Part 5: Adult Basic Life Support

2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations

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Note From the Writing Group: *Throughout this article, the reader will notice combinations of superscripted letters and numbers (eg, "Initial Recognition[BLS-003A, BLS-003B]"). These callouts are hyperlinked to evidence-based worksheets, which were used in the development of this article. An appendix of worksheets, applicable to this article, is located at the end of the text. The worksheets are available in PDF format and are open access.*

The 2010 international evidence evaluation process addressed many questions related to the performance of basic life support. These have been grouped into the following categories: (1) epidemiology and recognition of cardiac arrest, (2) chest compressions, (3) airway and ventilation, (4) compression-ventilation sequence, (5) special circumstances, (6) emergency medical services (EMS) system, and (7) risks to the victim. Defibrillation is discussed separately in Part 6 because it is both a basic and an advanced life support skill. In the following summary, each question specific to the population, intervention, control group, and outcome (PICO Question) is listed with the consensus on science and treatment recommendation.

There have been several important advances in the science of resuscitation since the last ILCOR review in 2005. Not all topics reviewed in 2005 were reviewed in 2010. When evaluating the published science, evidence reviewers considered studies with adult and pediatric victims of cardiac arrest published or accepted for publication in peer-reviewed journals. However, the treatment recommendations in this chapter generally are limited to treatment of adult victims of cardiac arrest. Please see Part 10: "Pediatric Basic and Advanced Life Support" for information on basic life support for pediatric cardiac arrest victims. The following is a summary of the most important evidence-based recommendations for the performance of basic life support in adults:

- Rescuers should begin CPR if the victim is unresponsive and not breathing (ignoring occasional gasps). Gasping should not prevent initiation of CPR because gasping is not normal breathing, and gasping is a sign of cardiac arrest.
- Following initial assessment, rescuers may begin CPR with chest compressions rather than opening the airway and delivering rescue breathing.
- All rescuers, trained or not, should provide chest compressions to victims of cardiac arrest.
- A strong emphasis on delivering high-quality chest compressions remains essential: rescuers should push hard to a depth of at least 2 inches (or 5 cm) at a rate of at least 100 compressions per minute, allow full chest recoil, and minimize interruptions in chest compressions.
- Rescuers trained to provide ventilations use a compression-ventilation ratio of 30:2.
- For untrained rescuers, EMS dispatchers should provide telephone instruction in chest compression–only CPR.

Epidemiology and Recognition of Cardiac Arrest

Millions of people die prematurely every year from sudden cardiac arrest (SCA) worldwide, often associated with coronary heart disease. The following section summarizes the burden, risk factors, and potential interventions to reduce the risk.

Epidemiology

Incidence[BLS-014B]

What is the incidence, prevalence, and etiology of cardiopulmonary arrest in-hospital and out-of-hospital?

Consensus on Science

Measuring the global incidence of cardiac arrest is challenging, because there are many different definitions of patient

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Table. Global Incidence of Cardiac Arrest per 100 000 Population

	All Ages Included		Adult Only	
Incidence Definition (No. of Studies)	Mean	(SD)	Mean	(SD)
Incidence of out-of-hospital cardiac arrest (n=5)	82.9	(21.4)	213.1	(177)
Incidence of patients considered for CPR (n=34)	76.3	(35.7)	95.9	(30.5)
Incidence of arrest with CPR initiated (n=55)	41.5	(18.4)	64.2	(19.9)
Incidence of arrest with CPR initiated, cardiac cause (n=87)	40.5	(17.1)	61.8	(37.7)
Adjusted incidence of arrest with CPR initiated, cardiac cause (n=14)	56.6	(13.7)	84.7	(58.8)
Percentage of cases with CPR initiated (n=43)	72.3	(20.4)	68.9	(25.6)
Percentage of cases with cardiac etiology (n=48)	71.8	(12.4)	72.0	(11.8)

populations. The Table lists the average crude incidence per 100 000 population reported for adult cases of cardiac arrest and cases of all ages (children and adults). The number of studies included is shown for each category.[1–22]

There are no significant differences in the incidence of out-of-hospital cardiac arrest (OHCA) or the incidence of patients in whom resuscitation was attempted with all causes of arrest when comparing Europe, North America, Asia, and Australia. The incidence of patients with OHCA considered for resuscitation is lower in Asia (55 per year per 100 000 population) than in Europe (86), North America (94), and Australia (113). The incidence of patients in OHCA with presumed cardiac cause in whom resuscitation was attempted is higher in North America (58 per year per 100 000 population) than in the other three continents (35 in Europe, 32 in Asia, and 44 in Australia).

For in-hospital cardiac arrest, there are more limited incidence data.[23]

Recognition of Cardiac Arrest

Early recognition is a key step in the initiation of early treatment of cardiac arrest and relies on using the most accurate method of determining cardiac arrest.

Initial Recognition[BLS-003A, BLS-003B]

In adults and children who are unresponsive (out-of-hospital and in-hospital), are there any specific factors (or clinical decision rules) as opposed to standard assessment that increase the likelihood of diagnosing cardiac arrest (as opposed to nonarrest conditions, such as postseizure, hypoglycemia or intoxication)?

Consensus on Science

Pulse Check

There are no studies assessing the accuracy of checking the pulse to detect human cardiac arrest. There have been 9 LOE D5 studies demonstrating that both lay rescuers[24–26] and healthcare providers[27–32] have difficulty mastering the pulse check and remembering how to perform it. Three LOE D5 studies support the ability of healthcare providers to perform the pulse check; 2 evaluated the direct ear-to-chest method in infants,[33,34] and the third supported an alternative technique for the carotid pulse check when tested by dental students on healthy volunteers.[35] In 1 LOE D5 study,[36] the technique of simultaneous pulse check and breathing check by professional rescuers increased the diagnostic accuracy.

Two LOE D5 studies[32,37] conducted in infants and children with nonpulsatile circulation during extracorporeal membrane oxygenation (ECMO) demonstrated that doctors and nurses in a pediatric tertiary care institution, when blinded to whether the child was receiving ECMO support or not, commonly assessed pulse status inaccurately and often took longer than 10 seconds. In these pediatric studies, healthcare professionals were able to accurately detect a pulse by palpation only 80% of the time. They mistakenly perceived a pulse when it was nonexistent 14% to 24% of the time and failed to detect a pulse when present in 21% to 36% of the assessments. Although some of the children in this study were pulseless, all children had circulation (ie, none were in cardiac arrest), so other signs typically associated with pulseless arrest (delayed capillary refill, poor color) were absent in this population.

Breathing Assessment

Several studies have shown that lay rescuers do not easily master the techniques of breathing assessment, and they are often unable to recognize agonal gasps (LOE D5[25,26,38,39]). There is a high incidence of agonal gasps after cardiac arrest (LOE D4[40–43]), and EMS dispatchers have difficulty in diagnosing agonal gasping.[40]

Several strategies for teaching students how to differentiate agonal gasps from normal breathing have been evaluated. In 1 LOE D5 study,[44] teaching recognition of agonal gasps using a video clip improved the accuracy of lay rescuers in recognizing cardiac arrest. Another study (LOE D5[45]) demonstrated that detection of true cardiac arrest cases improved after introduction of the question "Is he breathing regularly?" in a seizure complaint question sequence used by EMS dispatchers.

Signs of Circulation

In the past, students were taught to recognize cardiac arrest by looking for the absence of signs of circulation, such as movement. No studies were found that measured the sensitivity and specificity of that approach for diagnosing cardiac arrest. An LOE D4 study[46] showed that CPR guidance by EMS dispatchers was impeded by callers mentioning "signs of life."

Treatment Recommendation
It is reasonable that lay rescuers and healthcare professionals use the combination of unresponsiveness and absent or abnormal breathing to identify cardiac arrest. Palpation of the pulse as the sole indicator of the presence or absence of cardiac arrest is unreliable. Agonal gasps are common during cardiac arrest and should not be considered normal breathing. The general public and EMS dispatchers should be taught how to recognize agonal gasps as a sign of cardiac arrest.

Etiology of Cardiac Arrest[BLS-050A, BLS-050B]
In adults and children with presumed cardiac arrest (out-of-hospital and in-hospital), are there any factors/characteristics that increase the likelihood of differentiating between an SCA (ie, VF or pulseless ventricular tachycardia [VT]) and other etiologies (eg, drowning, acute airway obstruction)?

Consensus on Science
In 1 registry study (LOE 2[47]), cardiac arrest was more likely to be due to a cardiac cause in victims above the age of 35 years and to a noncardiac cause up to the age of 35 years. Two other registry studies (LOE 3[48,49]) do not demonstrate diagnostically useful cutoff ages. An additional registry study (LOE 2[50]) demonstrated that 83% of cardiac arrests under the age of 19 years are of noncardiac origin. One prospective study (LOE 2[51]) and 1 retrospective study (LOE 3[52]) showed that identification of the cause of cardiac arrest by healthcare providers can be inaccurate, leading to an underestimation of noncardiac etiology cardiac arrest, in particular, failure to diagnose exsanguination. Additional studies in children are summarized in Part 10: "Pediatric Basic and Advanced Life Support."

Treatment Recommendation
For lay rescuers there is insufficient evidence to recommend any diagnostically reliable method to differentiate SCA of cardiac origin from one of noncardiac origin. Except in cases of obvious external causes of cardiac arrest (eg, gunshot wound, drowning), professional rescuers should rely on rhythm analysis from cardiac monitors or AEDs and other diagnostic tests to determine the cause of cardiac arrest.

Check for Circulation During BLS[BLS-008B]
In adults and children with cardiac arrest (out-of-hospital and in-hospital), does the interruption of CPR to check circulation, as opposed to no interruption of CPR, improve outcome (eg, ROSC, survival)?

Consensus on Science
A study in manikins (LOE D5[29]) confirmed a low ability (<50%) of EMS providers to correctly identify the presence of a carotid pulse as an indication to stop further chest compressions. A palpable pulse is usually absent immediately after defibrillation during OHCA (LOE 5[53,54]). AED algorithms that recommend that rescuers check for a pulse immediately after a shock delivery are not useful and will lead to delay in resumption of chest compressions following shock delivery (LOE 5[53–55]). Three LOE D5 studies show that measurement of thoracic impedance through the AED electrode pads may be an indicator of return of circulation.[56–58]

One LOE D5 study in adults[27] and 2 LOE D5 studies in children with nonpulsatile circulation[32,37] showed that blinded healthcare providers commonly made inaccurate assessments of the presence or absence of a pulse and often took much longer than 10 seconds. Another study (LOE D5[59]) showed that accurately determining the presence of a pulse took more than 10 seconds in 95% of cases.

Treatment Recommendation
For lay rescuers, interrupting chest compressions to perform a pulse check is not recommended. For healthcare professionals, it is reasonable to check a pulse if an organized rhythm is visible on the monitor at the next rhythm check.

Epidemiology and Recognition Knowledge Gaps
How accurately do rescuers identify cardiac arrest outside of the hospital? Is advanced technology useful to assist with diagnosing cardiac arrest? Which specific factors improve diagnostic accuracy? What is the accuracy of the pulse check performed by healthcare professionals in cardiac arrest patients? Is there an association between the time required to successfully detect a suspected cardiac arrest victim's pulse and resuscitation outcome? Is there a difference in outcome when the decision to start CPR is based on the absence of consciousness and normal breathing as opposed to absence of a pulse?

Chest Compressions

Several components of chest compressions can alter effectiveness: hand position, position of the rescuer, position of the victim, and depth and rate of compression and decompression. Evidence for these techniques was reviewed in an attempt to define the optimal compression method.

Chest Compression Technique

Actual Hand Position During Compressions[BLS-032A, BLS-032B]
In adults and children with cardiac arrest (out-of-hospital and in-hospital), does the use of any specific placement of hands for external chest compressions compared with standard care (eg, "lower half of the victim's sternum") improve outcome (eg, ROSC, survival)?

Method to Locate Hand Position[BLS-033A]
In rescuers performing CPR on adults or children with cardiac arrest (out-of-hospital and in-hospital), does the use of any specific method for locating the recommended hand position compared with standard care (eg, "placement of the rescuer's hands in the middle of the chest") improve outcome (eg, time to commence CPR, decreased hands-off time, ROSC, survival)?

Consensus on Science
No randomized controlled human trials support use of an alternative to the hand position recommended in 2005 ("The rescuer should compress the lower half of the victim's sternum") when performing external chest compressions for adults or children in cardiac arrest.

In 1 study of CT scans, the internipple line was 3 cm superior to the lower third of the sternum (LOE 5[60]). One LOE 5 study[61] of adult surgical patients demonstrated that if the rescuer's hands are placed on the internipple line, hand deviation to or beyond the xiphisternum occurs in nearly half the cases, sometimes into the epigastrium.

During transesophageal echocardiography of humans receiving chest compressions with placement of the hands on the lower half of the sternum, the area of maximal compression was most often over the base of the left ventricle and the aortic root, a location that potentially impedes forward flow of blood (LOE 4).[62]

In 4 LOE 5 adult manikin studies,[63–66] locating the recommended hand position for chest compression using the instruction "place hands in center of the chest" resulted in a significant reduction in hands-off time and no significant reduction in accuracy compared with locating the rib margins and xiphisternum. One LOE 5 adult manikin study[67] showed a similar reduction in hands-off time but also loss of hand-placement accuracy. In a single LOE 5 study using a template of an infant,[68] placing the fingers in the recommended position on the chest (below the internipple line) resulted in placement of fingers over the xiphisternum and abdomen.

Treatment Recommendation
For adults receiving chest compressions, it is reasonable for rescuers to place their hands on the lower half of the sternum. It is reasonable to teach this location in a simplified way, such as, "Place the heel of your hand in the center of the chest with the other hand on top." This instruction should be accompanied by a demonstration of placing the hands on the lower half of the sternum. Use of the internipple line as a landmark for hand placement is not reliable.

Chest Compression Rate[BLS-034A, BLS-034B]
In adults and children with cardiac arrest (out-of-hospital and in-hospital), does the use of any specific rate for external chest compressions compared with standard care (ie, approximately 100/min) improve outcome (eg, ROSC, survival)?

Consensus on Science
The number of chest compressions during a certain period (eg, 1 minute) given to cardiac arrest patients is determined by 2 factors: the time interval between compressions (ie, the compression rate) and the duration of any interruptions in compressions. One LOE 4 study of in-hospital cardiac arrest patients[69] showed that chest compression rates >80/min were associated with ROSC. An observational study of 506 patients with out-of-hospital cardiac arrest showed improved survival to hospital discharge with increasing chest compression fraction (CCF, ie, proportion of total resuscitation time during which compressions are delivered), and best results when a CCF >0.60 was achieved. With compression rates between 100 and 127 per minute, this CCF corresponded with >60 chest compressions delivered in each minute. However, there was not an association between compression rate and survival (LOE 4[70]).

Treatment Recommendation
It is reasonable for lay rescuers and healthcare providers to perform chest compressions for adults at a rate of at least 100 compressions per minute. There is insufficient evidence to recommend a specific upper limit for compression rate. Pauses should be minimized to maximize the number of compressions delivered per minute.

Chest Compression Depth[BLS-006A, BLS-006B]
In adults and children with cardiac arrest (out-of-hospital and in-hospital), does any specific compression depth, as opposed to standard care (ie, depth specified in treatment algorithm), improve outcome (eg, ROSC, survival)?

Consensus on Science
Three adult human LOE 4 studies[71–73] showed that the measured compression depth during adult human resuscitation is often less than 4 cm (1.5 inches). No human studies directly compared the effectiveness of a compression depth of 4 to 5 cm (1.5 to 2 inches) with alternative compression depths.

One adult human LOE 4 case series,[74] 2 adult human studies with retrospective control groups (LOE 3[75,76]), and 1 LOE 5 study[77] suggest that compressions of 5 cm (2 inches) or more may improve the success of defibrillation and ROSC. These findings are supported by 3 swine studies (LOE 5[78–80]) showing improved survival with deeper compression depths and 1 adult human study (LOE 4[81]) showing that improved force on the chest produced a linear increase in systolic blood pressure. However, 1 swine study (LOE 5[82]) reported no improvement of myocardial blood flow with increased compression depth from 4 cm to 5 cm, although coronary perfusion pressure (CPP) improved from 7 to 14 mm Hg.

Treatment Recommendation
It is reasonable to compress the sternum at least 2 inches/5 cm for all adult cardiac arrest victims. There is insufficient evidence to recommend a specific upper limit for chest compression depth.

Chest Decompression[BLS-045A]
In adults and children with cardiac arrest (out-of-hospital and in-hospital), does optimizing chest wall recoil during CPR, compared with standard care, improve outcome (eg, ROSC, survival)?

Consensus on Science
There are no human studies specifically evaluating ROSC or survival to hospital discharge with or without complete chest wall recoil during CPR. One LOE 4 out-of-hospital case series[83] documented a 46% incidence of incomplete chest recoil by professional rescuers using the CPR technique

recommended in 2000, and 2 in-hospital pediatric case series demonstrated a 23% incidence of incomplete recoil that was more common just after switching providers of chest compressions (LOE 4[84,85]). Another LOE 4 study[86] electronically recorded chest recoil during in-hospital pediatric cardiac arrests and found that leaning on the chest occurred in half of all chest compressions. Animal studies (LOE 5[87,88]) demonstrate significant reductions in mean arterial pressure, coronary perfusion pressure, cardiac output, and myocardial blood flow with only small amounts of incomplete chest recoil. Chest recoil can be increased significantly with simple techniques; for example, lifting the heel of the hand slightly but completely off the chest during CPR improved chest recoil in a manikin model. However, these alternative techniques may also reduce compression depth (LOE 5[83,89]).

Treatment Recommendation

While allowing complete recoil of the chest after each compression may improve circulation, there is insufficient evidence to determine the optimal method to achieve the goal without compromising other aspects of chest compression technique.

Firm Surface for Chest Compressions[BLS-035A, BLS-035B]

For adults or children in cardiac arrest on a bed (out-of-hospital and in-hospital), does the performance of CPR on a hard surface like a backboard or deflatable mattress, compared with performance of CPR on a regular mattress, improve outcome (eg, ROSC, survival)?

Consensus on Science

One case series (LOE 4[90]) and 4 manikin studies (LOE 5[91–94]) demonstrated that chest compressions performed on a bed are often too shallow. However, the case series (LOE 4[90]) and 1 of the manikin studies (LOE 5[94]) found that accelerometer-based CPR feedback devices failed to correct for compression of the underlying mattress, so it overestimated actual compression depth and may have contributed to delivery of shallow chest compressions. Two studies using manikins weighted to 70 kg (LOE 5[94,95]) suggested that adequate compressions can be performed on a bed if the immediate feedback mechanism measures actual chest compression, regardless of the presence or absence of a backboard. No studies have examined the risks or benefits of moving the patient from a bed to the floor to perform CPR.

No studies in humans have evaluated the risks or benefits of placing a backboard beneath a patient during CPR. Manikin studies (LOE 5[94,96,97]) suggested that placing a backboard may improve compression depth by a few millimeters. One manikin study (LOE 5[98]) showed that deflating a special mattress improved compression efficiency, but another manikin study (LOE 5[93]) failed to demonstrate any benefit from deflating an air-filled mattress.

Treatment Recommendation

CPR should be performed on a firm surface when possible. Air-filled mattresses should be routinely deflated during CPR. There is insufficient evidence for or against the use of backboards during CPR. If a backboard is used, rescuers should minimize delay in initiation of chest compressions, minimize interruption in chest compressions, and take care to avoid dislodging catheters and tubes during backboard placement.

Feedback for Chest Compression Quality[BLS-020A, BLS-020B]

In adults and children in cardiac arrest (out-of-hospital and in-hospital), does the use of feedback regarding the mechanics of CPR quality (eg, rate and depth of compressions and/or ventilations), compared with no feedback, improve any outcomes (eg, ROSC, survival)?

Consensus on Science

Chest compression frequency, rate, and depth provided by lay responders (LOE 4[99]), hospital teams (LOE 4[71]), and EMS personnel (LOE 4[73,100]) were insufficient when compared with recommended methods. Ventilation rates higher than recommended during CPR will impede venous return (LOE 5).[101]

CPR feedback/prompt devices may improve several discrete measures (ventilation rate, end-tidal CO_2, and compression rate, depth, and chest recoil) that have been linked with CPR quality. Eleven studies investigated the effect of giving real-time CPR performance feedback to rescuers during actual cardiac arrest events in both in-hospital and out-of-hospital settings. Two studies in adults (LOE 2[102,103]) and 1 study in children (LOE 2[104]) showed improved end-tidal CO_2 measurements and consistent chest compression rates when feedback was provided from audio prompts (metronomes or sirens).

In 4 LOE 3 studies[75,86,105,106] and 2 LOE 4 studies,[76,107] real-time feedback from force transducers and accelerometer devices was useful in improving CPR quality metrics, including compression depth, rate, and complete chest recoil. Two manikin studies (LOE 5[90,94]) demonstrated the potential for overestimating compression depth when using an accelerometer chest compression feedback device if compressions are performed (with or without a backboard) on a soft surface. No studies to date have demonstrated a significant improvement in long-term survival related to the use of CPR feedback/prompt devices during actual cardiac arrest events (LOE 3[75]).

In 1 retrospective analysis of cardiac arrest records and 1 report of 2 cases (LOE 4[108,109]), changes in transthoracic impedance were potentially useful to measure ventilation rate and detect esophageal intubation. In a case series (LOE 4[110]), capnography and chest-wall impedance algorithms were inaccurate for determining ventilation rate.

Treatment Recommendation

It is reasonable for providers and EMS agencies to monitor and improve CPR quality, ensuring adherence to recommended compression rate and depth and ventilation rates. Real-time chest compression–sensing and feedback/prompt technology (ie, visual and auditory prompting devices) may be useful adjuncts during resuscitation efforts. However, rescuers should be aware of the potential overestimation of compression depth when the victim is on a soft surface.

Alternative Compression Techniques

"Cough" CPR[BLS-017A, BLS-017B, BLS-017C]

In adult cardiac arrest (out-of-hospital and in-hospital), does the use of alternative methods of manual CPR (eg, cough CPR, precordial thump, fist pacing), compared with standard CPR, improve any outcomes (eg, ROSC, survival)?

Consensus on Science

A few case reports (LOE 4[111–118]) documented limited benefit of cough CPR during the initial seconds to minutes of cardiac arrest in patients who remained conscious in a controlled, monitored setting of electrophysiology testing with patient instruction prior to the onset of anticipated cardiac arrest.

Treatment Recommendation

Use of cough CPR may be considered only for patients maintaining consciousness during the initial seconds to minutes of VF or pulseless VT cardiac arrest in a witnessed, monitored, hospital setting (such as a cardiac catheterization laboratory).

Precordial Thump[BLS-017A, BLS-017B, BLS-017C]

In adult cardiac arrest (out-of-hospital and in-hospital), does the use of alternative methods of manual CPR (eg, cough CPR, precordial thump, fist pacing), compared with standard CPR, improve any outcomes (eg, ROSC, survival)?

Consensus on Science

In 5 prospective case series of out-of-hospital (LOE 4[119–123]) and 2 series (LOE 4[120,121]) of in-hospital VF cardiac arrest, healthcare provider administration of the precordial thump did not result in ROSC.

In 3 prospective case series of VT in the electrophysiology laboratory (LOE 4[120,124,125]), administration of the precordial thump by experienced cardiologists was of limited use (1.3% ROSC). When events occurred outside of the electrophysiology laboratory, in 6 case series of in- and out-of-hospital VT (LOE 4[121–123,126–128]), the precordial thump was followed by ROSC in 19% of patients. Rhythm deterioration following precordial thump occurred in 3% of patients and was observed predominantly in patients with prolonged ischemia or digitalis-induced toxicity.

In 3 case series of asystolic arrest (LOE 4[119,122,129]), the precordial thump, but not fist pacing, was sometimes successful in promoting ROSC when administered by healthcare providers to patients with witnessed asystole (some clearly p-wave asystolic arrest) for OHCA and in-hospital cardiac arrest.

Two case series (LOE 4[123,130]) and a case report(LOE 5[131]) documented the potential for complications from use of the precordial thump, including sternal fracture, osteomyelitis, stroke, and rhythm deterioration in adults and children.

Treatment Recommendation

The precordial thump is ineffective for VF, and it should not be used for unwitnessed OHCA. The precordial thump may be considered for patients with monitored, unstable VT if a defibrillator is not immediately available. There is insufficient evidence to recommend for or against the use of the precordial thump for witnessed onset of asystole caused by atrioventricular conduction disturbance.

Fist Pacing[BLS-017A, BLS-017B, BLS-017C]

In adult cardiac arrest (out-of-hospital and in-hospital), does the use of alternative methods of manual CPR (eg, cough CPR, precordial thump, fist pacing), compared with standard CPR, improve any outcomes (eg, ROSC, survival)?

Consensus on Science

There is little evidence supporting fist or percussion pacing in cardiac arrest, particularly when the effect of the maneuver cannot be confirmed by continuous electrocardiographic (ECG) monitoring and assessment of a pulse. Evidence consists of 6 single-patient case reports (LOE 4[132–137]) and a moderate-sized case series (LOE 4[138]) with mixed asystole and bradycardia.

Treatment Recommendation

For patients in cardiac arrest, percussion (fist) pacing is not recommended.

Chest Compression Technique Knowledge Gaps

What is the optimal hand position for maximizing cardiac output? How well is the simple method of teaching hand placement retained? Does a chest compression rate faster than 100/min increase long-term survival from cardiac arrest? What is the minimum number or count of chest compressions to be delivered each minute to enhance survival? What is the relationship between chest compression rate and depth? Does a chest compression depth greater than 5 cm improve survival? What is the chest compression depth beyond which complications increase? What is the optimal technique to facilitate complete chest recoil and maximize survival? When does use of CPR feedback/prompt devices translate to improvements in survival?

Airway and Ventilation

The best method of obtaining an open airway and the optimum frequency and volume of artificial ventilation were reviewed.

Airway

Opening the Airway[BLS-011A, BLS-011B]

In adults and children with cardiac arrest (out-of-hospital and in-hospital), does the provision of airway maneuvers by bystanders, as opposed to no such maneuvers, improve outcome (eg, ROSC, survival)?

Consensus on Science

Evidence from a case series of drowning victims (LOE 4[139]) and 6 prospective clinical studies in patients under anesthesia that evaluated clinical (LOE 5[140–142]) or radiological (LOE

5[143–145]) measures of airway patency indicates that the head tilt–chin lift maneuver is feasible, safe, and effective. Two prospective clinical studies evaluating clinical (LOE 5[146]) or radiological (LOE 5[147]) measures supported the chin lift maneuver in children under anesthesia, while 3 other prospective clinical studies failed to prove the effect compared to neutral position (LOE 5[148–150]). Of 5 studies of the effectiveness of the jaw thrust maneuver to open the airway of patients who received general anesthesia, 3 were supportive (LOE 5[148,151,152]), 1 was neutral (LOE 5[150]), and 1 opposed it (LOE 5[153]).

One LOE 5 study in anesthetized children[154] recommended the jaw lift with the thumb in the mouth. However, 3 studies have reported harm to the victim (LOE 5[155,156]) or rescuer (LOE 4[139]) from inserting digits into the mouth in attempts to clear the airway.

Treatment Recommendation

For unresponsive adults and children, it is reasonable to open the airway using the head tilt–chin lift maneuver when assessing breathing or giving ventilations.

Passive Ventilation[BLS-009A]

In adults and children with cardiac arrest (out-of-hospital and in-hospital) and receiving chest compression–only CPR, does the addition of any passive ventilation technique (eg, positioning the body, opening the airway, passive oxygen administration) as opposed to no addition improve outcome (eg, ROSC, survival)?

Consensus on Science

No study was identified that reported outcomes from lay rescuer techniques for airway maintenance and oxygen insufflation during chest compression–only CPR. Furthermore, no study was identified that compared outcomes of any passive airway or ventilation technique with no airway or ventilation technique during chest compression–only CPR. One LOE 2 study[157] failed to show a difference in neurologically intact survival when comparing EMS use of high-flow passive insufflation of oxygen through an oropharyngeal airway with bag-mask ventilation interposed during minimally interrupted chest compressions. Two other studies (LOE 5[158,159]) reported improved survival for OHCA patients receiving minimally interrupted chest compressions by EMS personnel. These studies evaluated variable, nonrandomized use of passive oxygen insufflation by nonrebreather mask or interposed bag-mask ventilation and did not include a control group (ie, without any airway/ventilation intervention).

Treatment Recommendation

For lay rescuers performing chest compression–only CPR, there is insufficient evidence to recommend the use of any specific passive airway maneuver or adjunct ventilation device.

Foreign-Body Airway Obstruction[BLS-013A]

Like CPR, relief of foreign-body airway obstruction (FBAO) is an urgent procedure that should be taught to laypersons.[160] Evidence for the safest, most effective, and simplest methods was sought.

In adults and children with FBAO (out-of-hospital and in-hospital), does the provision of abdominal thrusts, and/or back slaps, and/or chest thrusts, compared with no action, improve outcome (eg, clearance of obstruction, ROSC, survival)?

Consensus on Science

Case series and case reports have documented successful relief of FBAO in conscious victims with the use of back blows (LOE 4[161,162]), abdominal thrusts (LOE 4[161–165]), and chest thrusts (LOE 4[161]; LOE 5[166]). More than 1 technique was occasionally required to relieve the obstruction.

Thirty-two case reports have documented life-threatening complications associated with the use of abdominal thrusts.[160,167] One randomized trial of maneuvers to clear the airway in cadavers (LOE 5[168]) and 2 prospective studies in anesthetized volunteers (LOE 5[166,169]) showed that higher airway pressures could be generated by using the chest thrust rather than the abdominal thrust. In a few case reports, a finger sweep was effective for relieving FBAO in unconscious adults and children aged >1 year (LOE 4[161,162,170]). Case reports documented harm to the victims or biting of the rescuer's finger with finger sweeps (LOE 4[145,171] and LOE 5[155,156,173]).

Treatment Recommendation

Chest thrusts, back blows, or abdominal thrusts are effective for relieving FBAO in conscious adults and children >1 year of age. These techniques should be applied in rapid sequence until the obstruction is relieved. More than 1 technique may be needed; there is insufficient evidence to determine which should be used first. The finger sweep may be used in the unconscious patient with an obstructed airway if solid material is visible in the airway. At this time, there is insufficient evidence for a treatment recommendation specific for an obese or pregnant patient with FBAO.

Ventilation

Tidal Volumes and Ventilation Rates[BLS-052B]

In adults in cardiac arrest (out-of-hospital and in-hospital) who are NOT intubated, does providing ventilation with a 1-second inspiratory time and tidal volume of about 600 mL compared with other inspiratory times and tidal volumes improve any outcomes (including ventilation, oxygenation)?

Consensus on Science

In 3 human studies (LOE 5[174–176]), tidal volumes of 600 mL using room air were sufficient to maintain oxygenation and normocarbia in apneic patients. When tidal volumes less than 500 mL were used, supplementary oxygen was needed to achieve satisfactory oxygenation. Three studies of mechanical models (LOE 5[177–179]) found no clinically important difference in tidal volumes when a 1- or 2-second inspiratory time was used. In 1 human study with 8 subjects (LOE 4[180]), expired air resuscitation using tidal volumes of 500 to 600 mL led to hypoxia and hypercarbia.

Treatment Recommendation
For mouth-to-mouth ventilation for adult victims using exhaled air or bag-mask ventilation with room air or oxygen, it is reasonable to give each breath within a 1-second inspiratory time and with an approximate volume of 600 mL to achieve chest rise. It is reasonable to use the same initial tidal volume and rate in patients regardless of the cause of the cardiac arrest.

Airway and Ventilation Knowledge Gaps
What is the effectiveness of airway maneuvers by bystanders during standard and chest compression–only CPR? What is the optimal ventilation tidal volume in cardiac arrest patients?

Compression-Ventilation Sequence
In the basic life support/CPR sequence for the lone rescuer, the choice is between starting with airway and breathing (ventilation) or starting with chest compressions. Because of the importance of initiating chest compressions as soon as possible, the need for initial breaths is questioned.

Starting CPR[BLS-026A, BLS-026B]
In adults and children in cardiac arrest (out-of-hospital and in-hospital), does the use of compressions first (30 compressions then 2 breaths) compared with standard care (2 breaths and then 30 compressions) improve outcome (eg, ROSC, survival)?

Consensus on Science
There is no published human or animal evidence to determine whether starting CPR in adults or children with 30 compressions rather than 2 ventilations leads to improved outcomes.

Evidence from 1 observational, adult manikin LOE 5 study[181] shows that starting with 30 compressions rather than 2 ventilations leads to a shorter delay to first compression.

Treatment Recommendation
For treatment of adult victims of cardiac arrest, starting CPR with chest compressions rather than ventilations may be considered.

Effect of Interruptions on Delivery of Chest Compressions
Interruptions to chest compressions during CPR must be minimized. Legitimate reasons for the interruption of CPR include the need to ventilate, the need to assess the rhythm or to assess ROSC, and the need to defibrillate.

Interruption of Compressions for Post-Shock Rhythm Analysis[BLS-022A, BLS-025A, BLS-025B]

- In patients with VF, will the resumption of chest compressions, compared with delayed initiation for rhythm analysis, result in better outcomes?[BLS-022A]
- In adults and children with cardiac arrest (out-of-hospital and in-hospital), does the minimization of hands-off time for rhythm analysis, including frequency and duration of checks, as opposed to standard care (according to treatment algorithm) improve outcome (eg, ROSC, survival)?[BLS-025A, BLS-025B]

Consensus on Science
In 2 observational studies (LOE 4[71,73]) and secondary analyses of 2 randomized trials (LOE 5[53,182]), interruptions of chest compressions were common. Interruption of CPR was associated with a decreased probability of conversion of VF to another rhythm (LOE 5[182]).

In 2 case series (LOE 4[53,54]), a palpable pulse was rarely present immediately after defibrillation, suggesting that a pulse check after a shock is not useful and delays the resumption of chest compressions. However, in 1 randomized study (LOE 1[183]), immediate resumption of chest compressions after defibrillation was associated with earlier VF recurrence when compared to a pulse check prior to resumption of CPR; there was no difference in cumulative incidence of VF 60 seconds after the shock.

Five animal studies (LOE 5[184–188]) and 1 human study (LOE 5[182]) confirmed that more interruption of chest compressions during CPR reduced ROSC and survival. In 2 adult out-of-hospital witnessed VF studies (LOE 3[21,55]) and 3 animal studies (LOE 5[185,188,189]), immediate resumption of chest compressions after defibrillation was associated with better survival rates and/or survival with favorable neurological outcome compared with immediate rhythm analysis and delayed resumption of chest compression. Another LOE 1 randomized study[190] of an AED protocol based on the 2005 Guidelines,[160,167] which included CPR during charging and immediate resumption of chest compressions after shock delivery, did not show significantly improved survival to admission or to discharge.

There is no evidence for or against immediate resumption of chest compressions in adults with VF of short duration.

Treatment Recommendations
Rescuers should minimize interruptions of chest compressions during the entire resuscitation attempt.

Use of Filtering Devices for Rhythm Analysis During CPR[BLS-039]
In adults and children with cardiac arrest (out-of-hospital and in-hospital), does the analysis of cardiac rhythm during chest compressions compared with standard care (analysis of cardiac rhythm during pauses in chest compressions) optimize the time of appropriate chest compression by avoiding unnecessary interruptions and unnecessary prolongations?

Consensus on Science
In 6 LOE 5 studies[191–196] using human-derived ECG recordings with actual or simulated CPR artifacts and 1 LOE 5 study in a swine model of VF,[197] the use of computerized algorithms that removed compression artifacts from the ECG during CPR reduced the accuracy of rhythm analysis relative to rhythm analysis during pauses. Sensitivity was between 90% and 98%, which would cause inappropriate prolongations in chest compression for shockable rhythms in up to 1 out of 10 patients. Specificity was between 80% and 89%, which could result in inappropriate interruptions in chest compression for

shock delivery in victims who actually had nonshockable rhythms.

Treatment Recommendations
There is insufficient evidence to support or refute the use of artifact-filtering algorithms for analysis of ECG rhythm during CPR.

Compression-Ventilation Ratio During CPR[BLS-023A, BLS-023B]

Any recommendation for a specific CPR compression-ventilation ratio represents a compromise between the need to generate blood flow and the need to supply oxygen to the lungs and remove carbon dioxide (CO_2) from the blood. At the same time, any such ratio must be taught to would-be rescuers, so the effect of the compression-ventilation ratio on skills acquisition and retention must be considered.

In adults and children in cardiac arrest (out-of-hospital and in-hospital), does the use of an alternative compression-ventilation ratio, compared with standard care (30:2 compression to ventilation ratio), improve outcome (eg, ROSC, survival)?

Consensus on Science
Evidence from 6 human studies (LOE 3[14,21,198,199]; LOE 4[70]; LOE 5[6]) in adults and 23 additional studies (LOE 5: animal, manikin, and computer models) provides conflicting information about the optimal compression-ventilation ratio to maximize ROSC and survival to hospital discharge when CPR is administered by lay rescuers or by professional rescuers to patients with cardiac arrest in any setting.

In 2005, a single compression-ventilation ratio of 30:2 for the lone rescuer of an infant, child, or adult victim was recommended.[200,201] After implementation of this new guideline, 2 studies (LOE 3[21,199]) showed improvement of survival compared to survival with use of the previous 15:2 compression-ventilation ratio. However, other studies (LOE 3[14,198,202]) failed to show any beneficial effect of the new guidelines on survival, although the potential contribution of each change in the guidelines could not be assessed.

Animal studies (LOE 5) showed improved survival with a compression-ventilation ratio above 30:2.[203,204] However, a compression-ventilation ratio of more than 100:2 was associated with a low ROSC rate and reduced arterial partial pressure of oxygen.[205] The mathematical studies (LOE 5) suggested that the optimal compression-ventilation ratio was near 30:2 for healthcare professionals and near 60:2 for lay rescuer[206] or was a function of body weight in children.[207] Other theoretical studies have recommended ratios of 15:2 or 50:5[208] or around 20:1.[209]

Many manikin studies (all LOE 5) showed that CPR performance, quality, and rescuer's fatigue were not significantly different with differing compression-ventilation ratios,[204,210–213] while others showed mixed results among various compression-ventilation ratios from 5:1 to 60:2.[64,214–219]

Treatment Recommendation
A compression-ventilation ratio of 30:2 is reasonable for an adult victim of cardiac arrest whose airway is not secured.

Chest Compression–Only CPR[BLS-046A, BLS-046B, BLS-047A, BLS-047B, BLS-049A, BLS-049B]

Any recommendation regarding the use of compression-only CPR versus standard CPR is dependent not only on the skill level and ability of the provider (eg, untrained layperson, trained layperson, professional rescuer) but also on the patient (eg, age and etiology of arrest) and the situation (eg, number of providers, phases of prehospital care).

- In adults in cardiac arrest, does the calling of EMS and the provision of chest compressions (without ventilation) by trained laypersons or professionals compared with calling EMS only improve survival to hospital discharge?[BLS-046A, BLS-046B]
- In adults in cardiac arrest, does the provision of chest compressions (without ventilation) from bystanders, both trained and untrained, compared with chest compressions plus mouth-to-mouth breathing, improve survival to hospital discharge?[BLS-047A, BLS-047B]
- In adults in cardiac arrest, does provision of chest compressions (without ventilation) by EMS, compared to chest compressions plus ventilations, improve survival to hospital discharge?[BLS-049A, BLS-049B]

Consensus on Science
There are no human studies that have compared compression-only CPR with standard CPR using a 30:2 ratio of compressions to ventilations. Multiple mathematical and educational studies (LOE 5[67,206,208,213,220–223]) show some supporting evidence favoring a high compression-ventilation ratio or compression-only CPR. Some animal models of sudden VF cardiac arrest (LOE 5[184,186,203,224]) demonstrate benefits of compression-only CPR compared with conventional CPR. Additional animal studies (LOE 5[225–231]) demonstrate neutral evidence, while other animal studies (LOE 5[184,232–236]) show advantages to adding ventilations to chest compressions.

Evidence from 1 interventional human trial (LOE 1[237]) and 8 observational studies (LOE 2[8,15,99,238–241]; LOE 3[242]) document consistent improvement in survival to hospital discharge when compression-only CPR compared with no CPR is administered by untrained or trained bystanders to adults with an out-of-hospital witnessed cardiac arrest.

Four human studies (LOE 2[157,158]; LOE 3[159,243]) demonstrated that provision of continuous chest compressions by trained professional (EMS) providers led to an improvement in survival to hospital discharge compared to standard CPR. Lower methodological rigor limits the ability to determine whether those improvements in survival were attributable to the provision of continuous chest compressions without pauses for ventilation or to other factors.

However, 3 additional studies (LOE 1[244]; LOE 2[245]; LOE 5[246]) failed to consistently show improvement in survival to hospital discharge when compression-only CPR compared with conventional CPR was administered by professionals to adult patients with an OHCA.

Evidence from 1 LOE 2 large pediatric prospective observational investigation[247] showed that children in cardiac arrest of noncardiac etiology (asphyxial arrest) had higher 30-day survival with more favorable neurological outcome if they received standard bystander CPR (chest compressions with rescue breathing) compared with chest compression–only CPR. Standard CPR and chest compression–only CPR were similarly effective and better than no bystander CPR for pediatric cardiac arrest from cardiac causes. Of note, the same study showed that more than 50% of children with OHCA did not receive any bystander CPR. Compression-only CPR was as ineffective as no CPR in the small number of infants and children with asphyxial arrest.

Treatment Recommendation
All rescuers should perform chest compressions for all patients in cardiac arrest. Chest compressions alone are recommended for untrained laypersons responding to cardiac arrest victims. Performing chest compressions alone is reasonable for trained laypersons if they are incapable of delivering airway and breathing maneuvers to cardiac arrest victims. The provision of chest compressions with ventilations is reasonable for trained laypersons who are capable of giving CPR with ventilations to cardiac arrest victims.

Professional rescuers should provide chest compressions with ventilations for cardiac arrest victims. There is insufficient evidence to support or refute the provision of chest compressions plus airway opening and oxygen insufflation by professional rescuers during the first few minutes of resuscitation from cardiac arrest.

Chest Compression Knowledge Gaps

What is the optimal duration of CPR following administration of a defibrillation shock prior to rechecking the patient? Can ECG rhythm analysis during chest compressions be incorporated into resuscitation algorithms? Should the compression to ventilation ratio vary according to the victim's age or arrest etiology? What is the effect of compression-only CPR bystander training on the overall survival of OHCA in the community compared to standard CPR training? What is the effect of compression-only CPR training on the willingness of bystanders to perform CPR compared to standard CPR training? Does EMS provision of chest compressions plus airway opening and oxygen insufflation improve long-term survival of cardiac arrest when compared with high-quality CPR using a 30:2 compression to ventilation ratio?

Special Circumstances

Cervical Spine Injury

For victims of suspected spinal injury, additional time may be needed for careful assessment of breathing and circulation, and it may be necessary to move the victim if he or she is found face down.

Face-Down Victim[BLS-007B]

In adults and children with cardiac arrest (out-of-hospital and in-hospital) and suspected major injury, does any different strategy for positioning (eg, leaving them in the position in which they are found), as opposed to standard care (ie, positioning the victim on his or her back), improve outcome (eg, ROSC, survival)?

Consensus on Science
No human studies have evaluated the relative benefits of strategies for positioning adults and children with cardiac arrest and suspected major injury. Head position is an important factor affecting airway patency (LOE 5[248]), and it is more difficult to check for breathing with the victim in a face-down position. Checking for breathing by lay and professional rescuers is often inaccurate when done within the recommended 10 seconds (LOE 5[38,39]). A longer time to check for breathing will delay CPR and may compromise outcome.

Treatment Recommendation
It is reasonable to roll a face-down, unresponsive victim into the supine position to assess breathing and initiate resuscitation. Concern for protecting the neck should not hinder the evaluation process or delay life-saving procedures.

Emergency Medical Services (EMS) Systems

The call to EMS dispatchers for help is generally the first action when a collapsed victim is found. Recognition of cardiac arrest as the cause of the collapse is rarely simple and requires the dispatcher to elicit critical information from the caller. Failure to recognize the true cause of the collapse precludes the use of bystander CPR and telephone instructions and may also delay the arrival of appropriate help. Not recognizing a cardiac arrest occurs in up to 50% of cases and is associated with lower survival.[249]

Dispatcher Recognition of Cardiac Arrest[BLS-044A, BLS-044B]

In adults and children with OHCA does the description of any specific symptoms to the dispatcher compared with the absence of any specific description improve accuracy of the diagnosis of cardiac arrest?

Consensus on Science
One before-and-after trial (LOE D3[250]) demonstrated a significant increase from 15% to 50% in cardiac arrest recognition after the implementation of a protocol requiring that EMS dispatchers assess absence of consciousness and quality of breathing (normal/not normal). Many descriptive studies (LOE D4[46,251–259]) using a similar protocol to identify cardiac arrest report a sensitivity on the order of 70%, ranging from 38%[255] to 97%,[259] and a high specificity ranging from 95%[254] to 99%.[256]

One case-control trial (LOE D3[249]), 1 before-and-after trial (LOE D3[43]), and 4 observational studies (LOE D4[41,42,260,261]) describe agonal gasps or abnormal breathing as a significant barrier to cardiac arrest recognition by emergency medical dispatchers. Two before-and-after trials (LOE D3[262,263]) improved the recognition of abnormal breathing using education or counting of breaths. Information spontaneously provided by the caller about the quality of breathing and other information such as facial color or describing the victim as "dead" can aid in identifying cardiac arrest cases (LOE D3[249,262,263]).

One descriptive study (LOE D4[264]) suggests that in cases where the victim's problem is "unknown" to the EMS dispatcher, inquiring about the victim's level of activity (standing, sitting, moving, or talking) helps to identify cases who are not in cardiac arrest. Two descriptive studies (LOE D4[261,265]) suggest that confirming the absence of a past medical history of seizure may increase the likelihood of recognizing cardiac arrest among victims presenting with seizure activity. A case-control study (LOE D3[45]) suggests that asking about regularity of breathing may help to recognize cardiac arrest among callers reporting seizure activity.

Treatment Recommendation

EMS dispatchers should inquire about a victim's absence of consciousness and quality of breathing (normal/not normal) when attempting to identify cardiac arrest victims. If the victim is unresponsive, it is reasonable to assume that the victim is in cardiac arrest when callers report that breathing is not normal. Dispatchers should be specifically educated about identification of abnormal breathing in order to improve cardiac arrest recognition. The correct identification of cardiac arrest may be increased by careful attention to the caller's spontaneous comments and by focused questions about seizures.

Dispatcher Instruction in CPR[BLS-010A, BLS-010B]

In adults and children with cardiac arrest (out-of-hospital and in-hospital), does the provision of dispatch CPR instructions, as opposed to no instructions, improve outcome (eg, ROSC, survival)?

Consensus on Science

Three studies (LOE 2[249,258,266]) provide evidence that dispatcher telephone CPR instructions may improve survival from OHCA. In 3 randomized trials (LOE 1[237–237b]), compression-only dispatcher telephone CPR instruction produced survival to discharge at least equivalent to compression plus ventilation dispatcher telephone CPR instruction. Five additional simulation studies (LOE 5[67,220,223,267,268]) demonstrated that simplified chest compression–only telephone instructions in CPR reduce barriers to achieving reasonable-quality bystander CPR.

In 4 simulation studies (LOE 5[269–272]), video-enabled cell phone delivery of visual CPR instructions enhanced performance of CPR. However, in another simulation study (LOE 5[273]), simplified CPR instructions did not improve performance of bystander CPR by elderly rescuers.

Treatment Recommendation

Bystanders who call their local emergency response number should receive initial instructions on performing CPR. Dispatchers should assertively provide compression-only CPR instructions to untrained rescuers for adults with suspected OHCA without any delay. If dispatchers suspect asphyxial arrest, it is reasonable to provide instructions on rescue breathing followed by chest compressions. When performing quality improvement efforts, it is reasonable to assess the accuracy and timeliness of dispatcher recognition of cardiac arrest and the delivery of CPR instructions.

Risks to Victim

Many rescuers are concerned that delivering chest compressions to a victim who is not in cardiac arrest will lead to serious complications, and thus, they do not initiate CPR for some victims of cardiac arrest.

Risks for the Victim[BLS-051A, BLS-051B]

In adults and children who are NOT in cardiac arrest, how often does provision of chest compressions from lay rescuers lead to harm (eg, rib fracture)?

Consensus on Science

There are no data to suggest that the performance of CPR by bystanders leads to more complications than CPR performed by professional rescuers. One LOE 4 study[274] documented no difference in the incidence of injuries on chest radiograph for arrest victims with and without bystander CPR. One LOE 5[275] study documented a higher rate of complications among inpatient arrest victims treated by less-experienced (non-ICU) rescuers. Four LOE 5[276–279] reports document bystander CPR-related injuries in individual cases. Only 1 of these[276] was a patient who was not in cardiac arrest.

Two LOE 4 studies[237,280] reported that serious complications among nonarrest patients receiving dispatch-assisted bystander CPR occurred infrequently. Of 247 nonarrest patients with complete follow-up who received chest compressions from a bystander, 12% experienced discomfort; only 5 (2%) suffered a fracture; and no patients suffered visceral organ injury.[280]

Treatment Recommendation

In individuals with presumed cardiac arrest, bystander CPR rarely leads to serious harm in victims who are eventually found not to be in cardiac arrest; and therefore, bystander CPR should be assertively encouraged.

2005 Topics Not Reviewed in 2010[160,167]

The following topics were included in 2005, but not in this document: devices for airway positioning, duty cycle, CPR in prone position, leg-foot chest compressions, mouth-to-nose ventilation, mouth-to-tracheal stoma ventilation, recovery position, airway opening, CPR for drowning victim in water, removing drowning victim from water, and improving EMS response interval. The reader is referred to the 2005 publication for the reviews.[160,167]

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Disclosures

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Michael T. Cudnik	The Ohio State University Medical Center: Assistant Professor, Department of Emergency Medicine	†I am currently the PI on a 4 year Scientist Development Grant funded by the AHA. The grant is not in any financial or intellectual conflict with this writing group	None	None	None	None	None
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Tetsuo Hatanaka	Emergency Life Saving Technique Academy: Educational institution for municipal paramedics—Professor	†Research grant for "Cardiovascular Disease H18-Heart-01: A Study on Automated External Defibrillator Program and System Development for Improved Survival from Emergency Cardiovascular Disease" from the Ministry of Health, Labour and Welfare, Japan	None	*Several kinds of honoraria for scientific meetings	None	None	None
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Jerry P. Nolan	Royal United Hospital NHS Trust; National Health Service Hospital; Consultant in Anaesthesia and Intensive Care	None	None	None	None	None	None
Andrew H. Travers	Emergency Health Services, Nova Scotia: Department of Health, Nova Scotia—Provincial Medical Director	†I was the lead Principal Investigator for the Public Access Defibrillation Trial for Edmonton, Alberta, Canada and received grant funding from NHLBI through contracts at the University of Washington which acted as the CRC	None	None	None	None	None

This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be “significant” if (a) the person receives $10 000 or more during any 12-month period, or 5% or more of the person’s gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be “modest” if it is less than “significant” under the preceding definition.

*Modest.

†Significant.

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CoSTR Part 5: Worksheet Collaborator Disclosures, *Continued*

Worksheet Collaborator	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
Dana P. Edelson	University of Chicago—Assistant Professor	†CURRENT RESEARCH GRANTS Pending NHLBI Career Devel. Award Strategies to Predict &Prevent In-Hospital CA (IHCA) (1K23HL097157-01) To validate a clinical judgment–based tool for predicting impending clinical deterioration of hospitalized floor patients, and compare it to previously described physiology-based tools. Role: PI (funds delivered to university) †2009–present Philips Healthcare Research Grant Advancements in CPR and Emergency Care during Hemodynamic Crisis-To measure capnography and pulse pressure, using a novel plethysmographic sensor, in critically ill pts & correlate quality of CPR with these measures during CA. Role: PI (funds delivered to university) 2008–present Philips Healthcare Research Grant Q-CPR Users & Development Research Alliance-To establish a multi-center registry of in-hospital resuscitation quality data and a network for clinical trials of resuscitation. Role: PI (funds delivered to university) 2008–present NIH Clinical Research Loan Repayment—2 years of student loan repayment aims to evaluate the effects of integrated team debriefing using actual performance data to improve CPR quality and pt survival following IHCA. Role: PI (funds delivered to loan servicing program) 2007–present AHA Scientist Development Grant Improving CPR Quality and Patient Outcomes Using a Novel Educational Program—To evaluate the effects of integrated team debriefing using actual performance data to improve CPR quality and patient survival following IHCA. Role: PI (funds delivered to university) COMPLETED RESEARCH GRANTS 2006–2008 Philips Medical Systems Research Grant. 2008–2009 NIH Agency for Healthcare Research and Quality Immersive Simulation Team Training—Impact on Rescue, Recovery and Safety Culture (5U18HS016664-02)-To study the effects of simulation based training for Rapid Response Teams. Role: Consultant (funds to university) 2006–2008 NIH Clinical Research Loan Repayment Granted 2years of student loan repayment for a study of end-tidal CO2 as a means of feedback for improving CPR quality during IHCA.Role: PI (funds delivered to loan servicing program)	*Philips Healthcare, Andover, MA	*Philips Healthcare, Andover, MA	None	*Triage Wireless, San Diego, CA	*Hanna Campbell & Powell LLP, Akron, OH—Hankton V Beeson
Raul Gazmuri	N. Chicago VA	Vitamin-C Preserves Myocardial Distensibility during Resuscitation from Cardiac Arrest Sponsor: Zdravstveni Dom. Dr. Adolfa Drolca, Maribor, Slovenia Support comes to Rosalind Franklin University Purpose: To support work in a rat model of VF and resuscitation Volume-Controlled Manual Ventilation during Resuscitation from CA. Sponsor: Dessinier Corporation Purpsoe: To study the hemodynamic effects of vol. controlled ventilation during chest compression in a swine model of VF Unrestricted Gift to Support Resus.research Sponsor: Michael G. Klug and Marie Kube Support to Rosalind Franklin Univer	None	None	None	None	None
Laura S. Gold	Public Health Seattle King County Research Assistant	None	None	None	None	None	None
Antonius P.M. Gorgels	Maastricht University Medical Centre Cardiologist	None	None	None	None	None	None
Colin A. Graham	Chinese University of Hong Kong—Professor of Emergency Medicine *modest honorarium annually from Wolters Kluwer Health Medical Research, LW & W, London as Editor-in-Chief of the European Journal of Emergency Medicine, from 1 January 2009	None	None	None	None	None	None

(*Continued*)

CoSTR Part 5: Worksheet Collaborator Disclosures, *Continued*

Worksheet Collaborator	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
Ahamed H. Idris	UT Southwestern Medical Center at Dallas—Professor of Surgery	†NIH funding for the Resuscitation Outcomes Consortium. I am the PI for the Dallas-Fort Worth ROC site. Payments are made to UT Southwestern, my employer. *I participate as an investigator in a study funded by the American Heart Association	*My research organization receives in-kind support from Philips, Medtronics, and Zoll for manikins, software, and defibrillators used in training CPR	*Doctor's Hospital in Dallas paid me $750 for a lecture	None	*I am a member of advisory boards for the US Army and the NIH, which pays for my travel expenses to attend board meetings	None
Jan L. Jensen	Dalhousie University/Emergency Health Services: Researcher	None	None	None	None	None	None
Peter Kohl	University of Oxford: Higher Education—Reader	None	None	None	None	None	None
Peter J. Kudenchuk	University of Washington—Professor of Medicine	†Principal Investigator, Resuscitation Outcomes Consortium (ROC)—NIH	None	*Sanofi-Aventis *Network for Continuing Medical Education (CME organization) (unclear if this represents a COI for this topic) Academy for Healthcare Education (CME organization) (unclear if this represents a COI for this topic)	*Modest stock holding in Aventis (purchased >13 years ago without further purchases in the interim). Unclear if this represents a COI for this topic	None	*Recently retained expert witness for AED use (unclear if represents a COI for this topic)
Michael A. Kuiper	Medical Center Leeuwarden, the Netherlands: General teaching hospital—Intensivist	None	None	*Lecture at the conference of the National resuscitation council; June 4th, 2009 Lecture on Delirium at the "Delirium Masterclass" in Amsterdam, April 2008	None	None	None
Douglas Kupas	Geisinger Health System: Serve as Associate Chief Academic Officer for Medical Student and Resident Affairs, as Service EMS Medical Director (for Danville Ambulance Service), and faculty and clinical physician in Emerg.Dept & Emerg.Med. Residency Program—Assoc. Chief Academic; Bureau of EMS, Pennsylvania Depart. of Health Officer Commonwealth EMS Med Director	None	None	*I have received honoraria of up to $500 for speaking at EMS related conferences like the Rural EMS and Trauma Summit at the Lakes conference. These include speaking on various EMS topics, including some related to BLS and ALS resuscitation	None	None	*Acted as expert witness for Pennsylvania law firm of Foulkrod Ellis on a case related to treatment of anaphylaxis in an allergy office. Provided expert opinion, but case settled without deposition or trial
Bo Løfgren	Department of Cardiology, Aarhus Univ. Hospital, Skejby: University Hosp/Acad Med. Center-Research Fellow; The Institute of Clinical Medicine, Aarhus University—Research Fellow	None	None	*Speaking Honoraria for Cardiac Science Corporation, Denmark	None	None	*Travel grant, Medtronic Inc., Denmark
Raina Merchant	University of Pennsylvania—Research fellow	None	None	None	None	None	None
Tommaso Pellis	Santa Maria degli Angeli Hospital: Public hospital of the city of Pordenone founded by the Italian public health care system—Medical doctor, consultant in Anesthesia, Intensive Care and EMS	None	None	None	None	None	None

(*Continued*)

CoSTR Part 5: Worksheet Collaborator Disclosures, *Continued*

Worksheet Collaborator	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
Gavin D. Perkins	University of Warwick—Associate Clinical Professor	†UK Department of Health National Institute for Health Research—Quality of CPR improvement initiative—PI Resuscitation Council (UK) PhD studentship—quality of CPR—PI UK Department of Health National Institute for Health Research—mechanical CPR (LUCAS)—Co-PI	None	None	None	None	†Expert witness to The Court; commissioned by UK government Health and Safety Executive to advice on pathophysiology/time sequence of drowning (single case; civil prosecution)
Thomas D. Rea	University of Washington; Physician, Associate Professor of Medicine Emergency Medical Services Division of Public Health—Seattle & King County Program Medical Director	*In the past, I have received unrestricted (modest) grant support from Philips Inc and PhysioControl. The topics were related to improving resuscitation generally (changing resuscitation protocols) and not specific to proprietary information or equipment. *I am currently an investigator in the Resuscitations Outcomes Consortium. As part of this group, I am directly involved in the Feedback Trial to evaluate dynamic feedback available on the Philips MRX. The ROC is also evaluating the impedance threshold device. These studies are supported by the NIH primarily and I receive no support from Philips or the company that makes the impedance threshold device. Finally I am participating in a trial of chest compression only versus chest compression plus ventilation for dispatch-assisted CPR that is supported in part by the Laerdal Foundation. Collectively, I receive less than 5% salary support for these activities. I do not own or hold stock in the commercial companies	*Conducted an AED training study that recently completed where Philips and PhysioControl contributed equipment for the research. I did not receive any of this equipment	None	None	None	*I serve on a DSMB for a trial sponsored by Philips to evaluate quantitative VF waveform algorithm to guide care. I receive no support for this effort in order to minimize (eliminate) any conflict
Andrea Scapigliati	Università Cattolica del S. Cuore, School of Medicine, Rome, Italy Assistant Professor	None	None	None	None	None	None
Robert A. Swor	William Beaumont Hospital: Emergency Physician	None	None	None	None	None	None
Keiichi Tanaka	Fukuoka University: Educational institution for undergraduate and graduate education, Prof. School of Med.	None	None	None	None	None	None
Nigel V. Turner	University Medical Centre Utrecht, the Netherlands—Consultant anesthesiologist	None	None	*Speaking at the Dutch RC meeting—About Eur 500 a year	None	†Medical director of the Dutch Foundation for the Emergency Medical Care of Children—a charitable educational organization. This is a post I may accept from Sept 09 which would pay me personally about 10 000 Eur p.a. The work would include medical and educational advice but not include marketing of training and courses. I already teach for this organization on a voluntary basis. I do not consider this to be a COI but include it for completeness' sake	None
Tyler F. Vadeboncoeur	Mayo Clinic—Emergency Physician	*Collaborator on an AHA grant to Bentley J Bobrow and colleagues to study the efficacy of an ultra brief video to teach hands-only CPR. The grant is for $100 000 and I will not receive any monies or protected time	None	None	None	None	None

(*Continued*)

CoSTR Part 5: Worksheet Collaborator Disclosures, *Continued*

Worksheet Collaborator	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
Christian Vaillancourt	The Ottawa Hospital, Ottawa Hospital Research Institute Assistant Professor, Department of Emergency Medicine Scientist, OHRI Scientist	†All funds are administered by the Ottawa Hospital Research Institute; 2008–2010 A Survey of Factors Associated with the Successful Recognition of Agonal Breathing and Cardiac Arrest by 9-1-1 Call Takers Heart and Stroke Foundation of Ontario C. Vaillancourt (PI) $49 000.00 2007–2010 Effectiveness of Dispatch-Assisted CPR Instructions: An Evaluation of 9-1-1 Calls Canadian Institutes of Health Research C. Vaillancourt (PI) $378 517.00 *2009–2010 A Survey of Factors Associated with the Successful Recognition of Agonal Breathing and Cardiac Arrest by 911 Call Takers Department of Emergency Medicine, University of Ottawa C. Vaillancourt (PI) $8 800.00 2008–2009 A Systematic Review of the Effectiveness of Dispatch Prearrival CPR Instructions in Improving Survival in Cardiac Arrest Patients Department of Emergency Medicine, University of Ottawa C. Vaillancourt (PI) $8 500.00	None	None	None	None	None
Antonius M.W. van Stipdonk	Maastricht University Medical Centre+ Academical Hospital of Maastricht, departments of cardiology and social medicin employ me physician-researcher	None	None	None	None	None	None
Barbara Vantroyen	CAZ Midden Limburg Regional Hospital; Emergency physician, medical internist	None					

This table represents the relationships of worksheet collaborators that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all worksheet collaborators are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

Appendix

CoSTR Part 5: Worksheet Appendix

Task Force	WS ID	PICO Title	Short Title	Authors	URL
BLS	BLS-003A	In adult and pediatric patients with presumed cardiac arrest (prehospital or in-hospital) (P), are there any factors (eg. on clinical exam) (I) as opposed to standard care (C), that increase the likelihood of diagnosing cardiac arrest (as opposed to non-arrest conditions (eg post-seizure, hypoglycemia, intoxication) (O)?	Differentiation of cardiac arrest from other causes of unresponsiveness	Koenraad Monsieurs	http://circ.ahajournals.org/site/C2010/BLS-003A.pdf
BLS	BLS-003B	In adult and pediatric patients with presumed cardiac arrest (prehospital or in-hospital) (P), are there any factors (eg. on clinical exam) (I) as opposed to standard care (C), that increase the likelihood of diagnosing cardiac arrest (as opposed to non-arrest conditions (eg post-seizure, hypoglycemia, intoxication) (O)?	Differentiation of cardiac arrest from other causes of unresponsiveness	Tyler F. Vadeboncoeur	http://circ.ahajournals.org/site/C2010/BLS-003B.pdf
BLS	BLS-004B	In adult and pediatric patients with out-of-hospital cardiac arrest (including residential settings) (P), does implementation of a public access AED program (I) as opposed to traditional EMS response (C), improve successful outcomes (O) (eg. ROSC, survival)?	Public access AED programs	E. Brooke Lerner	http://circ.ahajournals.org/site/C2010/BLS-004B.pdf
BLS	BLS-006A	In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does any specific compression depth (I) as opposed to standard care (ie. depth specified in treatment algorithm) (C), improve outcome (O) (eg. ROSC, survival)?	Compression depth	Ahamed H. Idris	http://circ.ahajournals.org/site/C2010/BLS-006A.pdf
BLS	BLS-006B	In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does any specific compression depth (I) as opposed to standard care (ie. depth specified in treatment algorithm) (C), improve outcome (O) (eg. ROSC, survival)?	Compression depth	Koenraad Monsieurs	http://circ.ahajournals.org/site/C2010/BLS-006B.pdf
BLS	BLS-007B	In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) and suspected major injury (P), does any different strategy regarding positioning (eg. leaving them in the position they are found) (I) as opposed to standard care (ie. positioning the victim on his or her back) (C), improve outcome (O) (eg. ROSC, survival)?	Positioning of victim with traumatic cardiac arrest	Keiichi Tanaka	http://circ.ahajournals.org/site/C2010/BLS-007B.pdf
BLS	BLS-008B	In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the interruption of CPR to check circulation (I) as opposed to no interruption of CPR (C), improve outcome (O) (eg. ROSC, survival)?	Pulse check (risk benefit of interruption of CPR)	Peter Fenici, Ian Jacobs, Andrea Scapigliati	http://circ.ahajournals.org/site/C2010/BLS-008B.pdf
BLS	BLS-009A	In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) and receiving chest compression only CPR (P), does the addition of any passive ventilation technique (eg positioning the body, opening the airway, passive oxygen administration) (I) as opposed to no addition (C), improve outcome (O) (eg. ROSC, survival)?	Passive ventilation techniques	Douglas Kupas	http://circ.ahajournals.org/site/C2010/BLS-009A.pdf
BLS	BLS-010A	In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the provision of dispatch CPR instructions (I) as opposed to no instructions (C), improve outcome (O) (eg. ROSC, survival)?	Dispatch CPR instructions	James V. Dunford	http://circ.ahajournals.org/site/C2010/BLS-010A.pdf
BLS	BLS-010B	In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the provision of dispatch CPR instructions (I) as opposed to no instructions (C), improve outcome (O) (eg. ROSC, survival)?	Dispatch CPR instructions	Maaret Castrén	http://circ.ahajournals.org/site/C2010/BLS-010B.pdf
BLS	BLS-011A	In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the provision of airway maneuvers by bystanders (I) as opposed to no such maneuvers (C), improve outcome (O) (eg. ROSC, survival)?	Airway maneuvers in bystander CPR	Robert A. Swor	http://circ.ahajournals.org/site/C2010/BLS-011A.pdf
BLS	BLS-011B	In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the provision of airway maneuvers by bystanders (I) as opposed to no such maneuvers (C), improve outcome (O) (eg. ROSC, survival)?	Airway maneuvers in bystander CPR	Sung Phil Chung	http://circ.ahajournals.org/site/C2010/BLS-011B.pdf
BLS	BLS-013A	In adult and pediatric patients with foreign body airway obstruction (out-of-hospital and in-hospital) (P), does the provision of abdominal thrusts, and/or back slaps, and/or chest thrusts, compared with no action (C), improve outcome (O) (eg. clearance of obstruction, ROSC, survival)?	Choking treatment	Anthony J. Handley	http://circ.ahajournals.org/site/C2010/BLS-013A.pdf
BLS	BLS-014B	What is the incidence, prevalence, etiology of cardiopulmonary arrest in-hospital and out-of-hospital?	Incidence and etiology cardiac arrest	Jocelyn Berdowski	http://circ.ahajournals.org/site/C2010/BLS-014B.pdf
BLS	BLS-017A	In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of alternative methods of manual CPR (eg. cough CPR, precordial thump, fist-pacing) (I) compared with standard CPR (C), improve any outcomes (eg. ROSC, survival) (O)?	Alternative methods of CPR	Tom P. Aufderheide	http://circ.ahajournals.org/site/C2010/BLS-017A.pdf
BLS	BLS-017B	In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of alternative methods of manual CPR (eg. cough CPR, precordial thump, fist-pacing) (I) compared with standard CPR (C), improve any outcomes (eg. ROSC, survival) (O)?	Alternative methods of CPR	Jan L. Jensen	http://circ.ahajournals.org/site/C2010/BLS-017B.pdf
BLS	BLS-017C	In adult cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of alternative methods of manual CPR (eg. cough CPR, precordial thump, fist-pacing) (I) compared with standard CPR (C), improve any outcomes (eg. ROSC, survival) (O)?	Alternative methods of CPR	Peter Kohl, Tommaso Pellis	http://circ.ahajournals.org/site/C2010/BLS-017C.pdf
BLS	BLS-020A	In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of feedback regarding the mechanics of CPR quality (e.g. rate and depth of compressions and/or ventilations) (I) compared with no feedback (C), improve any outcomes (eg. ROSC, survival) (O)?	Feedback for CPR quality	Diana Cave	http://circ.ahajournals.org/site/C2010/BLS-020A.pdf
BLS	BLS-020B	In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of feedback regarding the mechanics of CPR quality (e.g. rate and depth of compressions and/or ventilations) (I) compared with no feedback (C), improve any outcomes (eg. ROSC, survival) (O)?	Feedback for CPR quality	Peter T. Morley	http://circ.ahajournals.org/site/C2010/BLS-020B.pdf
BLS	BLS-022A	In adult and pediatric patients with cardiac arrest (prehospital or in-hospital) (P), does the minimization of hands off time after defibrillation for rhythm check (I) as opposed to standard care (according to treatment algorithm) (C), improve outcome (O) (eg. ROSC, survival)?	Rhythm check (risk benefit of interruption of CPR)	Robert A. Berg	http://circ.ahajournals.org/site/C2010/BLS-022A.pdf

(*Continued*)

CoSTR Part 5: Worksheet Appendix, *Continued*

Task Force	WS ID	PICO Title	Short Title	Authors	URL
BLS	BLS-023A	In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of another specific C:V ratio (I) compared with standard care (30:2) (C), improve outcome (eg. ROSC, survival) (O)?	Compression ventilation ratio	Sung Phil Chung	http://circ.ahajournals.org/site/C2010/BLS-023A.pdf
BLS	BLS-023B	In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of another specific C:V ratio (I) compared with standard care (30:2) (C), improve outcome (eg. ROSC, survival) (O)?	Compression ventilation ratio	Michael Sayre	http://circ.ahajournals.org/site/C2010/BLS-023B.pdf
BLS	BLS-025A	In adult and pediatric patients with cardiac arrest (prehospital or in-hospital) (P), does the minimization of hands off time for rhythm analysis including frequency and duration of checks (I) as opposed to standard care (according to treatment algorithm) (C), improve outcome (O) (eg. ROSC, survival)?	Rhythm check (risk benefit of interruption of CPR)	Dana P. Edelson	http://circ.ahajournals.org/site/C2010/BLS-025A.pdf
BLS	BLS-025B	In adult and pediatric patients with cardiac arrest (prehospital or in-hospital) (P), does the minimization of hands off time for rhythm analysis including frequency and duration of checks (I) as opposed to standard care (according to treatment algorithm) (C), improve outcome (O) (eg. ROSC, survival)?	Rhythm check (risk benefit of interruption of CPR)	David C. Cone	http://circ.ahajournals.org/site/C2010/BLS-025B.pdf
BLS	BLS-026A	In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of compressions first (30:2) (I) compared with standard care (2:30) (C), improve outcome (eg. ROSC, survival) (O).	Compression first vs ventilation first	Anthony J. Handley	http://circ.ahajournals.org/site/C2010/BLS-026A.pdf
BLS	BLS-026B	In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of compressions first (30:2) (I) compared with standard care (2:30) (C), improve outcome (eg. ROSC, survival) (O).	Compression first vs ventilation first	Diana Cave	http://circ.ahajournals.org/site/C2010/BLS-026B.pdf
BLS	BLS-032A	In adult and pediatric patients with cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of any specific placement of hands for external chest compressions (I) compared with standard care (eg. "placement of the rescuer's hands in the middle of the chest") (C), improve outcome (eg. ROSC, survival) (O).	Hand placement	Raina Merchant	http://circ.ahajournals.org/site/C2010/BLS-032A.pdf
BLS	BLS-032B	In adult and pediatric patients with cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of any specific placement of hands for external chest compressions (I) compared with standard care (eg. "placement of the rescuer's hands in the middle of the chest") (C), improve outcome (eg. ROSC, survival) (O).	Hand placement	Nigel M. Turner	http://circ.ahajournals.org/site/C2010/BLS-032B.pdf
BLS	BLS-033A	In rescuers performing CPR on adult or pediatric patients with cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of any specific method for locating recommended hand position (I) compared with standard care (eg. "placement of the rescuer's hands in the middle of the chest") (C), improve outcome (eg. time to commence CPR, decreased hands off time, ROSC, survival) (O).	Hand placement	Anthony J. Handley	http://circ.ahajournals.org/site/C2010/BLS-033A.pdf
BLS	BLS-034A	In adult and pediatric patients with cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of any specific rate for external chest compressions (I) compared with standard care (ie. approximately 100/min) (C), improve outcome (eg. ROSC, survival) (O)?	Chest compression rate	Ahamed H. Idris	http://circ.ahajournals.org/site/C2010/BLS-034A.pdf
BLS	BLS-034B	In adult and pediatric patients with cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of any specific rate for external chest compressions (I) compared with standard care (ie. approximately 100/min) (C), improve outcome (eg. ROSC, survival) (O)?	Chest compression rate	Barbara Vantroyen	http://circ.ahajournals.org/site/C2010/BLS-034B.pdf
BLS	BLS-035A	In adult and pediatric patients with cardiac arrest while on a bed (prehospital [OHCA], in-hospital [IHCA]) (P), does the performance of CPR on a hard surface like backboard or deflatable mattress (I) compared with performance of CPR on a regular mattress (C), improve outcome (eg. ROSC, survival) (O)?	Soft vs hard surface for CPR	Gavin D. Perkins	http://circ.ahajournals.org/site/C2010/BLS-035A.pdf
BLS	BLS-035B	In adult and pediatric patients with cardiac arrest while on a bed (prehospital [OHCA], in-hospital [IHCA]) (P), does the performance of CPR on a hard surface like backboard or deflatable mattress (I) compared with performance of CPR on a regular mattress (C), improve outcome (eg. ROSC, survival) (O)?	Soft vs hard surface for CPR	Bo Løfgren	http://circ.ahajournals.org/site/C2010/BLS-035B.pdf
BLS	BLS-039	In adult and pediatric patients with cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the analysis of cardiac rhythm during chest compressions (I) compared with standard care (analysis of cardiac rhythm during pauses in chest compressions) (C), optimize the time of appropriate chest compression by avoiding unnecessary interruptions and unnecessary prolongations (O)?	Analysis of rhythm during chest compression	Raúl J. Gazmuri, Michael A. Kuiper	http://circ.ahajournals.org/site/C2010/BLS-039.pdf
BLS	BLS-044A	In adult and pediatric patients with cardiac arrest (prehospital [OHCA]) (P), does the description of any specific symptoms to the dispatcher (I) compared with the absence of any specific description (C), improve accuracy of the diagnosis of cardiac arrest (O)?	Rescuer communication with dispatcher for CPR	Manya Charette, Christian Vaillancourt	http://circ.ahajournals.org/site/C2010/BLS-044A.pdf
BLS	BLS-044B	In adult and pediatric patients with cardiac arrest (prehospital [OHCA]) (P), does the description of any specific symptoms to the dispatcher (I) compared with the absence of any specific description (C), improve accuracy of the diagnosis of cardiac arrest (O)?	Rescuer communication with dispatcher for CPR	Maaret Castrén	http://circ.ahajournals.org/site/C2010/BLS-044B.pdf
BLS	BLS-045A	In adult and pediatric patients with cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does optimizing chest wall recoil (I) compared with standard care (C), improve outcome (eg. ROSC, survival) (O)? In patients with CA (P), does optimizing chest wall recoil (I), improve survival (O)?	Chest wall recoil	Tom P. Aufderheide	http://circ.ahajournals.org/site/C2010/BLS-045A.pdf
BLS	BLS-046A	In adult patients suffering from a cardiac arrest (P) does the calling of EMS and the provision of chest compressions (without ventilation) by untrained laypersons, trained laypersons, or professionals (I) compared with calling EMS only (C) improve survival to hospital discharge (O)?	Untrained lay rescuer CC Only vs call EMS	Tetsuo Hatanaka	http://circ.ahajournals.org/site/C2010/BLS-046A.pdf
BLS	BLS-046B	In adult patients suffering from a cardiac arrest (P) does the calling of EMS and the provision of chest compressions (without ventilation) by untrained laypersons, trained laypersons, or professionals (I) compared with calling EMS only (C) improve survival to hospital discharge (O)?	Untrained lay rescuer CC Only vs call EMS	Thomas D. Rea	http://circ.ahajournals.org/site/C2010/BLS-046B.pdf

(*Continued*)

CoSTR Part 5: Worksheet Appendix, *Continued*

Task Force	WS ID	PICO Title	Short Title	Authors	URL
BLS	BLS-047A	In adult patients suffering from a cardiac arrest (P) does the provision of chest compressions (without ventilation) from bystanders, both trained and untrained, (I) compared with chest compressions plus mouth-to-mouth breathing (C) improve survival to hospital discharge (O)?	Chest compression only CPR	Csaba Dioszeghy	http://circ.ahajournals.org/site/C2010/BLS-047A.pdf
BLS	BLS-047B	In adult patients suffering from a cardiac arrest (P) does the provision of chest compressions (without ventilation) from bystanders, both trained and untrained, (I) compared with chest compressions plus mouth-to-mouth breathing (C) improve survival to hospital discharge (O)?	Chest compression only CPR	Andrew Travers	http://circ.ahajournals.org/site/C2010/BLS-047B.pdf
BLS	BLS-049A	In adult patients suffering from a cardiac arrest (P) does provision of chest compressions (without ventilation) by EMS (I) compared with chest compressions plus ventilations (C) improve survival to hospital discharge (O)?	EMS CC only vs standard CPR	Laura S. Gold, Peter J. Kudenchuk	http://circ.ahajournals.org/site/C2010/BLS-049A.pdf
BLS	BLS-049B	In adult patients suffering from a cardiac arrest (P) does provision of chest compressions (without ventilation) by EMS (I) compared with chest compressions plus ventilations (C) improve survival to hospital discharge (O)?	EMS CC only vs standard CPR	Andrew Travers	http://circ.ahajournals.org/site/C2010/BLS-049B.pdf
BLS	BLS-050A	In adult and pediatric patients with presumed cardiac arrest (prehospital or in-hospital) (P), are there any factors/characteristics (I) that increase the likelihood of differentiating between a sudden cardiac arrest (ie. VF) from other etiologies (eg drowning, acute airway obstruction) (O)?	Differentiating cardiac from non-cardiac etiologies	Anthony J. Handley	http://circ.ahajournals.org/site/C2010/BLS-050A.pdf
BLS	BLS-050B	In adult and pediatric patients with presumed cardiac arrest (prehospital or in-hospital) (P), are there any factors/characteristics (I) that increase the likelihood of differentiating between a sudden cardiac arrest (ie. VF) from other etiologies (eg drowning, acute airway obstruction) (O)?	Differentiating cardiac from non-cardiac etiologies	Michael A. Kuiper	http://circ.ahajournals.org/site/C2010/BLS-050B.pdf
BLS	BLS-051A	In adults and pediatric patients who are NOT in cardiac arrest (P), how often does provision of chest compressions from lay rescuers (I), lead to harm (eg rib fracture) (O)?	Harm from CPR to victims not in arrest	Anton P.M. Gorgels, Antonius M.W. van Stipdonk	http://circ.ahajournals.org/site/C2010/BLS-051A.pdf
BLS	BLS-051B	In adults and pediatric patients who are NOT in cardiac arrest (P), how often does provision of chest compressions from lay rescuers (I), lead to harm (eg rib fracture) (O)?	Harm from CPR to victims not in arrest	Daniel P. Davis	http://circ.ahajournals.org/site/C2010/BLS-051B.pdf
BLS	BLS-052B	In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) who are NOT endotracheally intubated (P), does providing ventilation with a 1 second inspiratory time and tidal volume of about 600 mL (I), compared with other inspiratory times and tidal volume (C), improve any outcomes (including ventilation, oxygenation) (O)?	Ventilation inspiratory time and volume	Colin A. Graham	http://circ.ahajournals.org/site/C2010/BLS-052B.pdf
BLS	BLS-053A	In adult patients in cardiac arrest (P), how frequently should chest compressions be paused to re-diagnose accurately the cardiac rhythm (I) to provide the best outcomes (eg ROSC, survival) (O)?	Timing of CPR cycles (2 min vs other)	Michael Cudnik	http://circ.ahajournals.org/site/C2010/BLS-053A.pdf

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