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Protocol of the National Association of Cardiologists of Mexico (ANCAM) for the creation of cardioprotected areas in sports races and Marathons in Mexico

Protocolo de la Asociación Nacional de Cardiólogos de México (ANCAM) para la creación de espacios cardioprotegidos en carreras deportivas y maratones en México

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Palabras clave:
carreras deportivas de maratón, paro cardiaco súbito, reanimación cardiopulmonar, cardioprotección, desfibrilador automático externo.

ABSTRACT

Large-scale sporting events, such as races and marathons in particular, present a unique cardioprotection challenge due to the geographical extent of the route and the large number of participants. This protocol proposes a comprehensive approach to minimize the risk of sudden cardiac death and optimize the response to cardiovascular emergencies during these events held in Mexico.

RESUMEN

Los eventos deportivos de gran escala, como lo son las carreras deportivas y más aún los maratones, presentan un desafío único en términos de cardioprotección debido a la extensión geográfica del recorrido y el gran número de participantes. Este protocolo propone un enfoque integral para minimizar el riesgo de muerte súbita cardiaca y optimizar la respuesta ante emergencias cardiovasculares durante estos eventos realizados en México.

Abbreviations:
AED = Automated External Defibrillator
CPR = Cardiopulmonary Resuscitation
EMS = Emergency Medical Services
SCA = Sudden Cardiac Arrest
SCD = Sudden Cardiac Death

INTRODUCTION

Exercise has several cardiovascular and general health benefits. However, Sudden Cardiac Death (SCD) can occur in seemingly healthy athletes who perform high-performance exercise, such as marathon running. Cardioprotection at sporting events, such as 5 K, 10 K, and marathon races, is vital to guarantee the safety and well-being of participants. The intense and prolonged nature of these races may increase the risk of SCD events.[1] Many diseases can cause Sudden Cardiac Arrest (SCA) and SCD. Like the general population, athletes may suffer from heart disease and be unaware of its existence. The most common causes of SCD in people under 35 years of age are primary cardiomyopathies, such as hypertrophic, dilated, non-compacted, and arrhythmogenic cardiomyopathies. Less common causes include ischemic heart disease and channelopathies such as long QT or Brugada syndrome.[2] In people over 35 years of age, the leading cause of SCD is ischemic heart disease, followed by the cardiomyopathies reported in those under 35 years of age.[3] Drug use or medication has been reported in up to 12% of athletes with SCD. Furthermore, acute physiological changes related to high-

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performance exercise (dehydration, electrolyte, and acid-base imbalance) and increased sympathetic tone may also play a key role.[4]

In the United States, the incidence of SCD among marathon runners ranged from 0.6 to 1.9 per 100,000, where males (from 37 to 48 years old) are from 57.1% to 100%.[5] The available data indicate a concentration of cases of sudden death at the stage finishes of marathon races. An investigation revealed that approximately 50% of sudden deaths during these athletic events occur within the final two kilometers of the race route.[6] The distance at which the marathon SCD takes place throughout the route is shown in *Figure 1*.

Most episodes of SCD in athletes occur during intense exercise, and only a third of these events may occur during sleep.[7] The rhythms reported in athletes who present SCA are in a high percentage (up to 78%) of ventricular tachycardia and ventricular fibrillation that are reversed with electrical defibrillation.[8] Immediate treatment with cardiopulmonary resuscitation (CPR) and early defibrillation has achieved survival rates of up to 70% of SCA victims, significantly reducing the incidence of SCD during athletic competitions. To prevent SCD, each athlete must undergo a pre-participation evaluation, which is recommended for children and adolescents to include at least a physical examination and a review of their medical history.[9] For adults over 35 years of age, in addition to the clinical history and physical examination, an electrocardiogram should be included. In abnormal cases, a physical stress test should be performed to rule out the presence of ischemic heart disease.[3]

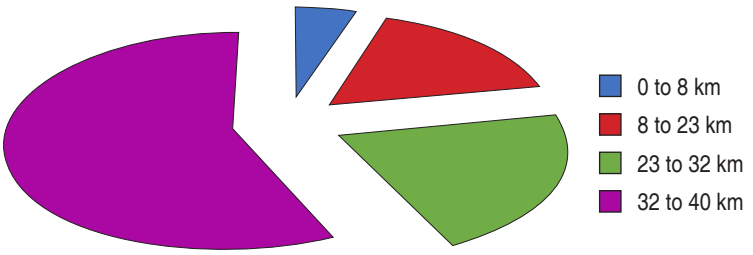

Figure 1: Distance at which marathon SCD occurred throughout the marathon course. Modified from.[16]

These measures can reduce the incidence and prevalence of SCA and SCD during athletic competitions, especially in marathons, half marathons, and long-distance races.

JUSTIFICATION

The recent increase in SCD cases, as well as their dissemination through the mass media and social networks has raised awareness of the need for established protocols for the development of cardioprotective sporting events. While the presence of an Automated External Defibrillator (AED) is essential for cardioprotection at sporting events, it does not make the space cardioprotective. Therefore, implementing an adequate cardioprotection protocol is essential to ensure a rapid and effective response in a cardiovascular emergency. In Mexico, there are no protocols for dealing with the presence of an SCA in athletic races. This proposal offers athletic leagues and organizations a protocol to help reduce the risk of SCA events during their competitions. At the same time, it provides the logistics and organization necessary for victims to receive adequate treatment, thereby reducing the possibility of an SCD.

OBJECTIVES

Ensure a rapid and effective response to SCA events during the marathon, ensure the availability and accessibility of AEDs throughout the marathon route, form and maintain teams trained in CPR and AED use, establish a coordinated action plan with Emergency Medical Services (EMS) and reference hospitals, promote awareness and continuous training in cardioprotection among event organizers, volunteers, and participants and create a protocol to follow that serves to carry out cardioprotection races.

IMPLEMENTATION STRATEGY

A. Arrangement of Automatic External Defibrillators (AED)

1. **Quantity and Location:** strategically plan the placement of AEDs so that they cover a radius of 2.5 minutes between potential victims and AEDs. Place AEDs at key points

along the route, especially in high-traffic areas and medical assistance stations. Ensure the visibility and accessibility of AEDs, using appropriate signage and approved display cases. Use technologies to deliver and deploy AEDs at the site where the potential victim is located, such as drones, remote-controlled cars, motorcycles, and bicycles, depending on the distance.

2. Characteristics of the AEDs: use AED equipment authorized by the Federal Commission for the Protection against Sanitary Risks (COFEPRIS for its Spanish abbreviation) with biphasic waves and adult and pediatric patches. Ensure that batteries and pads are in good condition and within their dates 24 hours before use.
3. **If possible, facilitate the initiation of CPR by a witness:** as indicated later, establish a dissemination protocol before the event that includes the competitors. The protocol must specify that, in the event of any collapse of a competitor, it is a priority for the event witnesses to activate the EMS and, if possible, initiate CPR. Only with the hands until the arrival of EMS. The Basic actions to help those witnessing sudden cardiac death during a race are shown in *Table 1*.

B. Training

1. **Trained Personnel:** ensure that sufficient volunteers and medical assistance personnel are trained in basic CPR and using AEDs. Ideally, the number of rescuers per AED is between three and five to cover the requirements requested in the CPR triangle and the team dynamics. Organize training and refresher courses in CPR and the use of AEDs (ideally at no cost) endorsed by officially established training centers, such as the National Association of Cardiologists of Mexico (ANCAM).
2. **Timed Drills:** carry out a drill prior to the event, with the personnel involved, in the coverage area to evaluate the protocol's effectiveness and the personnel's response capacity. Ensure that the drills include the activation of EMS, initiation of CPR, and use of the AED at appropriate times, as well as ambulance and transfer access routes (including alternate routes) in case of any contingency.
3. **Access maps:** the security and civil protection personnel covering the event must have maps that ensure at least two ambulance accesses (in case one has access problems for any reason) to each of the sites where the race will take place, as well as real-time maps through mobile applications, for example, on the routes to take to the access hospital. It will facilitate the response time to access the victim and reduce their travel time. Thus, optimizing the results. An example of the map with the location of the AEDs is shown in *Figure 2*. It is an example of the route and map created for the 2024 Mexico City Marathon.

Table 1: Basic actions to help those witnessing sudden cardiac death during a race.

Basic actions	Response
1. Recognize the emergency	Identify if the person is unconscious and not breathing normally
2. Activate emergency services	Immediately call the local emergency number (e.g. 911)
3. Start CPR	Begin high-quality chest compressions
4. Chest compressions	Press hard and fast on the center of the chest, at least 100-120 compressions per minute
5. Allow chest expansion	Allow the chest to expand fully between compressions
6. Minimize interruptions	Keep pauses between compressions to a minimum
7. Rotate rescuers	If possible, change the person giving compressions every two minutes
8. Use Automated External Defibrillator	If an automated external defibrillator is available, use it according to its instructions
9. Continue until help arrives	Maintain CPR until the emergency services arrive

Figure 2: Route of the Mexico City Marathon 2024, with the proposed sites for cardioprotection based on a temporal radius of less than five minutes in case of sudden death, and with emphasis on the last km of the route where there may be a greater probability of sudden cardiac death.

C. Coordination with Emergency Medical Services (EMS)

1. **Rapid Activation:** establish an agreement with EMS to ensure a rapid response to SCD events. Define a clear protocol for EMS activation, with a target response time of less than two minutes from the start of the SCA event to the arrival of the AED.
2. **Transfer and Specialized Care:** ensure the availability of high-tech ambulances and specialized medical personnel trained in advanced cardiopulmonary resuscitation to transfer victims to nearby reference hospitals *(Table 2)*. Establish agreements with hospitals with a Cardiovascular Intensive Care Unit and hemodynamics room available, both with certified personnel, during the event (from one hour before and up to two hours after the event).
3. **Functionality of AEDs AED inspection:** ensure that the equipment and its accessories are in optimal condition and have their maintenance logs or the guarantee of new equipment within 24 hours before use *(Table 3 and 4)*.
4. **Diffusion and Awareness:** diffuse the SCA response protocol to all participants, organizers, and volunteers of the event at least 24 hours before so that they are familiar with the response protocol for the event. Use digital and physical tools, such as mobile applications, to activate the protocol during the event.
5. **Emergency Number:** provide clear and accessible information on the emergency number and the steps to follow in the event of SCD. Ensure that everyone involved in the event is aware of this number and the action protocol, including the chain of survival and possible hands-only CPR by the witness.[10]

DISCUSSION

Implementing this cardioprotection protocol in sports races, regardless of the distance, not

only increases the chances of survival in SCD events but also promotes a culture of safety and prevention. Through the strategic deployment of AEDs, continuous training, and coordination with EMS and reference hospitals, a rapid and effective response can be ensured, saving lives.[11] By implementing these measures, marathon organisers can ensure the safety and protection of their events, providing reassurance to all participants and attendees that they are well-prepared to handle any potential cardiovascular emergencies. The survival obtained by using an AED during an SCD event in marathons can be 5 times greater, and death events can be reduced by more than half, as seen in *Figure 3*.

Moreover, if athletes and organizers of this type of event have adequate foresight and implement Mexican positioning for cardiovascular screening and evaluation prior to sports participation,[12] an almost absolute reduction in the risk of cardiovascular mortality during an event, such as a marathon, will be achieved. It should be an event of celebration and passion for the sport, and not become something regrettable due to the death of a participant during the event. It is the obligation of doctors, medical organizations, authorities at the three levels of government, and non-governmental organizations to promote the development

Table 2: Ambulance crash cart supply and equipment checklist.

Recommended equipment	Recommended medication (units)
Airway (oral and nasal) all sizes	Aspirin 81 mg tablets (4)
Three laryngoscope and endotracheal tubes	Morphine Hydrochloride 10 mg/mL-20 mg/mL
Bag valve mask (adult and pediatric)	Injectable ampoule (2)
Nasal cannula (adult and pediatric)	Nitroglycerin spray or 0.4 mg sublingual tablets (3)
Non rebreather oxygen face masks (three sizes)	Dextrose 50% (dextrose 25% if treating pediatrics)
IV start packs	0.9 NaCl normal saline solution 1,000 mL (5)
Normal saline solution (1,000 mL bags)	Dextrose 5% in water 1,000 mL (3)
IV tubing	Lactated Ringer´s solution 5% dextrosa 1,000 mL (3)
Angiocaths (various sizes)	Lactated Ringer´s solution 1,000 mL (3)
10 mL normal saline flush syringes (3 pieces)	Narcan (Naloxona) 1 mg/mL (6)
5 mL normal syringe (10 pieces)	Flumazenile 1 mg/10 mL amplue (2)
Gauze	Epinephrine 1:10,000 auto injector (10)
Alcohol preps	Atropine sulfate 1 mg (3)
Monitor with defibrillator (preferred) or AED	Amiodarone 150 mg Vial (3)
Syringe nasal adaptor (nasal narcan atomizer)	EpiPen® or epinephrine 1:1,000 (2)
A checklist confirming everything that should be on the cart	EpiPen Jr® or epinephrine 1:1,000 (2)
	Solumedrol 125 mg (1)
	Benadryl 50 mg vial (2)
	Adenosine 6 mg (3)
	Lopressor 10 mg (2)
	Cardizem 20 mg vial (2)
	Pronestyl (procainamide) 1 g (1)
	Lidocaine 100 mg (3) Midazolam
	Dopamine ampule 200 mg (2)
	Dobutamine ampule 250 mg (2)
	Adenosine 6 mg ampule (5)
	Water
	Midazolam ampule 5 mg

Table 3: Automated External Defibrillator maintenance checklist.

Troubleshooting		
Item	Problem	Solution
Automated External Defibrillator	Signs of foreign substances	Clean according to manual
	Signs of damage	Contact manufacturer
	Chirping noise	Follow troubleshooting guidelines; check battery and pads
Status ready indicator	Status ready indicator is showing unit is not ready	Follow troubleshooting guidelines; contact manufacturer if no resolved
Automated External Defibrillator battery	Date expired	Replace item
Automated External Defibrillator pads	Date expired	Replace item

Table 4: Automated External Defibrillator maintenance checklist.

Date of inspection	✓	x
Status ready indicator shows the unit is ready		
Battery is working and not expired		
Unit is free of cracks, foreign substances, or other signs of damage		
Pads are sealed, unused and not expired		
Supporting materials are sealed and unused before expiration – face shield, scissors, gloves, razor, alcohol wipes		

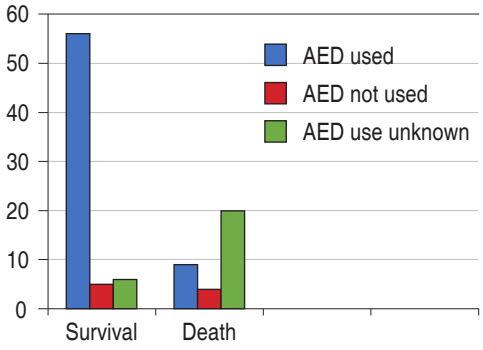

Figure 3: Outcome of SCD in marathons with respect to AED use in resuscitation.
Modified form.[16]

of cardioprotective spaces in Mexico and to educate the general population on hands-only CPR and the use of CPR, provided free of charge by AED.[13] Although some protocols for the creation of cardioprotective spaces have been published in Mexico.[14] Much more needs to be done to improve survival rates for out-of-hospital cardiac arrest in order to achieve the triple survival rates reported in other countries.[10,15] This will help address a public health problem that, unfortunately, tends to affect productive individuals, altering the personal, economic, and family expectations of everyone involved.

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