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The Effect of Cardiopulmonary Resuscitation Quality on Cardiac Arrest Outcome

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Abstract

Background: Cardiac arrest is a leading cause of death in USA, nearly 90% of them fatal and Out of Hospital Cardiac Arrest (OHCA) is a leading cause of death worldwide. The Cardiopulmonary Resuscitation (CPR), especially if administered immediately after cardiac arrest, can double or triple a person's chance of survival. CPR by training persons increases the frequency the survival rate. Therefore, we aim to look into the common pitfalls that both medical students and genior physicians face in the recognition and dealing Compression in Cardiopulmonary Resuscitation with its outcome.

Aims of the study: The Effect of Cardiopulmonary Resuscitation Quality on Cardiac Arrest Outcome in Adults

Targeted Population: All adult CA patients who are requiring urgent management in the ED, with Emergency Physicians for teaching high quality CPR protocol.

Targeted End User: Emergency Medicine, Critical Care Medicine and Anesthetist physicians.

Methods: Collection of all possible available data about the Cardiopulmonary Resuscitation Quality on Cardiac Arrest Outcome by many research questions to achieve these aims so a midline literature search was performed with the keywords "critical care", "emergency medicine", "principals of Cardiac Arrest", "High Quality Compression", " Cardiopulmonary Resuscitation", "Automated External Defibrillator (AED)". Literature search included an overview of recent definition, causes and recent therapeutic strategies in Cardiopulmonary Resuscitation.

Results: All studies introduced that the early diagnosis of Cardiopulmonary arrest and their interventions by simple tools e.g. High-Quality Compression and Automated External Defibrillator (AED) that face patients of critical care situations with increase survival rate.

Conclusion: High Quality CPR will be Improving Cardiac Resuscitation Outcomes both inside and outside the Hospital by; deeper chest compressions and rate of 85 to 100 compression per minute were also associated with higher survival rates.

Keywords: CPR; Emergency Medicine physicians; Cardiac arrest

Introduction

Cardiac arrest is the loss of heart function in a person who may or may not have been diagnosed with heart disease. It can come on suddenly, or in the wake of other symptoms. Cardiac arrest is often fatal, if appropriate steps aren't taken immediately [1].

Cardiac arrest may be caused by almost any known heart condition. Most cardiac arrests occur when a diseased heart's electrical system malfunctions. This malfunction causes an abnormal heart rhythm such as ventricular tachycardia or ventricular fibrillation. Extreme slowing of the heart's rhythm (bradycardia) also causes some cardiac arrests [2].

Other causes of cardiac arrest include:

- Scarring of the heart tissue
- A thickened heart muscle (cardiomyopathy)
- Heart medications
- Electrical abnormalities
- Blood vessel abnormalities
- Recreational drug use [3].

Cardiac arrest is a leading cause of death in US. There are more than 356,000 out-of-hospital cardiac arrests (OHCA) annually in the U.S., nearly 90% of them fatal, according to the American Heart Association's newly released Heart and Stroke Statistics-2019 Update. According to the report, the incidence of EMS-assessed non-traumatic OHCA in people of any age is estimated to be 356,461, or nearly 1,000 people each day. Survival to hospital discharge after EMS-treated cardiac arrest is about 10% [4].

Out of hospital, cardiac arrest (OHCA) is a leading cause of death worldwide.

Rationale of Research

CPR combines rescue breathing, which provides oxygen for the lungs of the patient, and chest compression that keep the oxygen-rich blood flowing until the heartbeat and breathing is normally restored. CPR requires proper training and knowledge before an individual due to the variation in adults, children and infants can practice it. CPR has proven to increase survival rate for the patient when given properly and immediately [5].

CPR, especially if administered immediately after cardiac arrest, can double or triple a person's chance of survival. About 90 percent of people who experience an out-of-hospital cardiac arrest die [6].

Three million people in Sweden are trained in cardiopulmonary resuscitation (CPR). Whether this training increases the frequency of bystander CPR or the survival rate among persons, who have out-of-hospital cardiac arrests has been questioned. Methods We analyzed 30,381 out-of-hospital cardiac arrests witnessed in Sweden from January 1, 1990, through December 31, 2011, to determine whether CPR was performed before the arrival of emergency medical services (EMS) and whether early CPR was correlated with survival. RESULTS CPR was performed before the arrival of EMS in 15,512 cases (51.1%) and was not performed before the arrival of EMS in 14,869 cases (48.9%). The 30-day survival rate was 10.5% when CPR was performed before EMS arrival versus 4.0% when CPR was not performed before EMS arrival (P<0.001) [7].

A recent study examined chest compression depth and survival in out-of-hospital cardiac arrest in adults and concluded that a depth of <38 mm was associated with a decrease in ROSC and rates of survival [8].

So high quality Compression characters should be learned

➢ Place the heel of one hand in the center of the chest, Place other hand on top, Interlock fingers, Compress the chest, Rate 100-120 min-1, Depth 5-6 cm, Equal compression: relaxation, RHYTHM of Compression and breath ratio 30:2, If there is more than one rescuer, the other should take over CPR, every 1-2 min to prevent provider fatigue and Ensure the minimum of interruption during the changeover to try continue cardiac output as physiological compensation to provide blood flow to vital organs so the role of physiologic monitoring such as specifically cardiac output, coronary and cerebral perfusion during resuscitation that may be sensitive to small changes that determine resuscitative efforts [8].

The defibrillation fact is the major predictor of outcome. it is a process in which an electronic device gives an electric shock to the heart. This helps re-establish normal contraction rhythms in a heart having dangerous arrhythmia or in cardiac arrest. in recent years' small portable defibrillators have become available. These are called Automated External Defibrillators or AEDs. defibrillation is a process in which an electronic device gives an electric shock to the heart. This helps re-establish normal contraction rhythms in a heart having dangerous arrhythmia or in cardiac arrest. in recent years' small portable defibrillators have become available. These are called Automated External Defibrillators or AEDs [7].

AEDs allow trained lay rescuers to successfully deliver defibrillation even before EMS can arrive. AEDs are safe, effective, lightweight, durable, low maintenance and easy to use. AEDs interpret heart rhythm and determine if a shock is required. The unit prompts the rescuer to deliver the shock, if necessary. An AED will NOT shock someone who does not need defibrillation [9].

Defibrillation is the only technique that is effective in returning a heart in VF or Pulseless VT to its normal rhythm. Although defibrillation is only one component of definitive care, it is probably the most important when it is provided rapidly and may be all that is necessary to save the victim's life. Other life saving measures should not be minimized, but it is important to recognize the critically important role of rapid defibrillation in cardiac resuscitation Although defibrillation is only one component of definitive care, it is probably the most important when it is provided rapidly and may be all that is necessary to save the victim's life. Other life saving measures should not be minimized, but it is important to recognize the critically important role of rapid defibrillation in cardiac resuscitation Lightweight and portable. Automatically analyze heart rhythms. Determine whether defibrillation is advised. Guide the user through defibrillation. Easy to use, safe, and effective. Long life batteries and comprehensive "self-checking" protocols [10].

Safety considerations for AED

Do not shock the patient if they are wet, dry off the torso, do not shock on a metal surface, do not touch the patient while they are being shocked. You can be shocked as well, remove any medication patches with a gloved hand and do not place pads over external defibrillator [11]. We aim to look into the common pitfalls that both medical students and genior physicians face in the recognition and dealing Compression in Cardiopulmonary Resuscitation with its outcome by the effect of cardiopulmonary resuscitation quality on cardiac arrest by increase the knowledge and skills on principals of basic life support for physicians, paramedical and medical students' even popular people. As seen in Figure 1 the relation between high quality CPR, Defibrillation and early ACLS trained physicians which increase survival rate and improve outcome.

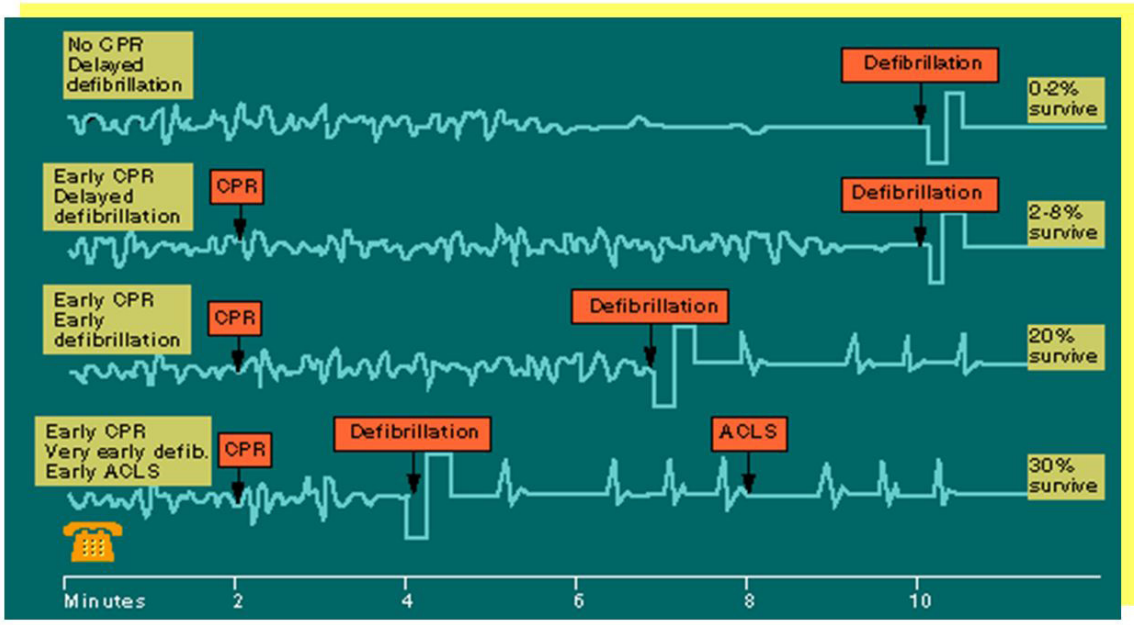

Figure 1: Relation between CPR, Defibrillation and early ACLS trained physicians to outcome

The Study Question

What is the Effect of Cardiopulmonary Resuscitation Quality on Cardiac Arrest Outcome in Adults (chest compression rate and depth)?

Evidence has accrued that cardiopulmonary resuscitation quality affects cardiac arrest outcome. However, the relative contributions of chest compression components (such as rate and depth) to successful resuscitation remain unclear.

Methodology

This section includes Collection of all possible available data about the Cardiopulmonary Resuscitation by many research questions to achieve these aims so a midline literature search was performed with the keywords "critical care", "emergency medicine", "principals of Cardiopulmonary Resuscitation", "high quality CPR" and "AED". Literature search included an overview of recent definition, causes and recent therapeutic strategies in Cardiopulmonary Resuscitation (CPR).

So the main aims and outcome of the study: initial assessment of Cardiopulmonary Arrest by simple tools to victim presentation e.g. Look, Listen Feels in less than 10 second with proper approach by High Quality Compression and Automated External Defibrillator (AED) that face patients of critical care situations with increase survival rate. And recognize potentially life-threatening conditions, reversible causes of cardiac arrest and to convey life-saving treatment so the key note here is that initial diagnosis in suspected arrest with initial treatment and rapid transfer proper cases to proper places.

While searching for this study, the Royal College of Emergency Medicine, Medline website and PubMed were searched for relevant the search was restricted to articles published between 1960 and 2011.

The databases were searched using the relevant terms, including all subheadings, and this was combined with a keyword search. Search words included "High Quality Compression", "patients cardiac arrest" 'reversible causes of cardiac arrest', 'cardiac arrest" and 'resuscitation management. The search was also limited to humans and the English language. The National Library for Health and the National Guidelines Clearing House were also searched for relevant guidelines and reviews.

Review of "Quantifying the Effect of Cardiopulmonary Resuscitation Quality on Cardiac Arrest Outcome a Systematic Review and Meta-Analysis" and "Cardiopulmonary Resuscitation Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital".

Discussion

For "Quantifying the Effect of Cardiopulmonary Resuscitation Quality on Cardiac Arrest Outcome." They searched for any clinical study assessing cardiopulmonary resuscitation performance on adult cardiac arrest patients in which survival was a reported outcome, either return of spontaneous circulation or survival to admission or discharge.

A 603 identified articles, 545 were excluded after review of the title and abstract. Forty-two studies were excluded for representing reviews (n=2), not assessing CPR quality metrics individually (n=22), comparing mechanical with manual CPR (n=2), report-

ing simulation data on manikins (n=1), including diseases other than cardiac arrest in the study population (n=2), not meeting outcome criteria (n=5), and representing overlapping publications from the same patient cohorts (n=8). A 6 additional studies excluded for assessing a categorical overall quality metric (e.g. "good" CPR versus "bad") concomitant with associated survival. Final number of studies included in the systematic review is 10 [9].

Standardized quality scores for observational studies have not been established. Thus, quality assessment of the included studies was performed by evaluating and scoring 6 criteria on an integer scale (0 or 1, with 1 being better), including (1) study design, (2) multicenter or single-center designation, (3) assessment of CPR quality measures, (4) assessment of outcome, (5) evidence of bias, and (6) whether CPR quality assessment was a pre-specified aim. Studies with a sum from 0 to 4 were considered low quality, whereas those with a sum of 5 or 6 were considered high quality [10].

All included studies were either prospective cohort studies or post hoc analyses of primary clinical trial cohorts. Effect sizes were reported as mean differences. Standard errors were calculated using group SD or 95% CI measures. Survival outcomes were categorized as ROSC, survival to admission, or survival to hospital discharge [11].

Evidence for statistical heterogeneity between studies was tested by goodness of ft ($\chi 2$). Heterogeneity was also quantified with the $I2$ measure. This measure, ranging from 0% to 100%, represents the degree of inconsistency across studies included in the meta-analysis. Low, moderate, and high heterogeneity correspond to $I2$ values of 25%, 50%, and 75%, respectively [12].

CPR was performed by trained prehospital personnel such as emergency medical technicians and paramedics in 8 publications and by trained in hospital personnel such as nurses, physicians, and medical students in 3 publications. Study quality was high in 6 investigations, as defined by our scoring system [13].

For chest compression, depth six studies provided separate estimates for the relationship between chest compression depth and outcome. In 4 investigations, this outcome was ROSC; in 1 study, it was survival to hospital discharge; and in 1 study, it was survival to hospital admission. Cardiac arrest survivors were significantly more likely to receive deeper chest compressions than non-survivors (mean difference, 2.44 mm; 95% CI, 1.19–3.69; $P<0.001$). No heterogeneity was detected among included studies [14].

For chest compression, rate six studies provided separate estimates for the relationship between chest compression rate and outcome. In 4 investigations, the outcome was ROSC; in 1 study, it was survival to hospital discharge; and in 1 study, it was survival to hospital admission. There was no overall difference in mean chest compression rate between survivors and no survivors (data not shown). We conducted a second analysis to determine whether proximity to a particular rate maximized survival (ie, that very high-compression rates were as detrimental as low rates). This was achieved by calculating the absolute difference between rates recorded among the 2 survival groups and a series of compression rate set points. For each such set point, the mean compression rate difference between survivors and non-survivors was assessed. Survivors were significantly more likely to receive chest compression rates closer to the range of 85 to 100 cpm, as shown in Figure 3 (absolute mean difference from 85 cpm, -4.81 cpm; 95% CI, -8.19 to -1.43 [$P=0.005$]; from 90 cpm, -6.58 cpm; 95% CI, -10.4 to -2.72 [$P=0.001$]; from 95 cpm, -6.58 cpm; 95% CI, -10.4 to -2.72 [$P=0.001$]; from 100 cpm, -5.04 cpm; 95% CI, -8.44 to -1.65 [$P=0.004$]). Low to moderate, non-statistically significant heterogeneity was detected among these associations [15].

This is the first systematic review and meta-analysis to evaluate such relationships including individual cardiac arrest events from an international and varied set of investigations. These results on the importance of chest compression depth are consistent with findings from previous laboratory studies such as a seminal investigation in dogs showing that cardiac output and blood flow were sensitive to compression depth. Another porcine study found that depth of chest compressions was closely related to the likelihood of ROSC. It is plausible that chest compression quality is more important during IHCA resuscitation in which defibrillation is less commonly required to achieve ROSC [16].

In the end of this study, they found CPR is an effective treatment modality for cardiac arrest and that the quality of CPR delivery is associated with survival. Specifically, we found that deeper chest compressions were associated with higher survival rates and that proximity to an ideal chest compression rate of 85 to 100 cpm was associated with improved survival in an independent fashion. Future efforts should be made to standardize how CPR quality variables are ascertained and reported to improve comparability between studies [17].

For "Cardiopulmonary Resuscitation Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital". They include too much point but I will focus only on chest compression depth and rate. I will not mention how they did the Consensus Statement but I will take what related to my point. Therefore, for chest compression rate the 2010 AHA Guidelines for CPR and ECC recommend a chest compression rate of ≥100/min. As chest compression rates fall, a significant drop-off in ROSC occurs, and higher rates may reduce coronary blood flow and decrease the percentage of compressions that achieve target depth. Therefore, they suggest an optimum target of between 100 and 120 compressions per minute. For chest compression depth the 2010 AHA Guidelines for CPR and ECC, recommend a single minimum depth for compressions of ≥2 inches (50 mm) in adults [16,17].

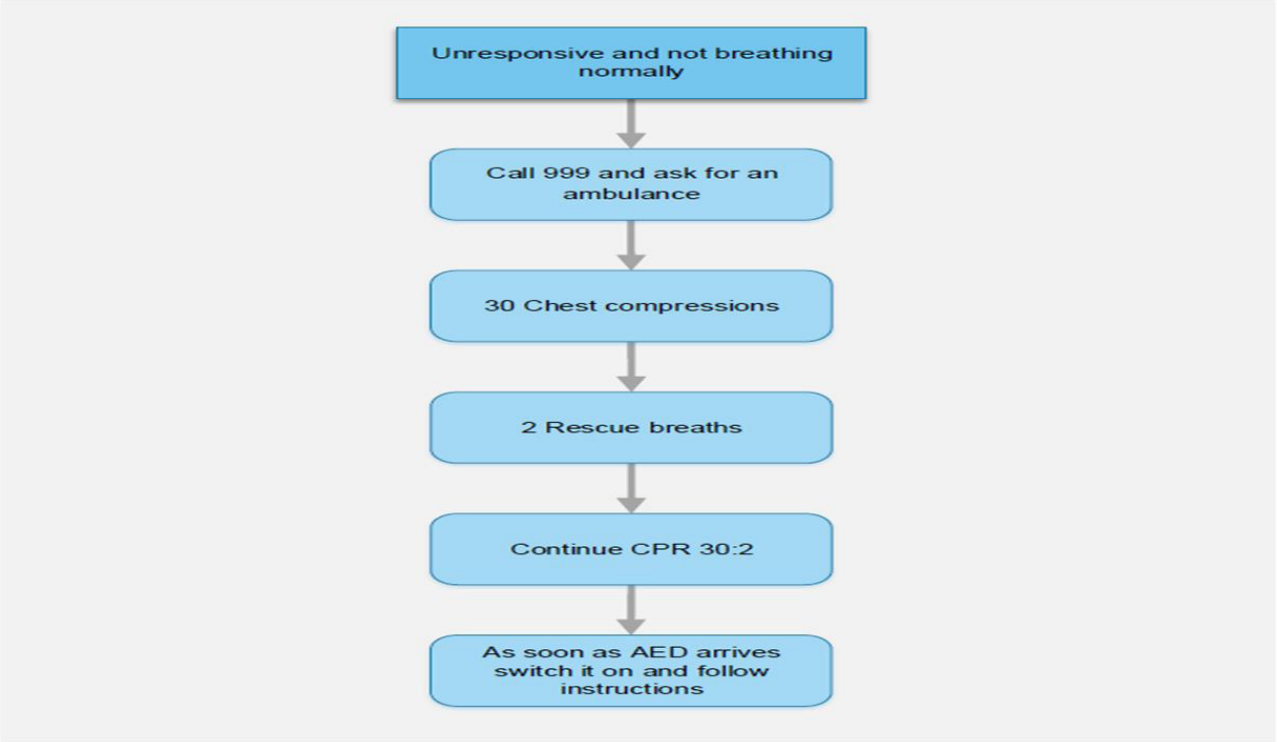

Figure 2: Proper Approach to Cardiac Arrested Patient [2]

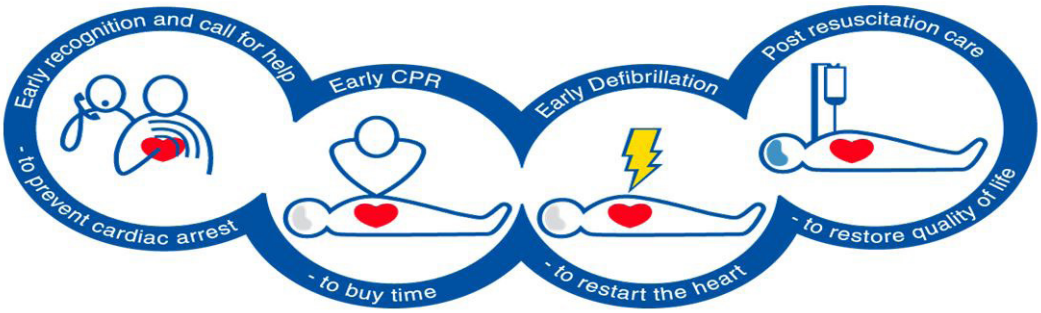

Figure 3: The Chain of Survival [3]

Sequence	Technical description
Safety	Make sure you, the victim and any bystanders are safe
Response	Check the victim for a response • Gently shake his shoulders and ask loudly: "Are you all right?" If he responds leave him in the position in which you find him, provided there is no further danger; try to find out what is wrong with him and get help if needed; reassess him regularly
Airway	Open the airway • Turn the victim onto his back • Place your hand on his forehead and gently tilt his head back; with your fingertips under the point of the victim's chin, lift the chin to open the airway
Breathing	Look, listen and feel for normal breathing for no more than 10 seconds In the first few minutes after cardiac arrest, a victim may be barely breathing, or taking infrequent, slow and noisy gasps. Do not confuse this with normal breathing. If you have any doubt whether breathing is normal, act as if it is they are not breathing normally and prepare to start CPR
Dial 997	Call an ambulance (997) • Ask a helper to call if possible, otherwise call them yourself • Stay with the victim when making the call if possible • Activate the speaker function on the phone to aid communication with the ambulance service
Send for AED	Send someone to get an AED if available If you are on your own, do not leave the victim, start CPR

Circulation	Start chest compressions • Kneel by the side of the victim • Place the heel of one hand in the centre of the victim's chest; (which is the lower half of the victim's breastbone (sternum)) • Place the heel of your other hand on top of the first hand • Interlock the fingers of your hands and ensure that pressure is not applied over the victim's ribs • Keep your arms straight • Do not apply any pressure over the upper abdomen or the bottom end of the bony sternum (breastbone) • Position your shoulders vertically above the victim's chest and press down on the sternum to a depth of 5–6 cm • After each compression, release all the pressure on the chest without losing contact between your hands and the sternum; • Repeat at a rate of 100–120 min-1
Give Rescue Breaths	After 30 compressions open the airway again using head tilt and chin lift and give 2 rescue breaths • Pinch the soft part of the nose closed, using the index finger and thumb of your hand on the forehead • Allow the mouth to open, but maintain chin lift • Take a normal breath and place your lips around his mouth, making sure that you have a good seal • Blow steadily into the mouth while watching for the chest to rise, taking about 1 second as in normal breathing; this is an effective rescue breath • Maintaining head tilt and chin lift, take your mouth away from the victim and watch for the chest to fall as air comes out • Take another normal breath and blow into the victim's mouth once more to achieve a total of two effective rescue breaths. Do not interrupt compressions by more than 10 seconds to deliver two breaths. Then return your hands without delay to the correct position on the sternum and give a further 30 chest compressions Continue with chest compressions and rescue breaths in a ratio of 30:2 If you are untrained or unable to do rescue breaths, give chest compression only CPR (i.e. continuous compressions at a rate of at least 100–120 min-1)
If an AED Arrives	Switch on the AED • Attach the electrode pads on the victim's bare chest • If more than one rescuer is present, CPR should be continued while electrode pads are being attached to the chest • Follow the spoken/visual directions • Ensure that nobody is touching the victim while the AED is analyzing the rhythm If a shock is indicated, deliver shock • Ensure that nobody is touching the victim • Push shock button as directed (fully automatic AEDs will deliver the shock automatically) • Immediately restart CPR at a ratio of 30:2 • Continue as directed by the voice/visual prompts If no shock is indicated, continue CPR • Immediately resume CPR • Continue as directed by the voice/visual prompts
Continue CPR	Do not interrupt resuscitation until: • A health professional tells you to stop • You become exhausted • The victim is definitely waking up, moving, opening eyes and breathing normally It is rare for CPR alone to restart the heart. Unless you are certain the person has recovered continue CPR
Recovery Position	If you are certain the victim is breathing normally but is still unresponsive, place in the recovery position • Remove the victim's glasses, if worn • Kneel beside the victim and make sure that both his legs are straight • Place the arm nearest to you out at right angles to his body, elbow bent with the hand palm-up • Bring the far arm across the chest, and hold the back of the hand against the victim's cheek nearest to you • With your other hand, grasp the far leg just above the knee and pull it up, keeping the foot on the ground • Keeping his hand pressed against his cheek, pull on the far leg to roll the victim towards you on to his side • Adjust the upper leg so that both the hip and knee are bent at right angles • Tilt the head back to make sure that the airway remains open • If necessary, adjust the hand under the cheek to keep the head tilted and facing downwards to allow liquid material to drain from the mouth • Check breathing regularly Be prepared to restart CPR immediately if the victim deteriorates or stops breathing normally

Table 1: Steps Guidelines in Cardiac Arrested [6,9]

1. High-quality CPR should be recognized as the foundation on which all other resuscitative efforts are built. Target CPR performance metrics include
   a. CCF>80%
   b. Compression rate of 100-120/min
   c. Compression depth of >=50mm in adults with no residual leaning
      i. (At least one third the anterior-posterior dimension of the chest in infants and children)
   d. Avoid excessive ventilation
      i. (Only minimal chest rise and a rate of <12 breaths/min
2. At every cardiac arrest attended by professional rescuers
   a. Use at least 1 modality of monitoring the team's CPR performance
   b. Depending on available resources, use at least 1 modality of monitoring the patient's psychological response to resuscitative efforts
   c. Continually adjust resuscitative efforts based on the patient's psychological response

3. Resuscitation teams should coordinate efforts to optimize CPR during cardiac arrest by
   a. Starting compressions rapidly and optimizing CPR performance early
   b. Making sure that a team leader oversees the effort and delegates effectively to ensure rapid and optimal CPR performance
   c. Maintaining optimal CPR delivery while integrating advanced care and transport
4. Systems of care (EMS system, hospital and other professional rescuer programs) should
   a. Determine a coordinated code team response with specific role responsibilities to ensure that high-quality CPR is delivered during the entire event
   b. Capture CPR performance data in every cardiac arrest and use an ongoing CPR CQI program to optimize future resuscitative efforts
   c. Implement strategies for continuous improvement in CPR quality and incorporate education, maintenance of competency, and review of arrest characteristics that include available CPR quality metrics
5. A national system for standardized reporting of CPR quality metrics should be developed:
   a. CPR quality metrics should be included and collected in national registries and databases for reviewing, reporting, and conducting research on resuscitation
   b. The AHA, appropriate government agencies, and device manufacturers should develop industry standards for interoperable raw data downloads and reporting from electronic data collected during resuscitation for both quality improvement and research

AHA indicates American Heart Association; CCF, chest compression factor; CPR, cardiopulmonary resuscitation; CQI, continuous quality improvement; EMS, emergency medical services.

Table 2: Cardiac Arrest Evaluation Checklist [12]

National Registry of Emergency Medical Technicians®
Emergency Medical Technician Psychomotor Examination

CARDIAC ARREST MANAGEMENT / AED

Candidate: _____ Examiner: _____
Date: _____ Signature: _____

Actual Time Started: _____

	Possible Points	Points Awarded
Takes or verbalizes appropriate PPE precautions	1	
Determines the scene/situation is safe	1	
Checks patient responsiveness	1	
Direct assistant to retrieve AED	1	
Requests additional EMS assistance	1	
Checks breathing and pulse simultaneously	1	
NOTE: After checking responsiveness, then checking breathing and pulse for no more than 10 seconds, examiner informs candidate, "The patient is unresponsive, apneic and pulseless."		
Immediately begins chest compressions [adequate depth and rate; allows the chest to recoil completely]	1	
Performs 2 minutes of high-quality, 1-rescuer adult CPR -Adequate depth and rate (1 point) -Correct compression-to-ventilation ratio (1 point) -Allows the chest to recoil completely (1 point) -Adequate volumes for each breath (1 point) -Minimal interruptions of no more than 10 seconds throughout (1 point)	5	
NOTE: After 2 minutes (5 cycles), candidate assesses patient and second rescuer resumes compressions while candidate operates AED.		
Turns on power to AED	1	
Follows prompts and correctly attaches AED to patient	1	
Stops CPR and ensures all individuals are clear of the patient during rhythm analysis	1	
Ensures that all individuals are clear of the patient and delivers shock from AED	1	
Immediately directs rescuer to resume chest compressions	1	
Actual Time Ended: _____ **TOTAL**	17	

Critical Criteria

____Failure to take or verbalize appropriate PPE precautions
____Failure to check responsiveness, then check breathing and pulse simultaneously for no more than 10 seconds
____Failure to immediately begin chest compressions as soon as pulselessness is confirmed
____Failure to demonstrate acceptable high-quality, 1-rescuer adult CPR
____Interrupts CPR for more than 10 seconds at any point
____Failure to correctly attach the AED to the patient
____Failure to operate the AED properly
____Failure to deliver shock in a timely manner
____Failure to ensure that all individuals are clear of patient during rhythm analysis and before delivering shock [verbalizes "All clear" and observes]
____Failure to immediately resume compressions after shock delivered
____Failure to manage the patient as a competent EMT
____Exhibits unacceptable affect with patient or other personnel
____Uses or orders a dangerous or inappropriate intervention

You must factually document your rationale for checking any of the above critical items on the reverse side of this form.

Conclusion

In the end we can say that high Quality Compression and others initial assessment and early management increase survival rate. CPR is one of the key principles for managing of cardiac arrest effectively so the majority of services are provided to the trained persons for high quality Compression and use of AED, that is essentially the philosophy of CPR for any victim.

Recommendation

We recommend increase knowledge and skills for the principals of CPR and other essential tools e.g. AED due to their simplicity of performance and reliability, even poor countries can use them in their systems and do so will prevent the collapse of healthcare services and improve patients' survival rates.

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