

CPR UPDATE

New Developments in Cardiopulmonary Resuscitation

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ABBREVIATIONS

CPR = cardiopulmonary resuscitation
ROSC = return of spontaneous
circulation
CCF = chest compression fraction
CPP = coronary perfusion pressure
ALS = advanced life support

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ABSTRACT

Cardiopulmonary resuscitation (CPR) is the only therapeutic option for patients with cardiac arrest. Resuscitation guidelines change every 5 years in order to follow the emerging scientific data. All changes focus on increasing survival rate which remains surprisingly low. Newer developments and recently published scientific statements emphasize the need for adequate implementation of the existing guidelines and improvement of the CPR quality.

INTRODUCTION

Ischemic heart disease becomes the leading cause of death in several developed countries. From 1999 to 2009, the relative rate of death attributable to cardiovascular disease declined by 32.7%. Yet, it still accounts for 32.3% of all deaths, or 1 of every 3 deaths in the United States.¹ The incidence and outcome of cardiac arrest varies around the globe but given that survival from out of hospital cardiac arrest is <15%, this establishes cardiac arrest as one of the most lethal public health problems. Resuscitation science continues to advance, and clinical guidelines are updated in a 5-yearly cycle in order to reflect these developments and advise healthcare providers on best practice. Awaiting for the 2015 guidelines to come, all the latest developments on cardiopulmonary resuscitation (CPR) are focusing on optimizing the quality of CPR in order to maximize survival from cardiac arrest efforts.

Survival from cardiac arrest depends on early recognition, immediate activation of the emergency response system, but equally critical is the quality of CPR delivered. A poor CPR quality has detrimental effects on victim's survival and post resuscitation neurological status. The critical parameters of CPR that can enhance quality are summarized in 3 principal areas: CPR performance; Monitoring and feedback (for both victim and resuscitation team); and Team approach and Quality-improvement strategies.

1. CPR PERFORMANCE

To ensure high-performance CPR the essential attributing components are chest compression fraction (CCF), chest compression rate, chest compression depth, chest recoil (residual leaning), and ventilation.

CHEST COMPRESSION FRACTION (CCF)

Chest compression fraction is the proportion of time that chest compressions are performed during cardiac arrest. Interruptions in chest compressions are usually made for victim's initial assessment, call for help, prolonged ventilation and pre - post shock pauses. A CCF lower than 80%, is associated with decreased return of spontaneous circulation (ROSC) and survival to hospital discharge.² To minimize no-flow time the former guidelines have addressed immediate initiation of resuscitation after cardiac arrest recognition (gasp included), minimizing pre shock pause and ventilation time, and immediate chest compression resumption after every shock delivery without rhythm analysis. Advised strategies for increasing CCF is by continuing chest compressions during defibrillator charging and rapid rescuer shifting when a resuscitation team is present.

CHEST COMPRESSION RATE

The compression rate should be at least 100 but not greater than 120 per min. Experimental data suggest optimum coronary perfusion pressure within the above range and marked hemodynamic deviation for rates below or above these values.³

CHEST COMPRESSION DEPTH

High quality chest compressions are essential. The aim should be to push to a depth of at least 5 cm. Rescuers do not compress the chest deeply enough despite recommendations. A depth of <38 mm is associated with a decrease in ROSC and rates of survival.⁴ Major contributors are rescuers and hospital bed height, patient size, compression rate, and environmental features (supporting mattress stiffness). Extrapolating the existing evidence for the pediatric population a compression depth of at least one third of the anterior-posterior dimension of the chest is recommended.

FULL CHEST RECOIL

Not allowing the chest to fully recoil after each compression by leaning over the victim's chest, the venous return and subsequent the cardiac output decreases.⁶

MINIMIZING VENTILATION

Immediate after cardiac arrest the oxygen content is initially sufficient, and high-quality chest compressions are crucial in circulating the oxygenated blood. When asphyxia is the cause of the arrest (children, drowning, toxins) or in prolonged resuscitation efforts (depletion in oxygen content), the combination of compressions and assisted ventilation are mandatory. To avoid hyperventilation especially in witnessed victims of cardiac arrest the ventilation rate (breaths per minute) must be under 12 per minute. Excessive ventilation volumes and positive-pressure ventilation also affects venous return so tidal volumes should produce no more than visible chest rise. Gastric insufflation and aspiration of gastric con-

tents caused by hyperventilation can further complicate the resuscitation effort. Long pauses for ventilation and airway management (tracheal intubation) affect the CCF decrease the probability of successful defibrillation.

**2. MONITORING AND FEEDBACK
(FOR BOTH VICTIM
AND RESUSCITATION TEAM)**

One of the most significant advances in resuscitation is monitoring CPR parameters. This can enhance CPR quality and feedback science.

MONITORING THE PATIENT

The primary determinant in effective resuscitation is coronary perfusion pressure (CPP), which is the difference between aortic diastolic pressure and right atrial diastolic pressure. When arterial and central venous catheters are present during CPR achieving a CPP >20 mm Hg is ideal. When only an arterial line is present experts recommend rescuers to optimize chest compression so that a diastolic blood pressure >25 mm Hg can be maintained. Finally, titrating CPR performance to a goal end tidal CO₂ (ETCO₂) of >20 mm Hg reflects good quality CPR when neither an arterial nor a central venous catheter is in place. Capnography is also good as an indicator of ROSC when there is an abrupt increase to normal levels (35 to 40 mm Hg).

MONITORING THE RESUSCITATION TEAM

Modern sophisticated devices (accelerometers, smart backboard, reference markers and others) can monitor CPR performance. Early fatigue and rescuer-patient mismatch must be early recognized and corrected by switching the compressors.

**3. TEAM APPROACH AND QUALITY-
IMPROVEMENT STRATEGIES**

Every resuscitation event (in or out of hospital cardiac arrest, two or more rescuers at field) should be organized in a team leader way.⁸ The team leader prioritizes the team actions and directs all its members with a central focus on high quality CPR. After every cardiac arrest event, debriefing can improve resuscitation quality.⁹ Short CPR checklists can provide invaluable feedback information and improve further team's effectiveness. Quality-improvement can be also achieved by using simulated team-training exercises and refreshment courses.¹⁰

ADDITIONAL CONSIDERATIONS

Mechanical compression devices should be considered after long standing arrest with limited numbers of providers.

The procedure is time consuming for untrained rescue teams so it is important for the rescuers to be familiar with the device used and decrease the pause required especially during the crucial first minutes of cardiac arrest.¹¹

The role of drugs should be deemphasized. Lacking scientific evidence adrenaline and amiodarone should be given after the third shock once chest compressions have restarted and then every 3–5 min. This approach simplifies the advance life support (ALS) algorithm and focuses on issues with priority such as CPR quality. The tracheal route is abandoned and intraosseous route seems to be equal to central intravenous access.

Post resuscitation care must be emphasized especially primary percutaneous coronary intervention in appropriate candidates. The value of therapeutic hypothermia needs to be further elucidated with more data after recent publications. Avoidance of hyperthermia may be equal to hypothermia. New ALS protocols are emerging in the United States such as Cardiocerebral Resuscitation that emphasizes chest compressions role especially during the first phase of cardiac arrest. Compression only CPR¹² is gaining respect in large scale national observational studies as equal or some times more effective than standard ALS algorithms.^{13,14}

CONCLUSIONS

Resuscitation science continues to advance, and clinical guidelines reflect these developments.¹⁵ Key element in this constant process is to bring science down to real life. Awaiting the 2015 resuscitation guidelines, basic parameter in evaluating every scientific progress, any innovative technique, sophisticated instrument or promising protocol is by measuring its effectiveness. Effectiveness in CPR is translated into more lives saved. Newer developments in CPR are focusing on something old: on proper implementation of all former recommendations.

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