ORIGINAL ARTICLE

Short Term Survival Rate of Patients after Cardiopulmonary Resuscitation in Hospital Emergency Department: A Narrative Review

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ABSTRACT

Cardiac arrest is sudden cardiac arrest, which may be reversible by immediate intervention, but may result in permanent death or damage to the brain. Sudden cardiac death is a direct result of cardiac arrest, which is reversible if treated promptly. Sudden death refers to death occurring within an hour or less of the onset of terminal illness. Cardiopulmonary resuscitation (CPR) is a set of measures to restore life after clinical death. Our aim is to review the short-term survival of patients after cardiopulmonary resuscitation in the hospital emergency department. We collected information without time and language limitation from international electronic database in Google Scholar pub med Web of Science and WHO site and magazine from 1989 to 2019. Cardiopulmonary resuscitation is increasing today in hospitalized patients. Although nearly 50 years have been passed from the beginning of Cardio-Pulmonary Resuscitation (CPR), the survival rate is still poor. Previous researches indicate that different factors affect CPR. These include underlying diseases, including the time spent between patients or companies, availability of hospital and emergency services, equipment and supplies needed, and resuscitation operations. Among the factors that can be attributed to the ineffectiveness of resuscitation success are age, gender, cardiac arrest time, and prenatal shift. Patients' survival rates and the short-term benefits of short-term and long-term follow-up depend on the onset of cardiac arrest and advanced cardiac interventions.
Key word: Heart arrest_ cardio-pulmonary resuscitation_ emergency_ Short-term survival of patients and related factors

INTRODUCTION:

Cardio-pulmonary resuscitation (CPR) is one of the most significant inventions in medical history. It is considered a fast and rapid intervention that prevents death or delays it in a person who suddenly gets a cardiac arrest. CPR include all organized actions done in patients with cardiac or pulmonary arrest in effort to artificially maintain function of circulation and pulmonary system in order to provide enough oxygen to avoid death in vital organs of the body until the physiological activity of circulation system returns to normal again. These actions include 2 parts that is basic life support (BLS) and advanced cardiac life support (ACLS). Since 1960 that Kouwenhoven did CPR by massaging for the first time, there has been a lot of developments in the used methods, consumed drugs and medical staff skills; but still death rate after a cardiac death is high in comparison to other causes. Factors effective on CPR are diverse, some of them like unavailability of experienced and educated medics , delayed time in starting the resuscitation and techniques in massaging are important matters discussed frequently in medicine[1].

CPR includes actions in an effort to return vital activities of heart and lungs to normal and attempting to artificially establish the circulation until it is done automatically. Because without these procedures it takes less than 4-6 minutes (golden time) to get permanent brain death due to lack of oxygen, the word cardio-pulmonary resuscitation has been changed to cardio-pulmonary cerebral resuscitation (CPCR) proposed by Peter Safar (Expert in resuscitation science) because of its importance to revive the brain and maintain its function[2]. CPR has shown its significance especially in patients with sudden death. Sudden death is a natural death occurred in less than an hour after the beginning of acute signs in a patient which may or may not have a diagnosed underlying disease[3]. Sudden death usually occurs after cardio pulmonary arrests. Although by the definition of sudden death it is easier to appoint it to patients out of the hospital and it is harder to relate it to hospitalized patients. But it is possible to attribute it to some cases which in those type of disease normally death is not expected. The most cause of out of hospitals cardiac arrest (OHCA) and deaths caused by it in adults are cardiovascular disease. On average 80% of coronary artery disease and 10-15 % of cardiomyopathies are responsible for sudden death. (3) The incidence of sudden death in adults starts to rise after 30 and peaks in 45-75 years old. The incidence rate is 1 or 2 cases in 1000 in a year.(3,4) The underlying causes of OHCA mainly include unexpected factors such as myocardial infarction , cardiac arrhythmia and accidents. The only important factor in facing them is the unpredictability and if enough time is provided it potentially can be curable. So we can conclude that speed in taking care of those patients can determine and limit the success of it. Ultimate CPR success rate in out of hospitals cardiac deaths is reported 1.4 – 29%. This outcome is higher in small cities and less in bigger ones. The probability of CPR success in out of hospital arrests is related to various factors. It depends on first recorded rhythm from the patient [bad prognosis are in bradycardia with cardiac asystole and electromechanical dissociation (EMD)] length of resuscitation, the gap between collapse and resuscitation and the interval between collapse and first electrical shock. By reviewing these factors it is evident that speed and other related elements plays the initial role in the success of out of hospitals CPRs.(5) in United states 335,000

people suffer from out of hospitals cardiac arrest yearly and it is estimated that the same as this number cardiac arrests occur inside the hospitals.(6,7) based on American Heart Association report on 2006 starting CPR more quickly in 3-5 minutes after patient's cardiac arrest with rapid advanced life saving cares increases survival rate and long term outcomes to more than 50 % in patients with cardiac arrest and having ventricular fibrillation for first rhythm recorded. In exchange for each minute delay in defibrillation 7-10% of survival rates in patients decline.(6,8) A lot of hospitals have a cardiac pulmonary resuscitation team whom by utilizing advanced technologies and performing standard protocols act on instantly while cardiopulmonary arrests occur. Despite all those efforts patients survival rates and checking out after cardio pulmonary arrests stays the same 14.7 % in US and 16.7 in England through 30 years[9]. Nurses are the first people able to attend to patients in time of cardiac arrest and can perform CPR until resuscitation team arrives and execute advanced interventions. Therefore role and importance of education and authorizing nurses to cardiac shock and use medication during the resuscitation is evident. Studies demonstrate that all the nurses do not have competence to start the CPR[10]. Today cardiac arrests, especially OHCA are a major and important health problem because of its high incidence and mortality rate[11,12]. In spite of all advances, resuscitation and discharging patients out of hospitals in OHCA is less than 16.2%[13]

Returning circulation of blood and short term survival despite precognition and study tools are still unpredictable[14,15]. Short term survival (30 days), in US is 15-20 % (16) and in Sweden 28%. (17) Even if short term survival is a good criterion for successful resuscitation, survivors are very high in numbers and this outlook is also related to long term results. A recent study in US done by Feingold and associates indicates that risk of death in 30 days survivors after IHCA is higher in comparison to similar controls, and the highest of death risk is in the first 90 days. (16) In developed countries cardiac arrest survival rates occurring in hospitals are less than 30 %. (18) In a lot of possible cases in time of cardio pulmonary arrest if CPR is done quickly and properly patient can return to life.(19) Moreover; although it has passed nearly 40 years from starting this procedure , survival rates after resuscitation is not ideal and still mortality after cardiopulmonary arrest is higher than other causes of death. In developed countries survival rate of cardiac arrest in and out of hospitals are in turn less than 30 % and 10 % .(20) As a result ,with attention to importance of this matter , a study has been done with the purpose of assessing short term survival rates after CPR in hospital emergency ward.

MATERIALS AND METHODS

In this study that is done by a non systematic narrative review search in WHO website and in international scientific databases such as: Pub med, Web of science, Google scholar, Elsevier and Scopus. And also in national databases such as: Barakatkns, SID, Medlib, Magiran and Civilica; these key words were used: heart arrest, cardio-pulmonary resuscitation, emergency, Short-term survival of patients and related factors.

Overall 90 scientific sources including books, articles, thesis and reports from 1989 to 2019 in English and Persian language related to CPR success and relevant factors have been gathered. Unrelated sources and articles were excluded and others have been studied. At last 84 articles and scientific resources with attention to the goal and requirement of the study were chosen and analysed.

RESULTS:

Cardio-pulmonary arrest is a condition that can occur unexpectedly in any time or place and is responsible for half of mortalities. A lot of those cases could be survived by beginning instant resuscitation. Survival rate and improvement in long term outcomes for patients after resuscitation depends on instant beginning of the CPR and performing advanced cardiac interventions; In fact it depends on the sequence of survival chain stages that includes identification and instant accessibility to patients, immediate start of the resuscitation and basic life supports, punctual defibrillation and executing advanced life supports[21 22]. Skirfvars and partners in their work which was designed to study causes of different survival rates after CPR in hospitals and study the impact different stages of hospitals have on it; they concluded that indicators of survival in patients with cardiac arrests are: early shifts in the morning, absence of diabetes, young ages, first rhythms that could be shocked, observed cardiac arrests, location in cardiac arrests and type of the hospital. They finally stated that comparing survival rates after cardiac arrests in hospitals are very difficult to calculate in different hospitals because there are a lot of unidentified and unknown causes related to survival rates in each hospital[23]. Incidence of cardiac arrest in bedridden patients are about 3-4 in 1000 bedridden adults; and depending on the quality of CPR only 20 - 50% of them successfully resuscitate and discharge from the hospital. In other words, mortality risk due to cardiac arrests in bedridden patients is 50-80%. And with all the changes in the field of CPR management this ratio hasn't changed through past 40 years[8]. One of the most important and effective factors in the outcome of CPR is the underlying condition[24]. Suraseranivongse and colleagues studied on 639 patients who experienced CPR in a one year period in a hospital with 2300 beds in Thailand. Results indicated that from this number, blood flow and pulse returned to normal in 394 patients (61.7%) but only 44 patients (6.9%) checked out of the hospital alive. No difference was seen between age, gender, starting time of advanced vital actions, and patient's survival rates, although in intensive care units survival rates were higher[25]. Survival rates in patients and improvement in their short term and long term outcomes depends on instant CPR beginning and performing advanced interventions after CPR which in fact is the sequence of survival chain stages discussed earlier that included identifying ill patients in order to prevent cardiac arrest, instant beginning of CPR and basic vital actions, instant and primary accessibility to the patient, on time defibrillation, executing advanced vital actions and cares after resuscitation[26,27].

Causes of cardiac arrest: Coronary artery disease (CAD) that is due to atherosclerosis is a cause of cardiac arrest.

Atherosclerosis is a disease which in that a plaque blocks the vessels connecting blood to the heart. If this plaque detaches from the vessels wall and enters the arteries it can slows down the blood flow or halts it. This causes decrease in oxygen transfer to the heart which can lead to heart attack. Any injury affected to the heart after the heart attack also increases the risk of arrhythmia and cardiac arrest.

Physical stress which can halt the electric system of the heart is also a reason of suffering. In patients suffering from cardiac problems, extensive physical activity or sports can lead to sudden cardiac arrest (SCA), because excreted adrenaline is a stimulant of SCA.

Genetic disorders can also cause cardiac arrests. Some kinds of arrhythmia are hereditary. Also people born with heart defects, coronary artery anomaly (CAA) or Brugada syndrome can be more at risk of SCA. Drugs prescribed for cardiac patients sometimes can increase the risk of arrhythmia too. Consumption of opioid drugs such as cocaine also elevates the risk of cardiac arrest. Changes in heart anatomy may cause problems in electric system for the heart and increase the risk of arrhythmia. In a report published from the national registry of cardiopulmonary resuscitation which is the largest centre of submitting researches, numbers and statistics in the field of resuscitation, through 2000 – 2002 from 14720 adult patients who had cardiac arrest in 207 hospitals in US; three major reasons for adult cardiac arrest are declared: acute respiratory failure, cardiac arrhythmia and low blood pressure. From this number in the end 44% had return of blood flow and pulse after resuscitation and 17% of the patients were discharged[28].

Serum lactate level (SLL): In previous studies it is proven that serum lactate may cause or increase the risk of important and discussable diseases such as: heart diseases, septic shock and severe trauma. In response to increase in heart disease the risk for cardiac arrest can be elevated[29,30,31]. Lactate is known as a product of anaerobic metabolism and lactic acidosis. Therefore, in recent years SLL potential is studied on predicting survival in cardiac arrests; although with various results from those studies it is difficult to decide on its basis[32,33,34,35].

CPR quality: CPR quality is an important deciding factor on cardiac arrest and resuscitation success and survival rate[36,37,38] and affects a lot on its results.(39) Also poorly done CPRs decreases the chance of blood flow return by itself and survival in patients with cardiac arrests (40) using feedbacks during CPR is effective in increasing the quality of CPR performance (41) Different resuscitating quality monitoring indicators include: physiological and mechanical parameters such as: arterial pressure, blood oxygen saturation in central vein and end tidal CO2 measurement with capnography[42,43].

End-Tidal Carbon Dioxide (ETCO2): Measuring ETCO2 with capnography is a simple non-invasive method for evaluation and monitoring of blood flow established by the resuscitator during CPR (44) Level of ETCO2 declines in time of cardiac arrest and rises again by automatic return of blood flow[45] ETCO2 can be considered as an indicator for effectiveness of cardiac massage; Since changes in ETCO2 are considerably related to changes in cardiac output it is mandatory to put effort in achieving higher ETCO2 during CPR or cardiac massage[46]. Monitoring ETCO2 can demonstrate insufficient pressure of cardiac massage due to fatigue in resuscitator that leads to undesirable cardiac output. Also it shows the time for substitution of resuscitators in order to perfect cardiac massages without pause because sudden and permanent increase of ETCO2 shows automatic blood flow. While automatic blood flow establishes again ETCO2 elevates and is a true indicator for automatic blood flow return in the patient[42,44,47] and it is certainly approved that return of blood flow automatically during resuscitation comes with sudden rise of ETCO2[43]

Capnography: Important direct and indirect role of capnography in resuscitation is providing results in order to optimize cardiac massage during CPR and compare the efficiency of different approaches in this action. And also it can be used as a monitoring utility and a therapeutic guide of resuscitation. Capnography is a more accessible and completely non invasive method compared to other methods of CPR quality monitoring measurements like arterial blood pressure. Capnography is used in CPRs in time of trying a tracheal intubation, non present CO2 in exhale strongly indicates that the tube is located in esophagus; while presence of CO2 shows proper place of the tube in trachea. Capnography can be used to ensure the proper place of tube after placing it in trachea and to control tube location during ventilation and CPR. In time of resuscitation, presence of CO2 in exhale shows efficiency of cardiac massage and effectiveness of pulmonary and systemic blood circulation other than confirming the correct location of tracheal tube[48].

Underlying disease: According to the study of Khoshfetrat and partners, causes of cardiopulmonary arrests are divided into 7 categories consisting of: respiratory, trauma, cardiac disease, internal problems, sepsis, CVA and 7th group being patients with multiple reasons named above. Internal causes with 23.6 % is on top of the list of cardiopulmonary causes of arrests and after that cardiovascular problems with 21% are the most reasons of cardiopulmonary arrests studied. In this study eventually 36.7% of resuscitations were successful. Most of the successful resuscitations were among patients who their cardiopulmonary arrest was related to internal disease with abundance of 31.4%. Also most reason for unsuccessful resuscitation was cardiovascular disease with abundance of 25.8%. These results demonstrated that there was no meaningful difference between underlying cause of cardiopulmonary arrest and CPR outcome.

Sex: According to studies, equality between both sexes in therapy and short term results is well documented. What is unidentified is whether this equality is also present in long term results between survivors or not. (50) In some studies it is proven that survival in female patients were higher in male patients after resuscitation. (51) Other results suggest that women are less eager to receive advanced supports after resuscitation[52,53,54].

DISCUSSION AND CONCLUSION

Brain injury is the main reason of disability and mortality after cardiac arrests[55,56]. Cerebral blood flow and securing oxygen during cardiac arrests is at risk in this condition. But

it is possible that after return of blood flow this stream changes instantly naturally. Experimental proofs indicate that severe hyperoxemia after resuscitation and ROSC (return of spontaneous circulation) may aggravate renewed blood flow injury. (55, 57, 58) Sudden respiratory depression and blood flow or cardiopulmonary arrests are conditions that the causes the patient to be in a clinical death. And the first action in facing clinical death is CPR[59]. Necessity and significance of CPR has been validated in every study[60]; in a way that if the procedure is done properly it can reduce mortality up to 50 %. (61) CPR is consisted of 2 parts: basic life support and advanced cardiopulmonary resuscitation. Basic life support includes: opening the airway, establishing ventilation and circulating blood by cardiac massage. Advanced cardiopulmonary resuscitation consists of tracheal intubation, intravenous drugs admission and rapid diagnosis and curing of heart arrhythmias[62]. In the stages of CPR, intubation is vital and necessary in order to achieve successful resuscitation[63] Significance of conducting an airway and intubation in trachea is to the point that if not executed properly will definitely lead to fail in resuscitation[64]. Necessity of intubation during resuscitation is evident for everyone[65]. Learning how to intubate inside trachea is an important stage of resuscitation that needs proper and suitable education in order to improve the knowledge and also skills of medical staff[65, 66] The more skilful medical staff is in intubation during CPRs, success rate increases[67]. Therefore in order to have a successful resuscitation on time and proper intubation is mandatory[68]. In a study done by Bogdansky and partners in 2015 it was specified that teaching intubation to medical students have a positive effect on resuscitation success; Bogdansky and partners believed that intubation education by anaesthesiologists on patients checked in for non emergency procedures have positive effects on intubation of cardiopulmonary arrest emergency patients[69].

Voyser and partners also believed in their review article done in 2017 that teaching procedures like tracheal intubation has to be done in environments with the least of stress (like Operation room) so that students confront the least anxiety possible in order to not affecting their education. (70) Angus and Donoghue mention possible effect of intubation education on CPR success[64,71]. This is although Gough and associates couldn't see any positive effect on success of CPR in their 2017 study[72].

Considering the emergency situation presenting during CPRs, efficiency management which is due to knowledge and skill of CPR can increase the chance of patient's survival to a very high degree[15]; hence theoretical and practical education of CPR is necessary to increase the quality and short term survival rates of patients[73]. According to studies, improper education of CPR stages could result in irrevocable damages to patients, increasing hospital costs, elevating the time of staying in intensive care units, having negative effects on medical doctors and other medical staff, distrusting of society toward medical staff and eventually lesser survival on patients and even higher mortality[74,75,76]. In recent years, innovations for more instant accessibility to life interventions resulted in great improvement in patient's survival after resuscitation. (77, 78) With advances of precognition in improving short term health of patients, researcher's interest was increased in long term recovery and quality of life related to survivor's health. (79) In Jaana Humaloja and partners study in a centre with cardiac arrest patients in intensive care units, there was no relationship found between high blood pressure and long term neurological results or mortality. These results show unclear relationship between primary short term hyperoxemia and long term outcomes after cardiac arrests and successful resuscitation. (80) In a prospective study done in Croatia , from 32861 patients in a hospital ,120 cardiac arrests occurred which on 96 of them CPRs were performed. 76.7 % were observed cardiac arrest and others were not. Overall 22.5 % of patients were discharged from the hospital alive[9]. Survival rate after cardiac arrests in hospitals in night shifts are lower because of less prepared number of staff[81] in Salari and partners' study there was a meaningful relationship between observed cardiac arrests and final outcome of resuscitation in a way that none of the patients having unobserved cardiac arrest were discharged alive. Survival and discharge rate in patients with shockable rhythms were evidently higher from unshockable rhythms and there was a meaningful relationship between type of the first cardiac rhythm and its being able to shock those rhythms to final results of the patients' resuscitation. That matter is important because of the delicacy of these rhythms toward cardiac shock and their return to normal rhythm in conditions of on-time cardiac shock. Most important indicators in discharging patients experienced CPR are cardiac rhythms, resuscitation team response time and duration of CPRs[82]. In Pottle A study , none of the patients whom hadn't received basic supports before the resuscitation team arrived were discharged alive[83].

In some studies it is proven that in both before and after intervention, successful resuscitation rate and discharged patients were a lot higher in patients who went through CPR in early shifts compared to evening and night shifts. This difference can be attributed to faster response time from resuscitation team in morning shifts, more rapid diagnosis of cardiac arrests due to more present doctors and more instant accessibility to specialists and nurses and also more skilful staff being present. This can show that even without intervention resuscitations outcome in morning work hours are more successful than evening and night shifts[8, 84].

In Salari and partners study it is also demonstrated that in patients whom return of the blood flow occurred after a short period, longer than 24 hours survival rate was 6.3% in the stage before the intervention and 13.8% in the stage of after intervention and discharge rate among patients was (2.5%) which was seen only in the after intervention stage, those low numbers can be attributed to inappropriate care after resuscitation, insufficient especial beds and equipments and inadequate staff for after resuscitation care and monitoring[85].

Patients' survival rate and improvement in short term and long term outcomes after resuscitation depends on the instant start of CPR and advanced interventions which in fact is the sequence of survival chain stages discussed earlier. These stages are identifying ill patients in order to prevent cardiac arrests, instant and primary accessibility to the patient, instant beginning of CPR and basic life

supports, punctual defibrillation, executing advanced vital actions and taking care of patients after resuscitation[21,22].

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