

Usability of the Automatic External Defibrillator in Out-of-Hospital Arrest by the Layman*Utilidad del desfibrilador externo automático en el arresto extrahospitalario por parte del profano**Usabilidade do Desfibrilador Externo Automático em parada extra-hospitalar pelo leigo***Thalisson Serrath de Carvalho¹**

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Submission: 11-29-2021**Approval:** 12-15-2021**Abstract**

The aim was to identify in the scientific literature the evidence about the use of technology, automatic external defibrillator by laypersons in cases of out-of-hospital cardiopulmonary arrest. This is an integrative literature review, with a critical and retrospective characteristic, with complete primary data sources, published between 2015 and 2020, in the following databases: MEDLINE, LILACS, BDNF, SciELO and Google Scholar. The results included 10 articles that showed that out-of-hospital cardiopulmonary arrest cases are usually due to arrhythmias whose initial treatment is defibrillation. It was possible to analyze that, when defibrillation is performed early, especially in the first five minutes of the event, it will lead to a good prognosis for the victim. The studies point to a series of gaps in relation to the knowledge of technical measures and procedures of Basic Life Support by lay people, regarding the use of the Automatic External Defibrillator in victims of cardiopulmonary arrest in an extra-hospital environment. It is concluded that, it is necessary that universities and the government promote spaces for reflection on the training of lay rescuers with a view to having a greater number of qualified people to work in this type of situation, thus improving the chances of survival of victims affected by cardiac arrest.

Descriptors: Electric Countershock; Teaching; Out-of-Hospital Cardiac Arrest; Biomedical Technology; Mentoring.**Resumen**

El objetivo fue identificar en la literatura científica la evidencia sobre el uso de tecnología, desfibrilador externo automático por personas no profesionales en casos de parada cardiorrespiratoria extrahospitalaria. Se trata de una revisión de literatura integradora, de carácter crítico y retrospectivo, con fuentes primarias completas de datos, publicada entre 2015 y 2020, en las siguientes bases de datos: MEDLINE, LILACS, BDNF, SciELO y Google Scholar. Los resultados incluyeron 10 artículos que mostraron que los casos de parada cardiorrespiratoria extrahospitalaria suelen deberse a arritmias cuyo tratamiento inicial es la desfibrilación. Se pudo analizar que, cuando la desfibrilación se realiza temprano, especialmente en los primeros cinco minutos del evento, conducirá a un buen pronóstico para la víctima. Los estudios señalan una serie de lagunas en relación al conocimiento de las medidas técnicas y procedimientos de Soporte Vital Básico por parte de los profanos, en cuanto al uso del Desfibrilador Externo Automático en víctimas de parada cardiorrespiratoria en un entorno extrahospitalario. Se concluye que, es necesario que las universidades y el gobierno impulsen espacios de reflexión sobre la formación de los socorristas legos con miras a contar con un mayor número de personas calificadas para trabajar en este tipo de situaciones, mejorando así las posibilidades de supervivencia de las víctimas. afectado por un paro cardíaco.

Descriptores: Cardioversión Eléctrica; Enseñanza; Paro Cardíaco Extrahospitalario; Tecnología Biomédica; Tutoría.**Resumo**

O objetivo foi identificar na literatura científica as evidências acerca do uso da tecnologia, desfibrilador externo automático por leigos em casos de parada cardiorrespiratória extra-hospitalar. Trata-se de revisão integrativa de literatura, de característica crítica e retrospectiva, com fontes de dados primários completos, publicados entre 2015 e 2020, nas seguintes bases de dados: MEDLINE, LILACS, BDNF, SciELO e o Google Scholar. Os resultados incluíram 10 artigos que evidenciaram que os casos de parada cardiorrespiratória extra-hospitalar geralmente são por arritmias cujo tratamento inicial é a desfibrilação. Foi possível analisar que, a desfibrilação quando realizada de forma precoce principalmente nos primeiros cinco minutos do evento, acarretará bom prognóstico para a vítima. Os estudos remetem a uma série de lacunas em relação ao conhecimento das medidas e procedimentos técnicos de Suporte Básico de Vida por pessoas leigas, quanto a utilização do Desfibrilador Externo Automático em vítimas de parada cardiorrespiratória em ambiente extra-hospitalar. Conclui-se que, seja necessário que as universidades quanto o poder público fomentem espaços de reflexão quanto a capacitação de socorristas leigos com vistas de se poder ter um maior quantitativo de pessoas qualificadas para atuar neste tipo de situação, melhorando assim, as chances de sobrevida das vítimas acometidas por parada cardíaca.

Descriptores: Cardioversão Eléctrica; Ensino; Parada Cardíaca Extra-Hospitalar; Tecnologia Biomédica; Tutoría.

Introduction

Cardiorespiratory arrest (CPA) can be defined as a sudden and unexpected interruption of ventricular mechanical activity that is useful and sufficient to maintain cardiac output in individuals without end-stage disease. In cases of early failure by health professionals or properly trained lay people, irreparable physiological damage can be generated in a short period, as every one minute without proper cardiopulmonary resuscitation, the individual has a ten percent less chance of survival, if this non-compliance exceeds the first five minutes of PCR, the patient may have irreversible brain damage¹.

According to the Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Guidelines of the Brazilian Society of Cardiology (SBC), although there is a paucity of data on events related to out-of-hospital cardiopulmonary arrest (HRCPR), it is estimated that a CPA occurs every 2nd 3 minutes, accounting for around 9,589 deaths per week and 350,000 deaths per year, with around 73% of these individuals dying before reaching the hospital. Also, according to SBC, a third of these events take place in non-hospital environments^{2,3}.

According to national and international bodies, PCREH is considered a public health problem. According to the article entitled Lay Responding Care for an Adult with Out-of-Hospital Cardiac Arrest in the United States of America (USA), around 155,000 people a year are treated by the emergency service outside hospitals, however, only 8% of this total survive this type of event. In contrast to these data, on the European continent, around 128,000 to 275,000 people are victims of a HRCPR, however, only 10% survive this type of event. It is known that, with the entire process of technological evolution in Brazil and in the world, several less than 40% of adults in a situation of CPA receive Cardiopulmonary Resuscitation (CPR) performed by lay people, even less (about 12%) is the chance of a victim receiving defibrillation from the Automated External Defibrillator (AED) before specialist care arrives^{4,5}.

The AED is a portable electronic device, consisting basically of a battery with an electrical capacitor and a computer capable of recognizing Ventricular Fibrillation (VF) and Ventricular Tachycardia (VT), consisting of the most frequent arrhythmias at the beginning of CA. When present, the device determines a direct current shock to the victim's chest, organizing the electrical rhythm of the heart. These semi-automatic defibrillators are widely used in pre-hospital care; however, they can also be used in the hospital environment⁶.

When thinking about the usability of this technology, the AED was designed both for the use of health professionals who work mainly in pre-hospital environments and for the layperson who can witness this type of event. In relation to the layperson, he/she can perform the first emergency care if they are properly trained and informed about the use of this technology. Although this device is already available in some places usually with more than fifteen hundred passersby, the use by a lay person about this technology is still low⁷.

Despite some scientific evidence showing that the process of health education through first aid in the most varied emergency events, including CPA, are effective, this type of education in Brazil is still a little disseminated topic. In a scene in which a person has a sudden illness in a public place, help is provided through the feeling of solidarity and often, without the technique or knowledge for such a situation. This is an action that can aggravate the victim's health condition⁸.

Based on the facts presented, the following guiding question emerged: How should laypersons use automatic external defibrillator technology in cases of out-of-hospital cardiopulmonary arrest? Which aims to identify in the scientific literature the evidence about the use of technology, automatic external defibrillator by laypersons in cases of out-of-hospital cardiopulmonary arrest.

Methodology

This is an Integrative Literature Review (RIL) as it enables the systematization of scientific knowledge, bringing those who research the problem they want to assess closer together, tracing the evolution of the topic over time and, therefore, visualizing possible research opportunities⁹.

The six steps intrinsic to this method were followed: Selection of the guiding question, Establishment of inclusion and exclusion criteria, Identification of pre-selected and selected studies, Categorization of selected studies, Analysis and interpretation of results and Presentation of the synthesis of knowledge⁹.

The integrative review was previously developed with the identification of the research theme, which is "layman's role in out-of-hospital cardiopulmonary arrest". Subsequently, the research problems were defined, these being the impact of the performance in relation to the best prognosis in relation to the CPA event and the initial performance of this individual in an emergency. Based on this definition, the guiding question of the study was elaborated, based on the PICo strategy, which presents as a question for its formulation the prognosis or prediction, in which the "P" indicates the population, patient (age, race, status, of health) or problem, the "I" demonstrates the interest and the "Co" context.

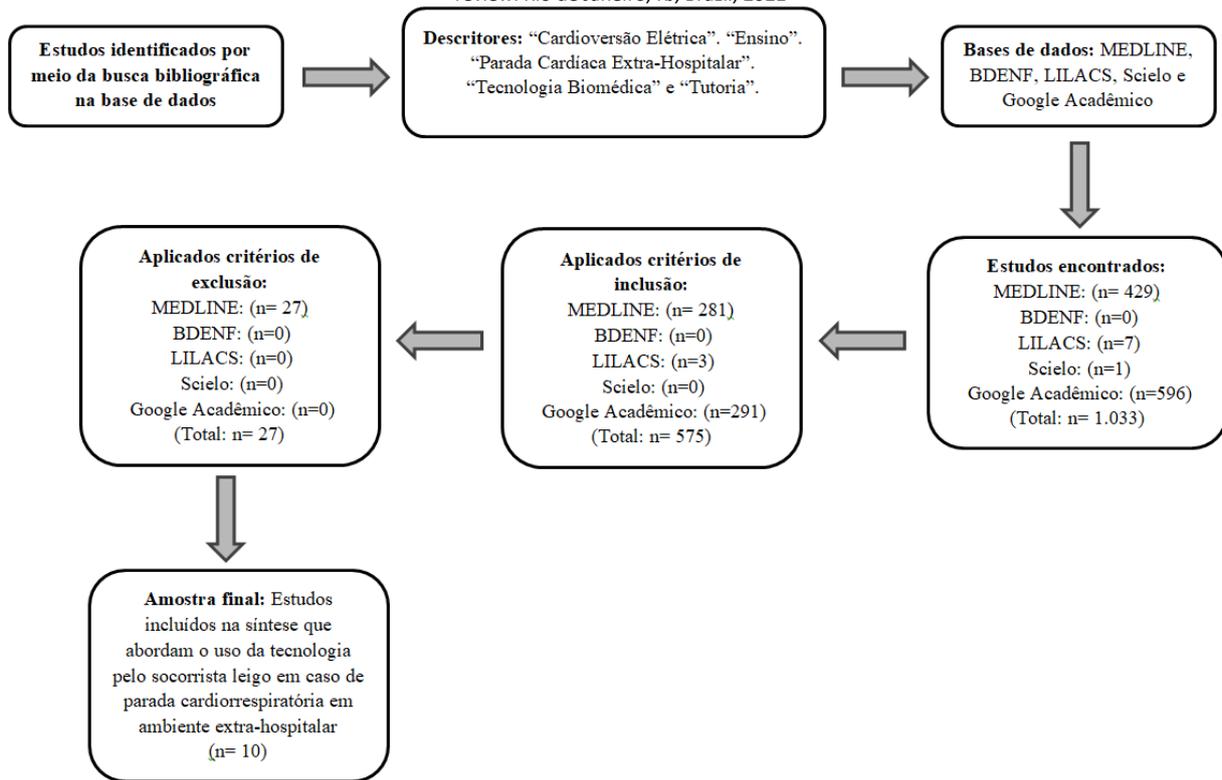
Given the above, the guiding question of this study was based on the PICo strategy, which is: How the layperson should use the technologies, especially the automatic external defibrillator (AED) in cases of out-of-hospital cardiopulmonary arrest?

To carry out the research, the Virtual Health Library and its respective databases were used: Medical Literature Analysis and Retrieval System Online (MEDLINE), Nursing Databases (BDENF) and the Latin American and Caribbean Literature in Sciences of the Health (LILACS), the Scientific Electronic Library online (SciELO) was also consulted, and to locate the largest number of publications, Gray Literature was also used with a search on Academic Google. The search period took place from January to the end of August 2021.

Based on the search strategy, the number of productions associated with the theme can be highlighted as described in the flowchart below:



Figure 1. Illustrative flowchart of the methodological approach for identifying pre-selected studies and selecting studies to be included in the adapted PRISMA review. Rio de Janeiro, RJ, Brazil, 2021



To carry out the searches, the descriptors registered in the Health Sciences Descriptors Portal (DeCS) were used: "cardiac arrest", "out-of-hospital cardiac arrest", "electrical cardioversion", "education", "biomedical technology" and "tutoring" and its equivalents in the English languages: "Electric Countershock"; "Teaching"; "Out-of-Hospital Cardiac Arrest"; "Biomedical Technology"; "Mentoring". and Spanish: "Cardioversión Eléctrica"; "Enseñanza"; "Out-of-hospital cardiac arrest"; "Biomedical Technology"; "Tutorship". The word "layman" was used separately, as a keyword, as it was not registered in DeCS until the work was carried out and crossed with the terms "cardiorespiratory arrest" and "defibrillator" to adapt the productions found to the theme of the search using the Boolean operator "AND".

As inclusion criteria: articles made available in full, which present adherence to the theme in Portuguese, Spanish, and English, published between 2015 and 2020, to identify evidence of the subject in question published in the last 05 (five) years, as the Guidelines referring to the guidelines of the CPR were revised in 2015 and 2020.

Duplicate studies, studies whose access link at the time of collection is unavailable, were excluded. To include the studies, the titles and abstracts of each publication were read to verify harmony with the guiding question. If there was any kind of doubt regarding the inclusion or exclusion of the study, the full reading was carried out to reduce the risk of harm by losing publications relevant to the study.

Figure 1 shown above illustrates the methodological approach to identifying pre-selected studies and selecting studies to be included in the review.

Through the data analyzed by Bardin's content analysis, it was possible to point out two thematic categories, which will be analyzed and discussed below¹⁰.

Results and Discussion

Given the above, the extracted data were described and organized in a table with information referring to: Title of the article; the authors of the publications; The journal name and date; Database and the main research findings, as described in Chart 1.

Chart 1. List of articles selected from the databases. Rio de Janeiro, RJ, Brazil, 2021

Title	Authors	Journal/Date	Data base	Main Findings
Public-access defibrillation and neurological outcomes in patients with out-of-hospital cardiac arrest in Japan: a population-based cohort study	NAKASHIMA, T.; NOGUCHI, T.; TAHARA, Y. et al. ¹¹	The Lancet, Dec, 2019	MEDLINE	The study concludes that people who had a HRCF and who had defibrillation before arrival at the emergency department had a better neurological prognosis than victims who did not receive early care.
The association between public access defibrillation and outcome in witnessed out-of-hospital	KIYOHARA, K.; NISHIYAMA, C.; KITAMURA, T. et al. ¹²	Resuscitation, May, 2019	MEDLINE	It is important when caring for a person in CPA to be able to reduce the interval between recognizing the collapse and delivering the shock. The Japanese study finds that those who



cardiac arrest with shockable rhythm				receive early defibrillation by a bystander when witnessing a HRCP obtain a favorable result. It also reports that the proportion of those who receive the shock in public places is still low.
Drone delivery of an automated external defibrillator - a mixed method simulation study of bystander experience	SANFRIDSSON, J.; SPARREVIK, J.; HOLLENBERG, J.; et al. ¹³	Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, Apr, 2019	MEDLINE	A Swedish simulation study carried out with elderly people on the use of a drone to deliver an AED and a device that offers video calling to assist in the care of a HRCP in a home. It was found that it made sense to use this technology for the first visit before the arrival of the emergency department and the study group perceived the delivery of the AED by the drone as being safe and feasible.
Automated external defibrillator use in out-of-hospital cardiac arrest: Current limitations and solutions	DELHOMME, C.; NJEIM, M.; VARLET, E. et al. ¹⁴	Archives of Cardiovascular Diseases, Nov, 2019	MEDLINE	It is necessary to improve the ability of a bystander to recognize a HRCP, to be aware of the importance of rapid initiation of CPR and defibrillation as soon as the AED is available at the site.
Outcomes after sudden cardiac arrest in sports centres with and without on-site external defibrillators	ASCHIERI, D.; PENELA, D.; PELIZZONI, V.; et al. ¹⁵	Heart, Feb, 2018	MEDLINE	The study assesses the results of using or not using the AED in sports centers. Between 1999 and 2014 there were 26 cases of CPA, 58% in places where the AED was available, in these sports centers the survival rate with an intact neurological status was 93%, whereas in environments without the AED available, the survival rate was 9% during the period.
Out-of-hospital cardiac arrest: Probability of bystander defibrillation relative to distance to nearest automated external defibrillator	SONDERGAARD, K. B.; HANSEN, S.M.; PALLISGAARD, J.L. et al. ¹⁶	Resuscitation, Nov, 2017	MEDLINE	Despite the recommendations of the American Heart Association and the European Resuscitation about the importance of making AEDs available in places of public access, and the great adherence of these recommendations by countries, only 2-4% of victims were defibrillated by a bystander. The work mentions some of these obstacles such as the great distance between an AED and the victim, the difference between a HRCP in a home and on a public street, places that provide closed AEDs and the population's lack of knowledge about using the device.
Automated external defibrillator and operator performance in out-of-hospital cardiac arrest	ZIJLSTRA, J. A.; BEKKERS, L.E.; HULLEMAN, M.; et al. ¹⁷	Resuscitation, May, 2017	MEDLINE	Dutch study analyzes the use of AED and operator performance in a HRCP. A total of 3,310 cases were included, 33% of which indicated shock by the device. The AED incorrectly advised shock 44 out of 1091 cases, fifteen of the cases were related to device error and 28 were caused by operator error. The device incorrectly gave a no-shock advice in 26 out of 2219 cases, 20 were device problems and 6 operator errors. 59 times the AED authorized the shock, and the operator did not proceed. 95% of the time the shock was performed correctly.
Public-access AED pad application and outcomes for out-of-hospital cardiac arrests in Osaka, Japan	KIYOHARA, K.; KITAMURA, T.; SAKAI, T. et al. ¹⁸	Resuscitation, Jun, 2016	MEDLINE	Data from the study carried out in Osaka, Japan, indicate that most cases (83%) of HRCP occur in households, however, the use of the device for defibrillation was relatively low. They were used more frequently in public places such as sports centers, airports, and train stations. The results suggest a favorable outcome in the clinical picture of victims who were defibrillated, but public access, use of the equipment and knowledge of the population are still insufficient.
A text message alert system for trained volunteers improves out-of-hospital cardiac arrest survival	PIJLS, R. W. M.; NELEMANS, P.J.; RAHEL, B.M. et al. ¹⁹	Resuscitation, Jun, 2016	MEDLINE	A message system alerting trained volunteers to possible ERCPs in their neighborhood has been implemented in the Netherlands. The total study population was 422 presumed cardiac arrests. In 69% of cases at least one volunteer went to the emergency room, in 31% of cases the volunteer did not show up. The text messaging system has been shown to be



				effective in increasing the survival rate after a HRCP.
Public Access Defibrillation: Great benefit and potential but infrequently used	AGERSKOV, M. NIELSEN, A. M.; HANSEN, C. M, et al. ²⁰	Resuscitation, Jul, 2015	MEDLINE	A study that analyzes 521 resuscitation attempts, of which only 3% were used with an AED, the work portrays the importance of public access defibrillation and highlights the rare use of the device. An AED was located within 100 meters of a cardiac arrest in 23.4% of cases, in 13 occasions the device was more than 100 meters from the event. The 30-day survival was better for those who had a defibrillation performed before the arrival of the emergency medical service at the location.

Next, it was possible to analyze the distributions of the articles chosen according to the year of publication. They were: (n=1; 10%) in the year 2015; (n=2; 20%) in the year 2016; (n=2; 20%) in the year 2017; (n=1; 10%) in the year 2018 and (n=4; 40%) in the year 2019.

Regarding the selected journals, (n=6; 60%) are from *Jornal Ressuscitation*; (n=1; 10%) from *The Lancet*; (n=1; 10%) of *the Heart*; (n=1; 10%) from *the Archives of Cardiovascular Diseases* and (n=1; 10%) from *the Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*. Regarding the language of publications, (n=10; 100%) of the selected articles were published in English. It was possible to verify the countries of origin of the surveys carried out, (n=3; 30%) from Japan; (n=2; 20%) from Denmark; (n=2; 20%) from the Netherlands; (n=1; 10%) from France; (n=1; 10%) from Italy and (n=1; 10%) from Sweden.

The following thematic categories will be analyzed and discussed below: Benefits of the use of automatic external defibrillators by lay people in cardiac arrest and The use of technology for a better prognosis for victims in cardiac arrest.

Benefits of the use of automatic external defibrillator by laypersons in cardiopulmonary arrest

Early defibrillation is a determining factor for obtaining a greater probability of survival for a person after a CA. In Japan, publicly accessible AEDs were authorized by the court in July 2004, because of which the cases in which the victim obtained a positive neurological prognosis increased. In 2007 France authorized the use of the DEA by visitors, even if they had no training. However, the rate of defibrillation in Paris remains low, less than 2% of victims have been shocked, this percentage increases to 4% when referring to the whole country^{11,14}.

The study that was conducted with a total of 8,126 patients over a 3-year period. Of that number, 2,282 (28.1%) achieved defibrillation before arriving at the emergency department. At least 61.4% (1401/2282) of shocked people achieved 1 month survival and satisfactory neurological outcome was 54.5% (1243/2282) in these cases. In 58% (1323/2282) of the cases the average was 5 minutes from collapse to the first shock. The longer until the first shock, the less chance of survival there is, 6-10 min (48.3%), 11-15 min (38.2%), 16-20 min (30.4%), 21-25 min (7.1%) and no person survived if shock was performed after 26 minutes of PCR¹⁸.

It is not enough just to make the DEA available; its location must be in strategic places as reported in the studies. The devices were used more frequently in sports facilities 69.4%, airports 66.7% and railway stations 46.2%. In addition to having a good location, according to surveys, only 3.8% of CPAs had the AED applied before the emergency medical service. There was the device available in up to 100 meters almost in one of four PCR. However, only in 15.1% of the cases the AED was accessible and only 10.6% of the victims had a defibrillation performed by these public access devices^{18,20}.

A study carried out in Denmark confirms that the further away an AED is available, the less likely it is to be used when needed. In a public environment with 0, 100 and 200 meters from a device, the chance of being used is, respectively, 35.7%, 21.3% and 13.7%. The studies compare sports centers with the presence of an AED and sports centers without the device, when there is the device in place, an increase in survival was associated with a favorable neurological outcome in 93% of cases against only 9% in non-professional equipped¹²⁻¹⁶.

According to the most current guidelines, quality chest compressions and early defibrillation are the basis for good care in case of CPA. Most victims in the onset of sudden illness are in shocking rhythms (ventricular fibrillation and pulseless ventricular tachycardia), in this case the most indicated to be defibrillated as quickly as possible. Having the devices available mainly in places with a high concentration of people and if possible 24 hours a day is a decisive factor in a victim's prognosis⁵.

Technology has always been an ally when it comes to first aid, from the manufacture of materials used in assistance to the way to contact an emergency center through a telephone device to request an ambulance. In the Netherlands a new text messaging system was introduced to notify a possible CPA in the vicinity and alert a volunteer trained in CPR and the use of the AED to provide first aid before the arrival of the emergency service on site. Many other cities have developed apps in order to send a text message indicating the exact location of the PCR and the nearest DEA^{14,19}.

Simulation studies with eight people, 50% women and 50% men without training in CPR or with no previous experience in this type of care. A drone transported an AED and a video device to a specified location, the participants had a communication with the dispatcher, and this built a relationship of trust and relief to perform the service alone



before help arrived. In other studies, the use of drone is effective and safe, especially in rural areas, the drone arrived before the emergency team in 93% of cases, thus saving 19 minutes^{13,14}.

The AED that has sound feedback in cases of HRCP is a determining factor for quality cardiac compression because the sound will guide the depth and speed of CPR. Furthermore, in more than 95% of emergency situations, the DEA correctly analyzes and generates the shock when indicated. In the adrenaline of the moment, especially lay people can exceed the number of compressions and not reach the necessary depth to be considered quality CPR¹⁷.

The use of technology for a better prognosis for victims in cardiac arrest

The decline in mortality from HRCP can be based on three pillars: The presence of a witness to the sudden illness, use of the AED and the rapid arrival of the emergency service. The first two are the basis of a significantly high chance of survival for the victim. Favorable neurological outcomes are greatest in places with an increased influx of people and where the AED is available, such as airports, train stations, and sports facilities^{6,22}.

Several municipal and state laws in Brazil require establishments with a certain amount of flow of passers-by to have a publicly accessible DEA available. Despite this, there is a lack of planning by the government to prepare studies identifying suitable locations for the implementation of the DEA, consequently, the inspection of the law is impaired. Due to the limitation in making the devices available in public places, many individuals do not know their true function, thus generating a deficient service when necessary. It is expected that in a short period of time this information can be socialized with the population in general, thus increasing not only the knowledge of places that can make this technology available, but also making the lay public interested and getting to know and at the same time handle it correctly^{23,24}.

Even with the advent of more current technologies that can support HCP victims, these devices not only help health professionals, but lay people as well. In Brazil, the incentive as well as the use of this technology are still incipient, mainly by the lay population. In this way, it is expected that it is both an initiative of public bodies and educational institutions to think of a way to introduce first-aid courses to society in general that can qualify and, at the same time, make these lay individuals sowers of knowledge

for their communities, thus contributing with quality care if there is a need for the victim of cardiac arrest in an extra-hospital environment²⁵.

Furthermore, the use of Information and Communication Technologies in the current scenario in which we find ourselves such as cell phones, tablets, computers, notebooks, can reduce the distance between training bodies and the population in general. The use of active methodologies for this type of professional qualification can also be an excellent teaching strategy to improve the acquisition of the necessary content so that the lay population can use this technology - DEA in a critical and conscious way²⁶.

Final Considerations

It appears that the objective was met because the work effectively managed to analyze the scientific production of totally different countries and at the same time bring evidence that this type of technology - automatic external defibrillator when used correctly, whether by health professionals or by properly qualified lay people can save lives, which was mainly evidenced in developed countries.

Thus, it is expected that gyms, as well as the competent bodies, can include in their planning first aid courses that include the use of automatic external defibrillators for victims in a situation of cardiopulmonary arrest. It is expected with the training of this audience that, in cases where a layperson witnesses this type of event, the chances of the victim are increased with the correct and conscientious use of the equipment.

Therefore, it is expected that this study can contribute to further research in this field of knowledge, since it was possible to analyze that in several countries there is a lack of people with knowledge to act in this type of emergency. Furthermore, it is expected that massive training, especially for the more popular classes, can motivate their performance in cases of cardiopulmonary arrest in an extra-hospital environment, thus increasing the survival rate of victims. In addition, it is possible to assert that training lay people is another field of action for professional nurses, mainly because of their comprehensive training also focused on teaching.

The main limitation to develop the research was the incipient work related to the topic at the time of the search, mainly developed in the Brazilian scenario. Therefore, this research points to the need for further study in this area of knowledge.

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