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Cardiopulmonary Resuscitation and Adult Basic Life Support

Kardiyopulmoner Resüsitasyon ve Erişkin Temel Yaşam Desteği

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Abstract

Cardiopulmonary arrest (CPA) is a phenomenon that can occur both in and out of hospital. Out-of-hospital cardiac arrest accounts for the majority of arrests treated in emergency departments. Cardiopulmonary resuscitation (CPR) refers to all interventions to restore organ perfusion caused by CPA. The first priority is to prevent the causes of arrest. On the other hand, if there are reversible causes, they should be treated and the condition that caused the arrest should be eliminated. CPA can be fatal if timely and effective CPR is not performed. Basic Life Support (BLS), the first stage of CPR, is the foundation of cardiac arrest care. BLS includes the first attempts at CPR without the use of devices. The first step in the chain of life in out-of-hospital cardiac arrest management is early recognition of the arrest and early calling for help. BLS should continue until advanced life support is provided. The first step in the chain of life in the management of out-of-hospital cardiac arrest is the rapid recognition of the patient's condition and the timely call for help. The steps continue with early chest compression and early defibrillation.As a matter of fact, with the use of an Automatic External Defibrillator (AEDs) in public areas, death can be significantly reduced by recognizing life-threatening compartment rhythms in the heart and applying early shock.

Key Words: First aid, cardiopulmonary resuscitation, heart arrest.

Özet

Kardiyopulmoner arrest (KPA), hastane dışı ve hastane içi olarak meydana gelebilecek bir olgudur. Acil servislerde müdahale edilen arrestlerin büyük bir kısmını hastane dışı kardiyak arrest oluşturmaktadır. Kardiyopulmoner Resüsitasyon (KPR) ise KPA'nın neden olduğu organ perfüzyonunu düzeltmek için yapılan tüm müdahaleleri ifade eder. İlk öncelik, arrest'ê yol açabilecek sebeplerden korunmaktır. Diğer yandan geri döndürülebilir nedenler var ise tedavi edilip arrest'e sebebiyet veren durumun ortadan kaldırılması gerekmektedir. KPA, zamanında ve etkili KPR yapılmazsa mortalite ile sonuçlanabilir. KPR'nin ilk aşaması olan Temel yaşam desteği (TYD), kardiyak arrestin temelini oluşturur. TYD, ekipman kullanmaksızın yapılan ilk müdahale girişimlerini içerir. TYD, ileri yaşam desteği sağlanıncaya kadar devam ettirilmelidir. Hastane dışı kardiyak arrest yönetiminde yaşam zincirinin ilk adımı, hastanın durumunun hızla tanınması ve yardım çağrısının zamanında yapılmasıdır Erken göğüs kompresyonuna başlama ve erken defibrilasyon işlemi ile adımlar devam eder. Nitekim halka açık alanlarda Otomatik Eksternal Defibrilatör (OED) kullanımı ile kalpteki hayatı tehdit eden düzensiz ritimleri tanıyarak ve erken şok uygulaması yaparak mortalite önemli ölçüde azaltılabilir.

Anahtar Kelimeler: İlk yardım, kalp durması, kardiyopulmoner resüsitasyon

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1. Introduction

Cardiopulmonary arrest (CPA) is the sudden, unexpected cessation of heart function, circulation and breathing due to a variety of causes. The mortality rate for patients with CPA is very high. Cardiac arrest is a leading cause of death in all parts of the world (Sarkisian et al., 2022). When cardiac arrest occurs, oxygen and glucose cannot be delivered to the cerebral cortex due to impaired circulatory function. The brain, deprived of oxygen, begins to suffer damage (Medicherla & Lewis, 2022). Preventing damage to the cerebral cortex depends on effective and timely cardiopulmonary resuscitation (CPR) from the first few minutes. Although CPR is a life-saving procedure used in cases of interrupted cardiac or respiratory arrest, including efforts to resuscitate the victim in cases of continued circulation and respiration, CPR is an emergency situation that requires not only practice but also decision-making (Garcia Macias et al., 2020). In 1966, the American Heart Association (AHA) established the first official guidelines for CPR and these guidelines have been regularly updated to incorporate new research and medical advances (American Heart Association, 2020). Updated every five years, the guidelines have guided healthcare professionals in the early recognition of cardiac arrest, activation of the emergency response system, rapid defibrillation and treatment. BLS, the first stage of CPR, is the foundation of cardiac arrest care. BLS is the set of interventions performed on patients without spontaneous breathing and circulation to support only external chest compressions and artificial respiration without invasive intervention and without the use of medical devices until advanced cardiac life support (ICLS) is provided (Ministry of Health of the Republic of Turkey, 2015). BLS, early recognition of sudden cardiac arrest (SCA), activation of the early emergency response system, early defibrillation, etc. have a significant impact on survival and are practices that significantly increase survival (American Heart Association, 2021).

Pre-hospital emergency health services (PHEAS) of the World Health Organization (WHO); covers emergency care provided during the period before the patient or injured person is transported to hospital. The main purpose of emergency health services is to prevent deaths and reduce disability through rapid and effective intervention in emergency illness and injury. Emergency health services range from first aid and rescue to transport (ambulance), casualty care and rehabilitation (Ekşi, 2015). Information on the top 10 causes of death published by the WHO in 2016 indicated that 15.2 million out of 56.9 million deaths were caused by ischaemic heart disease and stroke. Considering that the aim is to reduce these rates worldwide, the importance of PHEAS is clear (World Health Organization. 2020). Early recognition and medical intervention of cardiac arrest increases survival and significantly reduces mortality. Preventing cardiac arrest and reducing mortality is an effective and complementary approach to improving public health (Fletcher & Rea, 2017; Sarkisian et al., 2022).

2. Cardiac Arrest Definiton

Cardiac arrest (CA) is the sudden and unexpected cessation of respiration and/or cardiac arrest as a result of any disease or trauma. It is the result of a disruption in the electrical activity of the heart, resulting in a deterioration in pump function and the absence of a palpable pulse, which causes the patient to lose consciousness (Zheng et al., 2022; Zimmerman & Tan, 2021) Clinical diagnosis is confirmed by the patient being unresponsive, unconscious, no pulse in the arteries (carotid, etc.), cyanosis of the skin, and apnea. These symptoms of cardiac arrest, which is an important public health problem, require immediate medical attention (Soar et al., 2021).

3. Cardiac Arrest Epidemiology

Although cardiac arrest has been prevented to a great extent, the situation still remains serious. It is the leading cause of death in many countries around the world and can occur in any individual. In cardiac arrest, the incidence of which is unknown, reversible causes can be determined and CPR can be used. When we look at epidemiological studies; 75% of sudden deaths are due to cardiac causes, the rest are due to non-cardiac causes and represent 0.26% of the population (Berg et al., 2020). In studies of out-of-hospital sudden cardiac death, the rates of return of spontaneous circulation and hospitalisation vary from 9% to 65%. However, the frequency with which these patients are discharged from hospital varies from 1% to 31%. Survival in people with out-of-hospital cardiac arrest (OHCA) is <10%. This wide variation in efforts to restore circulation is due to differences in emergency medical systems. In people with OHCA, the chance of survival is less than 2% in patients without OHCA (Pocock et al., 2022).

Cardiac arrest can be OHCA and in-hospital cardiac arrest (IHCA). According to the AHA American Heart Association 2020 guidelines, 370,000 adults in the United States will experience a non-traumatic OHCA in 2019. In the United States of America (USA), 70% of OHCAs occur in the home and approximately 50% are unwitnessed arrests. According to the Turkish Statistical Institute, the number of deaths in 2022 will be 504,839, with cardiovascular disease being the leading cause at 35.4% (Tsao et al., 2022). Despite advances in the treatment of heart disease, patients with cardiovascular disease have poor outcomes and the initial rhythm of the patient during

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cardiac arrest is important for diagnosis. The incidence varies or increases with underlying causes and age. Men are 2 to 3 times more likely to have OHCA than women (Philippe et al., 2024). (Figure 1).

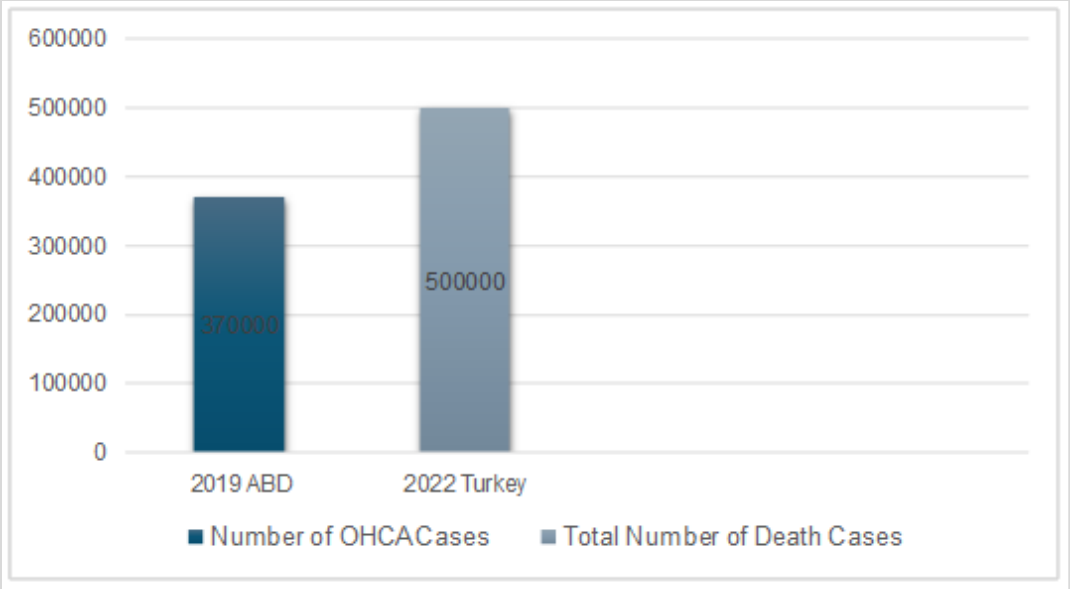

Figure 1. Out of hospital cardiac arrest and total deaths

4. Etiology of Cardiac Arrest

There are many causes of CPA in adults, and in most cases it is due to diseases of the cardiovascular system. CPA is classified in two different ways. The first is an anatomical classification based on the underlying causes and consists of four different groups: non-structural heart diseases, non-cardiac diseases, ischaemic heart diseases and non-ischaemic heart diseases. The second classification is the arrival rhythm of the individuals, which consists of three groups: Bradyasystole, Non-Electrical Activity (NEA) and Ventricular Tachyarrhythmias (Uysal, 2010). (Figure 2)

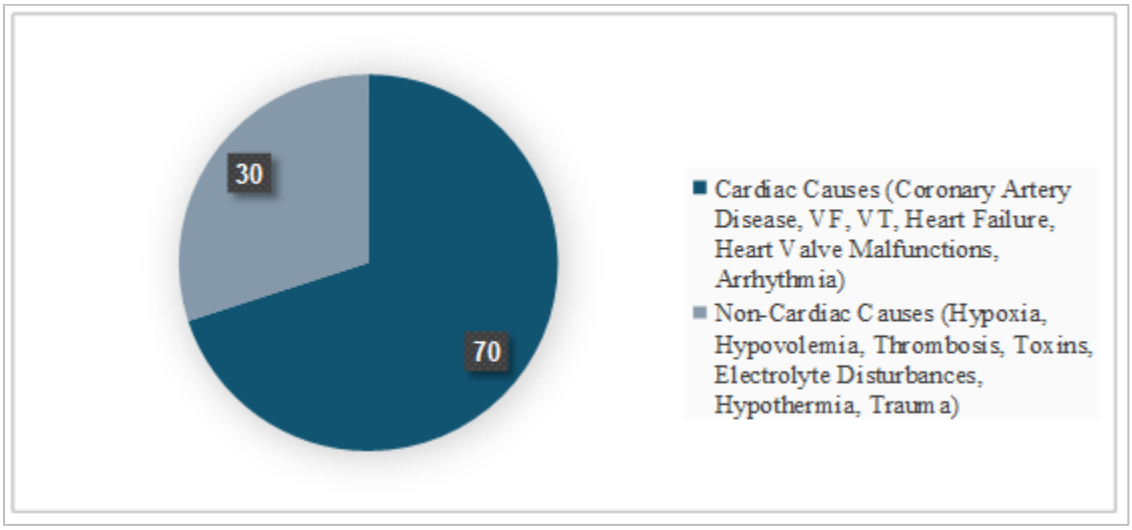

Figure 2. Causes of cardiac arrest

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5. Reversible Causes of Cardiac Arrest

Irrespective of the underlying cause of cardiac arrest, the interventions employed are universal and adhere to the chain of life. The chain of life comprises five stages: early diagnosis and calling for help, intervention to address the patient's deteriorating condition, emergency defibrillation and high-quality CPR, treatment of reversible causes, and finally post-resuscitation care. Reversible causes of cardiopulmonary arrest: Hypovolemia, hypoxia, hypokalemia, hyperkalemia and other electrolyte disorders, Hyperthermia and hypothermia, tension pneumothorax, thrombosis, tamponade and toxic agents. The 2021 ERC Special Conditions Guidelines place greater emphasis on the identification and prioritisation of recurrent causes of CPA. (Lott et al., 2021; Topjian et al., 2020).

6. Cardiopulmonary Arrest Rhythms

Arrest rhythms can be classified into two categories: those that are shockable and those that are non-shockable. CPA comprises four fundamental rhythm sources: ventricular fibrillation (VF), pulseless ventricular tachycardia (nVT), asystole and pulseless electrical activity (PEA). (Table 1). Non-shockable rhythms are typified by the presence of asystole or PEA, whereas shockable rhythms are defined by the presence of VF or nVT (Pocock et al.,2022).

The primary differentiating factor between shockable and non-shockable rhythms is the ability to perform defibrillation in the former, but not the latter. The remaining algorithms, intervention methods and medical treatments are comparable between the two groups. The implementation of early defibrillation and high-quality CPR for VF/nVT, as well as high-quality CPR for NEA/asystole, represents a pivotal element in the attainment of favourable treatment outcomes. In patients exhibiting VF or pulseless non-vitamin-K antagonist oral anticoagulant (NOAC)-induced ventricular tachycardia (nVT), it is recommended that CPR be performed for a period of 30 to 60 seconds prior to defibrillation. It is inadvisable to undertake rhythm checks following the administration of defibrillation. Subsequently, an assessment of the cardiac rhythm should be conducted at two-minute intervals. The survival rate is high when defibrillation is performed within the first three to five minutes (Isasi et al.,2019; Krasteva & Jekova, 2022).

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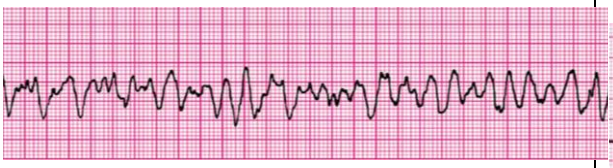
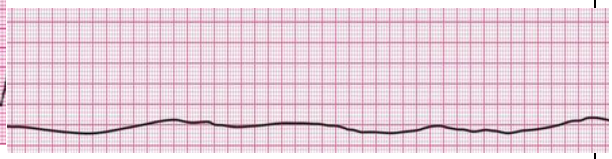
Table 1. Cardiopulmonary Arrest Rhythms

Shockable Rhythms	Unshockable Rhythms
Ventricular Fibrillation 	Asystole 
Pulseless Ventricular Tachycardia 	Pulseless Electrical Activity 

6.1. Ventricular Fibrillation (VF)

The most critical cardiac arrest rhythm for defibrillation is VF. In approximately 25% of cases of cardiac arrest, the initial rhythm is either non-ventricular tachycardia (nVT) or VF. VF is indicative of aberrant electrical activity, whereas nVT is indicative of electrical activity of the ventricular myocardium devoid of mechanical activity. The two rhythms share the common feature of being unable to produce systematic ventricular contractions and peripheral blood flow. In VF, the heart's contractions are rapid, uncoordinated, and ineffective (Deakin & Koster, 2016). In VF, the inability to achieve both depolarisation and repolarisation of the ventricle is due to the rapid rate and diversity of myocardial cells, which are unable to function independently of each other due to the rapid excitation from the focus within the ventricle. Irregular contractions of the myocardium are unable to generate cardiac contraction and thus result in a lack of cardiac output (İnce & Yavuz, 2017). An electrocardiogram (ECG) tracing of VF exhibits a specific, irregular and pulseless rhythm, characterised by indistinguishable QRS complexes. VF has the potential to cause brain damage and death within minutes if not treated promptly (Sudhir & Brady, 2023).

6.2. Pulseless Ventricular Tachycardia

The condition is characterised by the occurrence of rapid impulses originating from an ectopic focus, rather than from the normal sinus rhythm within the ventricle. These impulses occur abruptly between 150 and 250 beats per minute and are observed in an ECG tracing with a wide QRS pattern. It typically arises as a consequence of myocardial ischaemia and coronary artery disease, myocarditis or the effects of antiarrhythmic drugs (Topjian et al., 2021).

6.3. Pulseless Electrical Activity (PEA)

The term "pulseless electrical activity" (PEA) is used to describe the presence of organised cardiac electrical activity on an ECG monitor in the absence of a palpable pulse. The organised rhythm represents a distinctive pattern of CPA, manifesting as a rhythm in which a pulse is not discernible without the generation of cardiac output

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(Tintinalli et al., 2020). In general, the prognosis of PEA is less favourable than that of VF/VT, with a predicted prognosis of a survival rate of less than 3% for HFCA with PEA as the initial rhythm. In cases of PEA resulting in cardiac arrest, it is imperative to ascertain and address any reversible causes to enhance the likelihood of survival (Long et al., 2020). Asystole is represented on an ECG as a straight line lying on the isoelectric line. In rare instances, P waves indicative of atrial depolarisation may be observed, yet QRS complexes indicative of ventricular activity are absent. This is indicative of a lack of electrical activity within the myocardium, which is unable to perform its contractile function. Asystole represents a late arrest rhythm with a poorer prognosis than VF/VT. In cases of asystole, potential reversible causes should be investigated and treated (Ertan, 2016).

7. Cardiopulmonary Resuscitation

CPR is a vital procedure that can be used to save lives in cases of cardiac or respiratory arrest. It involves providing artificial respiration and compressions to the chest in an effort to restore circulation and breathing. These are all the interventions performed with the objective of restoring perfusion of vital organs until spontaneous circulation is restored (Neumar & Shuster, 2023).

CPA constitutes a significant medical emergency. In the absence of CPR within minutes, death or permanent brain damage may ensue. Four key interventions, collectively known as the chain of life, have been demonstrated to enhance outcomes, including early recognition of cardiac arrest, high-quality CPR, rapid defibrillation, and effective post-CPR care (Merchant et al., 2024). The CPR process is guided by regularly updated guidelines, such as those set forth by the AHA, ESC, and ILCOR. These guidelines are typically updated every five years, in accordance with evolving needs (Kiguchi et al., 2020).

8. Adult Basic Life Support

BLS is a technique that can be employed in situations where a person is unconscious, experiencing cardiac arrest, and/or has ceased breathing, with the objective of preserving life. The BLS technique involves performing chest compressions to support ventilation and circulation, while simultaneously administering breaths through the airway to maintain patency without the use of medical equipment or medication. These applications are continued until the arrest is terminated or advanced life support is initiated (Olasveengen et al., 2020). The primary objective of CPR is to ensure adequate oxygenation of the tissues in a patient whose respiration and circulation have ceased, and to stimulate cardiac output through chest compressions. The most crucial aspect of these procedures is to promptly identify circulatory arrest and take appropriate action, including maintaining airway patency, administering artificial respiration, and performing the Heimlich maneuver in the event of complete obstruction. These techniques fall within the scope of basic life support (Ching, 2024).

8.1. Life Saving Chain

The chain of life represents an algorithmic approach to the restoration of respiratory and circulatory function in the event of cardiac arrest. It is imperative that all the links, which are interdependent and critical at each stage, are implemented in sequence, without interruption, in a timely and effective manner (A Sueta, 2015). The American Heart Association has developed two fundamental algorithms for the Chain of Life, namely IHCA and OHCA. In OHCA management, the initial step is the prompt recognition of the patient in cardiac arrest and the prompt calling for assistance. This is followed by the immediate initiation of chest compressions, defibrillation,

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effective advanced life support and post-CPR care. In IHCA management, the initial step is to prevent and promptly identify the disease, activate the emergency response system, commence chest compressions, administer defibrillation as soon as feasible, provide post-CPR care, and allow for a recovery period, as outlined in the 2020 AHA CPR guideline (Penketh & Nolan, 2022).

9. Adult Basic Life Support (BLS) Algorithm

9.1.Early Recognition and Call for Help

The most crucial element in enhancing survival rates is the acknowledgement of cardiac arrest. Subsequently, it is imperative to deploy the emergency response system and perform CPR of the highest standard until the arrival of healthcare professionals. In the event of an emergency, the appropriate emergency services telephone number in this country is 112. In the event that the rescuer is a member of the public, it is of the utmost importance that they first assess the scene and ensure scene safety in order to prevent the situation from worsening. Subsequently, the rescuer should ascertain the patient's level of consciousness by asking, in a clear and audible voice, whether they are in pain. In the event that the patient is unresponsive to painful and verbal stimuli, early contact with the emergency call centre is of significant benefit in facilitating the recognition of arrest, learning the location of the automatic external defibrillator, how to perform CPR and its application (Soar et al., 2021).

In the event that the rescuer is a trained professional or healthcare personnel, it is imperative that they ascertain the presence of a pulse from the carotid artery with the utmost clarity for a period of no longer than 10 seconds. In the absence of a pulse, the patient should be considered to be in cardiac arrest, and the emergency response system should be promptly activated (Olasveengen et al., 2020).

9.2. Early and Effective CPR Application

It is of the utmost importance to commence CPR on the patient who has been admitted with CPA at the scene, as this is a critical factor in ensuring survival and recovery without long-term complications. The AHA guideline underscores the significance of promptly initiating CPR until the arrival of medical personnel. In the 2010 AHA CPR guideline, the sequence of steps for CPR was modified from the ABC (airway, breathing, circulation) approach to the chest compression, airway, breathing sequence. Chest compression is of paramount importance in the context of CPR. The efficacy of chest compressions is contingent upon the speed and depth of the compressions, as well as the extent to which they facilitate relaxation of the chest wall. Any intervals in the application of chest compressions result in a cessation of organ perfusion and, thus, should be kept to a minimum in order to prevent ischaemia (Idris et al., 2015).

Upon admission of the patient in cardiac arrest, the patient should be placed on a hard surface in the supine position. The rescuer should then assume a kneeling position adjacent to the patient to commence CPR in that environment, provided that it is safe to do so. (Neumar et al.,2015).

The palm of the hand should be positioned centrally on the lower portion of the sternum, with the other hand connected to the lower arm. Alternatively, the fingers of both hands can be locked together, ensuring that they do not make contact with the patient's chest. It is essential that the power be taken from the shoulder, not the arm, during the performance of chest compressions. The arms should be extended and the wrists should be fixed in

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position. The compression rate should be 100-120 per minute, resulting in a depth of 5-6 cm. During the chest compression, the chest wall should be permitted to return to its original position (relaxation). The relaxation phase should be approximately equal to the compression phase (Soar et al.,2021; Quality, 2015).

9.3. Ensuring Airway Patency

In the event that there is one or more than two rescuers present, and in the absence of intubation, the application of 30 chest compressions and two rescue breaths should be conducted at two-minute intervals. In the event that the patient is intubated, it is imperative that they be oxygenated at a rate of 8-10 ventilations per minute, without interruption to the chest compressions. It is imperative to refrain from excessive ventilation in order to prevent an increase in the patient's intrathoracic pressure. In the event of there being more than one rescuer present, it is recommended that the rescuers change positions at a ratio of 30:2 and every 5 cycles in order to maintain the quality of chest compressions (Panchal et al., 2020; Pocock et al.,2022). In the event that the rescuer is a healthcare professional and there is no indication of cervical spinal trauma in the patient, a head tilt-chin up maneuver is employed to ensure the airway remains patent. In the event that the rescuer suspects cervical spinal trauma, the use of equipment for stabilisation is contraindicated. Instead, the head should be fixed and the chin pushed forward (Pocock et al.,2022).

9.4. Head Back-Chin Up Maneuver

To perform the head tilt-chin up maneuver, the practitioner should place one hand on the patient's neck and the other hand on the patient's forehead, maintaining extension of the head along the neck and slight extension of the patient's neck. This movement brings the patient's head into the sniffing position, thereby pushing the nose forward. As the head is rotated posteriorly, the chin also elevates (Kleinman et al., 2015; Perkins et al., 2021). The chin lift is performed by placing the hand supporting the neck in a position beneath the symphysis mandible, taking care to avoid any contact with the soft tissue located at the submental triangle and the base of the tongue. Subsequently, the lower jaw is elevated in a forward and upward direction until the teeth make slight contact with one another. This procedure provides support for the jaw and facilitates the tilting of the head backwards (Topjian et al.,2020).

9.5. Chin Forward Maneuver

In the event of a suspected injury to the cervical spine, the optimal method for maintaining an open airway is to move the chin forward. This maneuver assists in maintaining the cervical spine in a neutral position. The rescuer, positioned over the victim, places their hands on either side of the victim's face, grasping each corner of the mandible, and lifts the mandible forward. This action elevates the chin, creating an open airway with minimal head movement (Kim et al., 2017).

9.6. Early Defibrillation

A device that produces an electric current which causes the myocardial layer of the heart to contract and relax at a rapid rate, thereby facilitating the restoration of the electrical rhythm within the myocardium, is referred to as a defibrillator. The process of administering an electric shock to achieve this is known as defibrillation. Automatic external defibrillators (AEDs) are sophisticated devices that are capable of detecting cardiac arrests and administering appropriate electrical shocks to restore normal rhythm. They are designed to be sensitive and safe,

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providing audible and visual indications when in use (Savastano et al.,2020). Defibrillators may be either semi-automatic or fully automatic. Automatic External Defibrillators (AEDs) are devices that evaluate the patient's heartbeat through a system in the defibrillator and, if necessary, administer an electric shock to the heart. They are equipped with gel and adhesive pads, batteries, and are designed to be portable. AEDs are user-friendly and provide audible or visual warnings indicating whether a shock is needed (Chan et al., 2008). Automated external defibrillators (AEDs) are utilised in instances where patients exhibiting signs of respiratory and circulatory failure are experiencing lethal rhythms, such as VF and ventricular tachycardia (VT), which are commonly observed during cardiac arrest. Automated external defibrillators (AEDs) are utilised in a multitude of settings, including airports, aircraft, railways, shopping centres, sporting arenas and entertainment venues (Aldaas & Birgersdotter-Green, 2024). The defibrillator pads should be applied to the patient's skin in an anterolateral or anteroposterior position by opening the patient's chest. It is imperative that verbal warnings from the AED are adhered to. It is of the utmost importance to ensure that no individual touches the victim while rhythm analysis is being conducted. In the event that the victim exhibits a shockable rhythm following rhythm analysis, a shock is administered without delay. Resuscitation and chest compressions must be continued immediately following the administration of the shock. In the absence of a shock in the AED rhythm analysis, CPR should be continued without interruption (Soar et al., 2021).

10. Conclusion

Cardiac arrest is a public health problem and the basis of cardiac arrest is CPR. The first step in TYD is to reach the patient or casualty as quickly as possible through the 112 Command Control Center (CCC), provide rapid and effective first aid at the scene, and then transport the patient/casualty to the most appropriate health institution. Cardiac arrest is the leading cause of death in many countries around the world. According to TUİK data, the number of people who died in 2022 was 504,839, and cardiovascular system diseases ranked first with 35.4%. Cardiac arrest can occur due to cardiac and non-cardiac causes. The causes are preventable. In cases of sudden cardiac arrest and injury, the duties and responsibilities of the paramedic are very important to prevent complications due to ignorance, negligence, improper transport and environmental conditions, and to ensure survival without sequelae. Cardiopulmonary resuscitation is an emergency that requires not only application but also decision-making. CPR is performed to ensure circulation and respiration in cardiac arrest. The aim of basic life support is to restore the vital functions of the patient or injured person, and if basic life support is not sufficient, advanced life support is performed. Paramedics play an important role in increasing the patient's and injured person's chance of survival, preventing complications and facilitating recovery.

Authors Contributions

Topic selection: SD.MA; Design: SD.MA; Planning: SD.MA; Data collection and analysis: SD.MA; Writing of the article: SD.MA; Critical revision: SD.MA.

Conflict of Interest

The authors declared that they have no conflict of interest.

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