not ready for SCA management. *Schmied et al* study analysed SCA incidence and prevention strategies used by *Fédération Internationale de Football Association* (FIFA) member associations and found out that only 2/3 of the associations had an official medical action plan and a similar percentage had requested AEDs regularly during official matches and just 1/3 had AEDs during training sessions. After disclosure of these results, FIFA decided to provide each member association with an AED and educate paramedics, coaches, referees to assist in these critical events, following an action plan previously established ⁵².

In a statement in 2002, the American Heart Association along with the American College of Sports Medicine advised the placement of AEDs in sports facilities with a large number of members and spectators and sports venues where it is expected more than 5 minutes to EMS arrival after recognition of SCA. They also promoted special AED programs to specific risk populations such as elderly sports programs ⁵³.

Implementing AEDs in specific setting should be part of an emergency response plan which implies a coordination between local EMS and health officials. Trainers should be the first responders and be trained in basic life support and AED use. The AEDs must be placed in a central location, such as a training room or a medical room, where there's usually staff, promoting an easier access to these devices ⁵⁴. A medical action plan should be written and regularly revised, describing the AEDs location in the sports venue and different events may have specific emergency plans according to its characteristics. This plan should be available for trainers, referees, athletes and other staff ^{41, 51}.

Portugal – What have we achieved

By the law nº. 188/2009, published in August 12th in 2009, Portuguese legislators introduced the first law allowing non-doctors to use AEDs, in an out-of-hospital setting, in an EMS context and a public access program to be implemented in the near future ⁵⁵. In a first step, AEDs should be installed and used in ambulances and other emergency vehicles and also in some public places (but which weren't defined by this law).

After the publication of European Resuscitation Council Guidelines for Resuscitation in 2010, it was introduced the first amendment in law nº 188/2009, so by the law nº. 184/2012 it was established as obligatory the installation of AED devices in public places such as commercial stores or departments with an area equal or superior to 2000 m²; shopping centres, with a total area equal or superior to 8000 m²; airports and commercial harbours; busy train, metro and bus stations; sports and recreation venues, with a capacity of over 5000 people ⁵⁶. It was set a 2-

years term to implement this law, so in September of 2014, Portugal had set PAD programs in many public places around the country.

The national program for AED (in Portuguese, *Plano Nacional de Desfibrilhação Automática*) is the competence of INEM, I.P. (*Instituto Nacional de Emergência Médica*), that regulates and defines the priorities and criteria to implement AED programs, establishing the monitoring mechanisms and defining the content of AEDs training ⁵⁷.

INEM, I.P. produced a manual of basic life support including AED use (figure 3) and rule the training courses ⁵⁸. It was also published a guide to implement AEDs in public places that should be used by those targeted by this law as obligated to install AEDs and implement emergency plans. These guidelines determine the medical supervision and quality control; mandatory training of determined laypeople to respond to emergency situations; it rules the distribution and monitoring of AEDs devices and the integration of these devices in the “*chain of survival*” ⁵⁹.

Although this crucial goal has been achieved by the emergency authorities, in Portugal, the use of AEDs by a bystander is still not possible by law. In the first version of this law, it was set that non-doctor using AEDs devices should be supervised by a doctor and that they should have some training in first aid response. The actual law considered that Portugal is still not able to allow the use of AEDs by bystanders and untrained laypeople. This law also establishes a fine to people that use AEDs without licence or without an appropriate training.

So, the next step should be the sensibilization of general community to basic life support training, allowing their empowerment to deal with emergency situations. Then, with a global knowledge of basic life support, Portuguese population must be able to achieve the standards of other European countries and AED use would then be accessible to everyone in case of emergency.

Conclusion

Unfortunately, out-of-hospital cardiac arrest survival rate remains low. However, it is now well known that survival rates shall increase if SCA victims will be provided with prompt cardiopulmonary resuscitation and AED use, reverting its condition, especially when initial OHCA rhythm is ventricular fibrillation which is a shockable rhythm potentially reverted by early defibrillation.

Deployment of AEDs in high-risk sites, with clear indications about location, widespread public education about its use and the existence of an assessment program of AEDs use should be supported.

Although several PAD programs have been implemented around the world, public awareness about the existence of this programs as well as comprehension about AEDs use and its importance in victim's survival should be improved once frequently laypeople become the first responders in numerous sudden cardiac death events.

Strategies to improve AEDs use should be worldwide encouraged. Some will be implemented in the future such as mobile notifications to trained laypeople after the recognition of a SCA, deployment of AEDs to the SCA scene by drones, encouraging trained people to carry their personal AEDs, among other strategies. These are promising interventions which may help to reduce mortality associated with SCA.

In Europe, lay rescuer use of AEDs is allowed by law only in some countries, but Portugal is not one of them. Our actual national law only allows trained first responders to use public access AEDs. The reason behind this measure is that population is not trained enough to use AEDs, not even having enough CPR training.

Public awareness to CPR and AED use along with mass-training programs in schools and also of public places staff will be the next steps to ensure that Portuguese communities have skills to respond to emergency events such as SCA before the arrival of EMS, when an AED is available. This will probably promote a change in law, bringing national Portuguese law closer to other European countries and to the most recent ESC-ERC Guidelines.

Actual data observed in this paper points that AED use significantly improved survival rates after SCA in the last few years, along with an increased availability of these devices. These successful results are promising in promoting quality of life and prolong it after an event such as a SCA.

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Figures captions

Figure 1 - “Chain of Survival” by American Heart Association

Figure 2 – Mechanism of commotio cordis injury

Figure 3 - Algorithm of basic life support with AED available (based in *Manual de Suporte Básico de Vida – Adulto*, by INEM, I.P.)

Figure 1

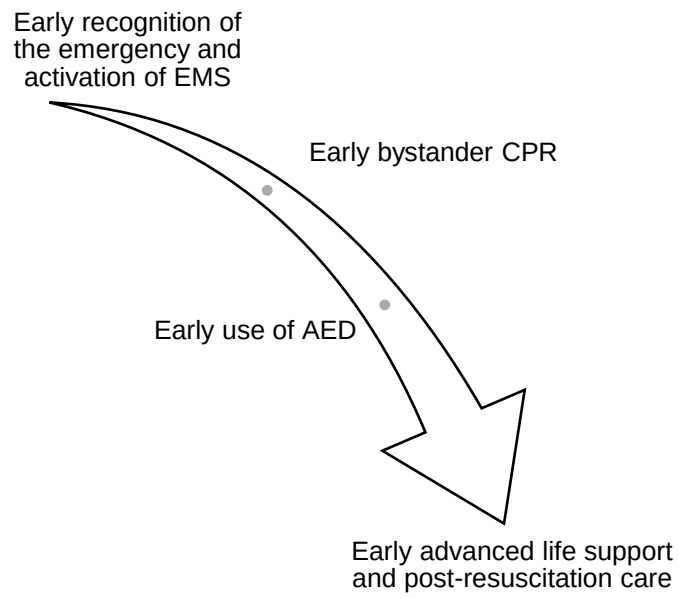


Figure 2

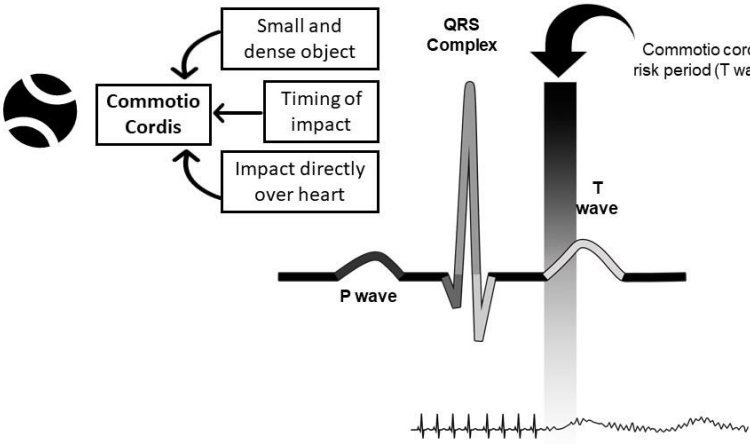
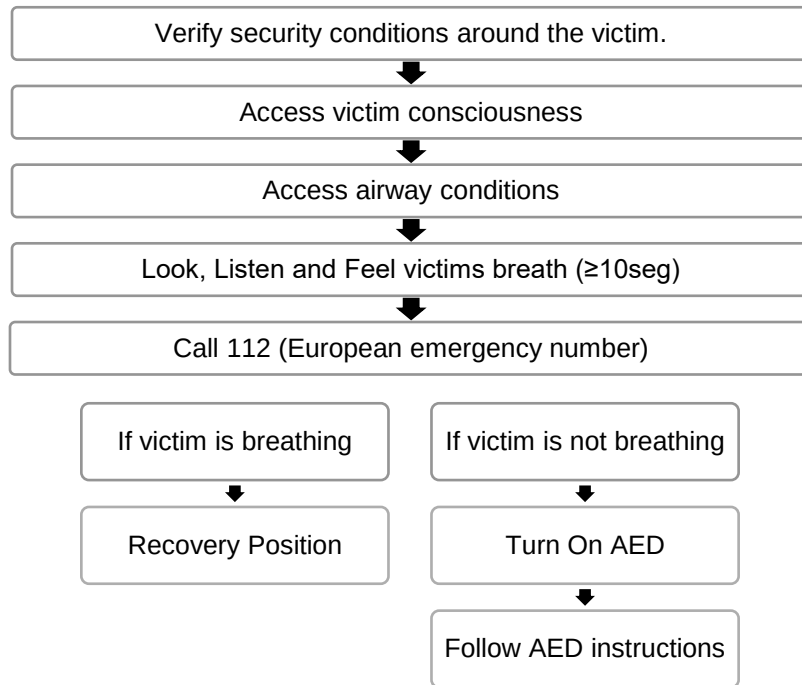


Figure 3



ANEXOS



Revista Portuguesa de Cardiologia

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GUÍA DE PUBLICACIÓN PARA AUTORES

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Revista Portuguesa de Cardiologia, órgão oficial da Sociedade Portuguesa de Cardiologia, foi fundada em 1982 com o objectivo de informar e formar os cardiologistas portugueses através da publicação de artigos científicos na área da arritmologia, cirurgia cardíaca, cuidados intensivos, doença coronária, ecocardiografia, electrofisiologia, hipertensão arterial, insuficiência cardíaca, métodos de imagem entre outros. Trata-se duma revista mensal de elevada qualidade científica e gráfica, publicada em português e em inglês desde 1999 o que permitiu a sua larga projecção no estrangeiro.

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- Guidelines; and
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Systematic Reviews should be structured as Introduction, Methods, Results, Discussion and Conclusion(s). The subject should be clearly defined. The objective of a systematic review should be to produce an evidence-based conclusion. The Methods should give a clear indication of the literature search strategy, data extraction, grading of evidence and analysis.

Systematic Reviews should not normally exceed 4000 words, with a total of up to 6 tables and/or figures and up to 100 references.

Authors are strongly recommended to consult the PRISMA statement (<http://www.prisma-statement.org/>), which is intended to help improve the reporting of systematic reviews and meta-analyses.

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Case Reports should not exceed 3000 words. They should have an Abstract (maximum 200 words; unstructured), 3-6 keywords and up to 4 figures. The main text should be divided into Introduction; Case report; Discussion; Conclusion(s) (optional); References (up to 30); and figure legends, if any. They should not contain tables.

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- Why was this guideline developed?
- How does this statement differ from existing guidelines?
- Why does this statement differ from existing guidelines?

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Peer reviewers will respond to the Editor within 30 days recommending acceptance, revision or rejection. The Editor will decide within 10 days whether to accept the manuscript without modification, to send the reviewers' comments to the authors for modification, or to reject it. When modifications are proposed, the authors have 30 days (which can be extended on request) to submit a revised version of the manuscript, incorporating the comments of the reviewers and the Editor. Any amendments should be highlighted in a different colour. The Editor will decide within 10 days whether to accept the new version, reject it, or send it for further review by one or more reviewers.

Letters to the Editor and Editorials will be reviewed by the Editorial Board, but external peer review may also be requested.

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It is important that the file be saved in the native format of the word processor used. The text should be in single-column format. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. In particular, do not use the word processor's options to justify text or to hyphenate words. However, do use bold face, italics, subscripts, superscripts etc. When preparing tables, if you are using a table grid, use only one grid for each individual table and not a grid for each row. If no grid is used, use tabs, not spaces, to align columns. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the [Guide to Publishing with Elsevier](#)). Note that source files of figures, tables and text graphics will be required whether or not you embed your figures in the text. See also the section on Electronic artwork.

To avoid unnecessary errors you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your word processor.

Estructura del artículo

Subdivision

Divide your article into clearly defined sections. Each subsection is given a brief heading. Each heading should appear on its own separate line. Subsections should be used as much as

possible when cross-referencing text: refer to the subsection by heading as opposed to simply 'the text'. Use generic names of drugs (first letter: lowercase) whenever possible. Registered trade names (first letter: uppercase) should be marked with the superscript registration symbol ® or ™ when they are first mentioned.

The Journal recommends the guidelines for publication of the EQUATOR network (<http://www.equator-network.org>), including the CONSORT statement and its extensions for randomized trials (<http://www.consort-statement.org/>), STROBE for observational (cohort, case-control and cross-sectional) studies (<http://www.strobe-statement.org/>), STARD for diagnostic accuracy studies (<http://www.stard-statement.org/>), PRISMA for systematic reviews and meta-analyses (<http://www.prisma-statement.org/>), SQUIRE for quality improvement studies (<http://www.squire-statement.org/>) and CARE for case reports (<http://www.care-statement.org/>). Reporting of the statistical aspects of studies should be in accordance with the Statistical Analyses and Methods in the Published Literature (SAMPL) guidelines (<http://www.equator-network.org/reporting-guidelines/sampl/>).

Introduction

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods

Provide sufficient details to allow the work to be reproduced by an independent researcher. Methods that are already published should be summarized, and indicated by a reference. If quoting directly from a previously published method, use quotation marks and also cite the source. Any modifications to existing methods should also be described.

Results

Results should be clear and concise.

Discussion

This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Conclusions

The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Cover letter and Essential title page information

Submission of an article must include a cover letter with the following information:

1. a brief description of the article's significance and/or interest;
2. a declaration of originality, specifying that none of the paper's contents have been published or are under consideration elsewhere;
3. a declaration that all authors have read and approved the manuscript;
4. a full disclosure of any potential conflict of interest for any of the authors;
5. and which manuscript type is being submitted for publication.

Title page must contain the following information:

- **Title.** Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible. Preferably not exceed 12 words. It may also include a subtitle of up to 4 words.
- **Author names and affiliations.** Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. You can add your name between parentheses in your own script behind the English transliteration. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.
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- **Word count** of the manuscript text.

Structured abstract

A structured abstract, by means of appropriate headings, should provide the context or background for the research and should state its purpose, basic procedures (selection of study subjects or laboratory animals, observational and analytical methods), main findings (giving specific effect sizes and their statistical significance, if possible), and principal conclusions. It should emphasize new and important aspects of the study or observations.

Abstracts for all article types should not contain any references. Abbreviations should be avoided or kept to a minimum.

The headings will consist of: Introduction and Objectives, Methods, Results and Conclusion(s))

Keywords

Immediately after the abstract, provide the keywords, using British spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. Keywords should ideally be selected from the list of MeSH terms available at www.nlm.nih.gov/mesh/. These keywords will be used for indexing purposes.

Abreviaturas

Abbreviations should be used only if the term occurs more than three times. An abbreviated term must be written out in full the first time it appears, followed by the abbreviation in parentheses, and only the abbreviation should be used thereafter. Example: "... acute coronary syndrome (ACS) is ... suffered ACS ... ACS occurs...."

All abbreviations in tables and figures must be accompanied by the full form of the term.

Abbreviations should not be used in the abstract, titles, headings or subheadings.

Ensure consistency of abbreviations throughout the article.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.)

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Follow internationally accepted rules and conventions: use the international system of units (SI). If other units are mentioned, please give their equivalent in SI.

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- Number the illustrations according to their sequence in the text.
- Use a logical naming convention for your artwork files.
- Provide captions to illustrations separately.
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Text graphics may be embedded in the text at the appropriate position. See further under Electronic artwork.

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Please submit tables as editable text and not as images. Tables can be placed either next to the relevant text in the article, or on separate page(s) at the end. Number tables consecutively in accordance with their appearance in the text and place any table notes below the table body. Be sparing in the use of tables and ensure that the data presented in them do not duplicate results described elsewhere in the article. Please avoid using vertical rules and shading in table cells.

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17. Sousa PJ, Gonçalves PA, Marques H, et al. Radiação na AngioTC cardíaca: preditores de maior dose utilizada e sua redução ao longo do tempo. *Rev Port Cardiol*. 2010;**29**:1655-65.

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2. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. *Heliyon*. 2018;**19**:e00205. <https://doi.org/10.1016/j.heliyon.2018.e00205>.

Reference to a book:

30. Cohn PF. Silent myocardial ischemia and infarction. 3rd ed. New York: Mansel Dekker; 1993.

Reference to a chapter in an edited book:

23. Nabel EG, Nabel GJ. Gene therapy for cardiovascular disease. In: Haber E, editor. *Molecular cardiovascular medicine*. New York: Scientific American;1995.p.79-96.

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12. Portuguese Registry on Acute Coronary Syndromes (ProACS). Available at: <http://www.clinicaltrials.gov/identifier/NCT01642329> [accessed 26 October 2013].

Reference to a dataset:

[dataset] 5. Oguro M, Imahiro S, Saito S, Nakashizuka T. Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1; 2015. <https://doi.org/10.17632/xwj98nb39r.1>.

Note shortened form for last page number. e.g., 51-9, and that for more than 3 authors the first 6 should be listed followed by 'et al.' For further details you are referred to 'Uniform Requirements for Manuscripts submitted to Biomedical Journals' (*J Am Med Assoc* 1997;**277**:927-34)(see also [Samples of Formatted References](#)).

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