High Performance CPR Toolkit
HIGH PERFORMANCE CPR TOOL KIT

This tool kit is free to EMS agencies interested in implementing high performance CPR into their programs. The materials have been developed to provide step-by-step instructions for implementing this technique and useful materials to assist you in this process. This and other toolkits may also be found at http://resuscitationacademy.org/.
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Overview

Cardiovascular disease is the single greatest cause of death in the United States. Each year upwards of a quarter of a million persons receive attempted resuscitation from cardiac arrest by Emergency Medical Services (EMS). The prognosis for the majority of these arrests remains poor.

Quality CPR is a means to improve survival from cardiac arrest. Scientific studies demonstrate when CPR is performed according to guidelines, the chances of successful resuscitation increase substantially. Minimal breaks in compressions, full chest recoil, adequate compression depth, and adequate compression rate are all components of CPR that can increase survival from cardiac arrest. Together, these components combine to create high performance CPR (HP CPR). This toolkit will provide you with teaching material to achieve HP CPR in your EMS system. The following written material is meant to compliment the accompanying DVD.
High Performance CPR

Buy-in

Research indicates that HP CPR can save lives. In order to create an environment of sustained HP CPR, everyone must be on board. EMTs first on scene must take responsibility or “OWN” the CPR portion of the resuscitation. When paramedics arrive, they will perform the advanced life support measures of the resuscitation and work in coordination with ongoing CPR. For systems in which an EMT/paramedic team arrives first at the scene the EMT must assume responsibility for CPR while the paramedic assumes responsibilities for ALS. The goal is for additional resuscitation care such as defibrillation, medication therapies, or airway management to compliment CPR. CPR should be the default action at all times.

In order to have effective HP CPR ALL involved must work as a team, not as separate entities. In order to achieve this goal, HP CPR must start at the top and be endorsed by the EMS Chief and Medical Director. The value of HP CPR must be communicated to the men and women who actually perform the resuscitation.

The priority of the resuscitation team needs to be HP CPR. In many systems the EMT is directed to provide CPR. The EMT needs to provide CPR with the appreciation that it is their primary responsibility. Even though the EMT is providing CPR, paramedics need to recognize its critical importance and work to integrate ALS care in a way that enables the EMT to achieve consistent CPR. This partnership between EMTs and paramedics will provide the basis to achieve HP CPR and in turn improve the chances of successful resuscitation.

**Teamwork is key: collaborate, communicate, and coordinate!**

2010 AHA Guidelines recommendation:

**Team Resuscitation**

- **Change:**
  - Increased focus on using a team approach during resuscitations
- **Why:**
  - Many CPR interventions performed simultaneously
  - Collaborative work minimizes interruption in compressions
  - Clear communication minimizes errors
10 Principles

There are 10 main principals of HP CPR. The final page of this toolkit contains a list of relevant articles regarding the science behind these principals.

10 principles of HP CPR

1. EMTs own CPR
2. Minimize interruptions in CPR at all times
3. Ensure proper depth of compressions (>2 inches)
4. Ensure full chest recoil/decompression
5. Ensure proper chest compression rate (100-120/min)
6. Rotate compressors every 2 minutes
7. Hover hands over chest during shock administration and be ready to compress as soon as patient is cleared
8. Intubate or place advanced airway with ongoing CPR
9. Place IV or IO with ongoing CPR
10. Coordination and teamwork between EMTs and paramedics
Building blocks of resuscitation

HP CPR begins with a foundation of EMT CPR. Advanced cardiac life support must be layered in a way that enables HP CPR. The approach requires teamwork by EMS crews.

- Compress > 2 inches
- Minimize interruptions
- Full recoil
- Rate between 100 and 120/min
- Switch compressors every 2 min.
- Hover hands
- Prioritize compressions C-A-B
- Rapid rhythm analysis
- Minimize pauses
- Administer drugs
- Intubation
- IV placement
- Improved survival

EMT CPR Foundation

Paramedic Advanced Life Support
High Performance CPR

Tools/Models

Every system is different and so many require a unique model to create the most effective HP CPR possible. Several models exist as examples of successful high performance CPR which can be adapted to fit different programs. The following chart shows two examples that are showcased in the accompanying DVD. Note that some EMS agencies require 1.5 to 3 minutes of CPR prior to the first rhythm assessment.

<table>
<thead>
<tr>
<th></th>
<th>BLS Continuous</th>
<th>BLS 30:2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression/ventilation ratio</td>
<td>10:1</td>
<td>30:2</td>
</tr>
<tr>
<td>Stop for ventilations</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Rhythm assessment</td>
<td>every 2 minutes</td>
<td>every 2 minutes*</td>
</tr>
<tr>
<td>Compressions prior to rhythm assessment</td>
<td>2 minutes or 200 compressions</td>
<td>variable*</td>
</tr>
</tbody>
</table>

*Some EMS agencies may require 30 compressions immediately prior to the first and every subsequent rhythm assessment.

No matter which model is used or how many responders are present, the following are **always** true:

- C-A-B
- Minimize interruptions in compressions
- Compress at least 100/min
- Allow complete chest wall recoil/decompression between compressions
- Rhythm assessment every 2 minutes
- Rotate compressors every 2 minutes
- Hover over patient with hands ready during defibrillation so compressions can start immediately after the shock (or analysis) has occurred

Each resuscitation is different and faces unique challenges. Depending on the number of responders, each responder may have a single or multiple designated roles. Examples of the choreography and coordination of these roles is demonstrated on the accompanying DVD.
High Performance CPR

Science behind High Performance CPR

The importance of good CPR

- CPR is the foundation of the resuscitation arsenal.
- High performance CPR improves the effectiveness of defibrillatory shock.
- High performance CPR improves the effectiveness of medication treatments.

How well do we do?

- Perceived performance does not always match observed performance.
- Aufderheide et al. showed that duty cycle, chest compression depth and complete recoil were performed significantly less well when directly observed than EMT perceptions of their performance.
- Wik et al. showed that chest compression rate and depth were both significantly below AHA guidelines by trained EMS providers, and no flow time (when there was neither a pulse nor CPR being given) was almost 50% in directly observed performance evaluations.
- The likelihood of ROSC increases significantly with higher mean chest compression rate (in a hospital study 75% of patients achieved ROSC with 90 or more chest compressions/minute compared to only 42% with 72 or fewer chest compressions/minute).
High Performance CPR

The components of CPR

- Better compressions lead to better organ perfusion which leads to better resuscitation.
- Greater depth of compressions = increased likelihood of a successful shock.
- Compression = Organ perfusion.
- Decompression = Heart perfusion.

Does pausing make a difference?

- YES!
- Longer pauses in chest compressions = lower chances of positive outcome.
- The longer the pause preceding shock or following a shock, the lower the chances of survival.

Effect of Interrupted Precordial Compression on Resuscitation Outcome

Yu T et al. Circulation 2002;106:368-372
High Performance CPR

Recoil/Decompression

- If decompression is incomplete, compression is not as effective due to inadequate blood volume in the heart and lungs.
- Yannopoulos et al. showed that 75% decompression (rather than 100% decompression) does not provide sufficient coronary or cerebral perfusion pressures to achieve ROSC.
- Inadequate decompression compromises both coronary and cerebral blood flow.
- Even limited periods of incomplete decompression can have a lingering effect on coronary and cerebral perfusion pressures, which may remain low even after this deficiency in CPR has been corrected.

Effect on medication

- Perfusion is the mechanism that circulates medications. The better the perfusion, the better the circulation of medications.
- Good CPR decreases two-fold the amount of time required for epinephrine to reach peak concentrations in circulating blood when compared to poor CPR.
- Better CPR = Decreased time to circulate and likely increased efficacy of medications.

Ventilations

- Ventilation is believed to be a vital component of resuscitation, but too much of a good thing (hyperventilation) can decrease survival.
- Long ventilations (greater than the 1 second per breath recommended by AHA) potentially increases the pause (during 30:2) and the amount of time spent without chest compressions.
- Even when not interrupting CPR (such as in an intubated patient), excessive ventilation prevents the development of negative intrathoracic pressure during the decompression phase of CPR, which impedes blood return (filling) to the heart.
High Performance CPR

Training

Depending on the size of the agency, responders might participate in one resuscitation a week or one a year. It is important that they are well prepared no matter how many times they perform CPR throughout the year. Training responders on the key principals of HP CPR on a regular basis will keep skills sharp and lead to more successful resuscitation attempts.

There are many different forms of training and recertification for EMTs and paramedics. The most effective form is a hands-on approach. Understanding what 100 compressions/minute feels like and being in the middle of a well-choreographed resuscitation will give responders a better understanding of the different roles people play and how all of these different roles fit together. The most effective training is simple, realistic, scenario driven, and completely hands on. Other training options include combinations of paper, video, and hands-on models. It is incredibly difficult to learn psychomotor skills without hands-on experience; power points and lectures alone will not suffice. At 3 o’clock in the morning at the scene of a resuscitation, responders will remember what they last practiced, but won’t necessarily remember a power point slide.

Education in the form of lectures, videos, and articles is valuable in gaining a better understanding of why high performance CPR is necessary, but it is the hands-on training that will give them the how.

HP CPR Training Module: Demonstrate, practice, practice, and more practice, and then evaluate.

Simplicity is essential for training EMTs and first responders. Get the tools out, explain the scenario, place the manikins on the floor, and “practice like you play.” Remember this type of training can become ineffective by trying to overcomplicate the core concepts.

In addition to technique, timing is also a very important aspect of HP CPR training. Yearly evaluations, bi-annual and monthly trainings, and timely training updates are effective in making sure staff is ready for the next call.
High Performance CPR

Maintaining successful HP CPR

Maintenance
In order to ensure that patients are receiving the best resuscitation possible, each EMS system must have a way to measure the performance of their responders. Many tools are available for this specific purpose, from training tools to tools used in the field.

For example:

- Manikins which measure cadence, depth, recoil
- CPR performance tools
- Defibrillators which record ECG, compressions, and audio

These devices can measure the quality of chest compressions, the ability of ALS and BLS to coordinate, the amount of time chest compressions were not being performed and the reason for the lack of compressions. Some of these devices may require software updates or new hardware, but will prove invaluable in improving CPR.

Feedback
Responders want to know how they performed. By quantifying performance measures such as CPR fraction and compression rate, they will have a solid marker to improve upon or try to maintain. Many agencies see it as a sort of competition, which can increase resuscitation performance as well as increase buy-in from responders.

Feedback is necessary to improve performance. How will a responder know what to improve upon during the next resuscitation if there is no feedback as to their performance on previous resuscitations?

There are many different options for providing feedback. Letters, short forms, and spreadsheets are just a few ways to provide the feedback. Additionally, options for timing and depth of feedback are also available. Individual feedback is key, but some agencies also choose to provide agency-wide feedback on a regular basis. The following pages show examples of different forms of individual and agency feedback for the purpose of quality improvement.
January 13, 2011

Training Officer John Smith
_____________ Fire Department
1234 1st Ave
AnyCity, USA

Training Officer John Smith:

As part of ongoing QA, we are adding a dimension to the defibrillator review that provides a measure of how much of the resuscitation was spent performing CPR. More and more evidence indicates that efforts to limit CPR interruptions can help improve the chance of survival. Historically, ________ County agencies had hands on the patient’s chest—performed CPR ___% of the time. The other ___% of the time was spent with hands-off the patient—no CPR—because of analysis and pulse checks or because of human factors.

We are currently reviewing each case in an effort to further reduce CPR interruptions. The goal is to help improve upon what is already very good performance. Each quarter we will report to you how your agency performed with regard to the proportion of time spent performing CPR during resuscitation, so that you can see how well your agency has done in the context of the rest of the EMS agencies in ________ County. The goals of this reporting are completely constructive. We will not share individual agency information and will mandate that this report be used strictly as a tool for improvement. This report is based on reviews from the last quarter of 2010.

1. On average, ________ Fire Department performed CPR during ___% of the resuscitation. Consequently, no CPR was performed for an average of the resuscitation.
2. The average for all ________ County agencies combines is CPR for ___% of the resuscitation and no CPR for ___% of the resuscitation.
3. The agency that performed the best on this measure performed CPR for an average of ___% of the resuscitation.

We will provide you with an updated report following the next quarter. Across all agencies in ________ County, we hope to increase CPR performance so that we reach (or exceed) 90% CPR during resuscitation.

Thank you for your efforts. Please let me know if you have questions or concerns.

Sincerely,

Peter Smith
Program Director – EMT Defibrillation
_____________ County EMS
This generic form has been used as a way for EMTs to have a brief overview of the case and clearly view pauses in CPR and the reasons for those pauses.

<table>
<thead>
<tr>
<th>DATE</th>
<th>CARDIAC ARREST - QA FOLLOW UP</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>START CPR</td>
<td>STOP CPR</td>
</tr>
<tr>
<td>GOAL</td>
<td></td>
<td></td>
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</table>

arrival at patient to IV
arrival at patient to ETT

OUTCOME:
High Performance CPR

Feedback from trained personnel to both technicians and training officers provides clear areas of improvement in addition to areas of excellence.

AED QUALITY ASSURANCE
FEEDBACK

To: John Smith
Generic Fire Department
1234 1st Ave
AnyCity, USA

Incident Date: 2/20/2011
Defib Tech: FF

Times below stated in seconds

| Time to first Analysis/shock/no shock | 31 |
| Time to CPR (analysis/shock to first compression in seconds) | 7 |
| Total time without compressions (From first analysis to first compression in sec) | 21 |
| Compression Rate | 106 |
| Depth of Compression | |
| Rhythm | VF |

EMS Training Officer,

FF ____ and crew responded to an alarm for a ____ y/o male in cardiac arrest on February 20th. (This was an unwitnessed arrest with dispatch-assisted CPR prior to your arrival. He had an estimated downtime of 7 minutes.)
He had a cardiac history and recent sinus infection but no symptoms mentioned prior to the event.
He developed a radial pulse and agonal respirations on analysis following your two minute post-shock interval of CPR.
Please take note of the time interval from shock to first compression (you asked for CPR to begin immediately)-7 seconds...Please make an effort to have your crew start chest compressions as quickly as possible!
The desired rate of chest compressions is 100 cpm, with a ratio of 30:2 (our goal is 100 cpm. While too fast is better than too slow, if your compressions are too fast the heart does not have time to refill between compressions). Practice with the metronome that you can download from www.emsolnet.net. It's a handy tool!
The goal of the first five minutes of resuscitation is that the CPR fraction is greater than 90%.
I have included a statistical summary taken directly from your AED. I hope you find it helpful.
Please remember to have the individual performing compressions/ventilations count out loud.
As you know the information gleaned from these reports is an important component to our continuing education and QA programs.
Thank you for your continued dedication to the EMT defibrillation program. If you have any questions or comments please feel free to contact me at any time.

Peter Smith
KCEMS Defib Program Coordinator

March 1, 2011
High Performance CPR

Checklists

The primary tool for maintaining high quality HP CPR is regular training and evaluation. Evaluation checklists have been created to ensure that responders are well practiced in critical areas of the resuscitation. The following pages show examples of checklists that may be used to maintain a record of rescuer performance in a training setting.

This is the King County checklist surveying performance using a 30:2 compression model.

<table>
<thead>
<tr>
<th>PPE / SAFETY (must demonstrate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloves</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMPRESSION PERSON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirm: uncon/Unresp</td>
</tr>
<tr>
<td>Remove clothing to start</td>
</tr>
<tr>
<td>Resume CC immediately after Analysis / Shock</td>
</tr>
<tr>
<td>Pulse Check (only after 2nd No Shock)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEFIB TECHNICIAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><em><strong>ANALYZE AS SOON AS AED APPLIED</strong></em></td>
</tr>
<tr>
<td>Shock Advised</td>
</tr>
<tr>
<td>Shock – (no pulse check)</td>
</tr>
<tr>
<td>Changes compressor</td>
</tr>
<tr>
<td>Analyze @ 2 mins. (post-shock)</td>
</tr>
<tr>
<td>2 Minutes of CPR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VENTILATION PERSON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give 2 ventilations every 30 compressions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CRITICAL FAIL CRITERIA</th>
<th>All elements are CRITICAL FAIL CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASS</td>
<td>YES</td>
</tr>
</tbody>
</table>

* EMS Checklist for arrest after arrival is the same with the exception that a defibrillatory shock should occur immediately in the case of VF.*

Version 1.0 March 2011
### High Performance CPR

The following is the Seattle skills checklist surveying performance using an asynchronous 10:1 compression model.

<table>
<thead>
<tr>
<th><strong>Seattle Fire Department</strong></th>
<th><strong>Skill Checklist</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2010 CPR / Basic Skills</strong></td>
<td><strong>Arrest Before SFD Arrival</strong></td>
</tr>
</tbody>
</table>

**Objective**

- **Given**: A 2-4 person company, BLS equipment and manikin
- **Demonstrate**: Assessment and treatment for Cardiac Arrest Before SFD Arrival as outlined in current Standing Orders for the Treatment of Cardiac Arrest.

**PPE / Safety** (must demonstrate)

- [ ] Gloves
- [ ] Eye Protection
- [ ] Respiratory Protection (as needed)
- [ ] AED Safety

**Compression Person**

- [ ] Unconscious / Unresponsive
- [ ] Pulse Check
- [ ] Airway / Breathing
- [ ] States “Cardiac Arrest”
- [ ] Switches w/o Pause
- [ ] Move Clothing to start
- [ ] Immediately begin chest compressions @ 100 per minute
- [ ] Resume CC after Analysis / Shock
- [ ] Pulse Check only after No Shock
- [ ] Hand Placement
- [ ] Compress ~1/3 to 1/2 thickness of chest
- [ ] Compress & Release equally
- [ ] Complete release / No Bouncing

**LP500 Person**

- [ ] Turn on LP 500, State “Company name, starting 2 min CPR”. Place electrodes, cut clothes.
  - **Shock Advised**
  - [ ] Shock, No Pulse Check
  - [ ] Change Compressor
  - [ ] Analyze @ 2 Min Shock
  - [ ] 2 Min CPR
  - **No Shock Advised**
  - [ ] No Shock Advised - 2 Min CPR
  - [ ] Change Compressor
  - [ ] After Each 2 Min CPR / No Analysis
  - [ ] Pulse Check Only < 10 Sec
  - [ ] 2 Min CPR

**Femoral Pulse Check with CPR**

**Ventilation Person**

- [ ] Interpose (1) ventilation / 10 compressions

**IV Person**

- [ ] Prepare Patient / Place Tourniquet
- [ ] Set up IV Bag

**Critical Fail Criteria**

All elements are **Critical Fail Criteria**

<table>
<thead>
<tr>
<th>Pass</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

*EMS Checklist for arrest after arrival is the same with the exception that a defibrillatory shock should occur immediately in the case of VF*
High Performance CPR

Articles


The Resuscitation Academy is supported by:

Seattle Medic One Foundation in partnership with
King County Medic One
Seattle Fire Department
King County Training
Asmund S. Laerdal Foundation
Medtronic Foundation
Public Health–Seattle & King County
Harborview Medical Center–University of Washington
Life Sciences Discovery Fund