I'm not a robot

1Top 10 Take-home Messages For Adult Cardiovascular Life Support On recognition of a cardiac arrest event, a layperson should simultaneously and promptly activate the emergency response system and initiate cardiopulmonary resuscitation (CPR). Performance of high-quality CPR includes adequate compression depth and rate while minimizing pauses in compressions. Early defibrillation with concurrent high-quality CPR is critical to survival when sudden cardiac arrest is caused by ventricular fibrillation or pulseless ventricular tachycardia. Administration of epinephrine with concurrent high-quality CPR improves survival, particularly in patients with nonshockable rhythms. Recognition that all cardiac arrest events are not identical is critical for optimal patient outcome, and specialized management is necessary for many conditions (eg, electrolyte abnormalities, pregnancy, after cardiac surgery). The opioid epidemic has resulted in an increase in opioid-associated out-of-hospital cardiac arrest, with the mainstay of care remaining the activation of the emergency response systems and performance of high-quality CPR. Post–cardiac arrest care is a critical component of the Chain of Survival and demands a comprehensive, structured, multidisciplinary system that requires consistent implementation for optimal patient outcomes. Prompt initiation of targeted temperature management is necessary for all patients who do not follow commands after return of spontaneous circulation to ensure optimal functional and neurological outcome. Accurate neurological prognostication in brain-injured cardiac arrest survivors is critically important to ensure that patients with significant potential for recovery are not destined for certain poor outcomes due to care withdrawal. Recovery expectations and survivorship plans that address treatment, surveillance, and rehabilitation need to be provided to cardiac arrest survivors and their caregivers at hospital discharge to optimize transitions of care to home and to the outpatient setting. 2Preamble In 2015, approximately 350 000 adults in the United States experienced nontraumatic out-of-hospital cardiac arrest (OHCA) attended by emergency medical services (EMS) personnel.1 Approximately 10.4% of patients with OHCA survive their initial hospitalization, and 8.2% survive with good functional status. The key drivers of successful resuscitation from OHCA are lay rescuer cardiopulmonary resuscitation (CPR) and public use of an automated external defibrillator (AED). Despite recent gains, only 39.2% of adults receive layperson-initiated CPR, and the general public applied an AED in only 11.9% of cases.1 Survival rates from OHCA vary dramatically between US regions and EMS agencies.2,3 After significant improvements, survival from OHCA has plateaued since 2012. Approximately 1.2% of adults admitted to US hospitals suffer in-hospital cardiac arrest (IHCA).1 Of these patients, 25.8% were discharged from the hospital alive, and 82% of survivors have good functional status at the time of discharge. Despite steady improvement in the rate of survival from IHCA, much opportunity remains. The International Liaison Committee on Resuscitation (ILCOR) Formula for Survival emphasizes 3 essential components for good resuscitation outcomes: guidelines based on sound resuscitation science, effective education of the lay public and resuscitation providers, and implementation of a well-functioning Chain of Survival.4 These guidelines contain recommendations for basic life support (BLS) and advanced life support (ALS) for adult patients and are based on the best available resuscitation science. The Chain of Survival, introduced in Major Concepts, is now expanded to emphasize the important component of survivorship during recovery from cardiac arrest, requires coordinated efforts from medical professionals in a variety of disciplines and, in the case of OHCA, from lay rescuers, emergency dispatchers, and first responders. In addition, specific recommendations about the training of resuscitation providers are provided in “Part 6: Resuscitation Education Science,” and recommendations about systems of care are provided in “Part 7: Systems of Care.” 3Introduction 3.1Scope of the Guidelines These guidelines are designed primarily for North American healthcare providers who are looking for an up-to-date summary for BLS and ALS for adults as well as for those who are seeking more in-depth information on resuscitation science and gaps in current knowledge. The BLS care of adolescents follows adult guidelines. This Part of the 2020 American Heart Association (AHA) Guidelines for CPR and Emergency Cardiovascular Care includes recommendations for clinical care of adults with cardiac arrest, including those with life-threatening conditions in whom cardiac arrest is imminent, and after successful resuscitation from cardiac arrest. Some recommendations are directly relevant to lay rescuers who may or may not have received CPR training and who have little or no access to resuscitation equipment. Other recommendations are relevant to persons with more advanced resuscitation training, functioning either with or without access to resuscitation drugs and devices, working either within or outside of a hospital. Some treatment recommendations involve medical care and decision-making after return of spontaneous circulation (ROSC) or when resuscitation has been unsuccessful. Importantly, recommendations are provided related to team debriefing and systematic feedback to increase future resuscitation success. 3.2Organization of the Writing Group The Adult Cardiovascular Life Support Writing Group included a diverse group of experts with backgrounds in emergency medicine, critical care, cardiology, toxicology, neurology, EMS, education, research, and public health, along with content experts, AHA staff, and the AHA senior science editors. Each recommendation was developed and formally approved by the writing group. The AHA has rigorous conflict of interest policies and procedures to minimize the risk of bias or improper influence during the development of guidelines. Before appointment, writing group members disclosed all commercial relationships and other potential (including intellectual) conflicts. These procedures are described more fully in “Part 2: Evidence Evaluation and Guidelines Development.” Disclosure information for writing group members is listed in Appendix 1(link opens in new window). 3.3Methodology and Evidence Review These guidelines are based on the extensive evidence evaluation performed in conjunction with the ILCOR and affiliated ILCOR member councils. Three different types of evidence reviews (systematic reviews, scoping reviews, and evidence updates) were used in the 2020 process. Each of these resulted in a description of the literature that facilitated guideline development. A more comprehensive description of these methods is provided in “Part 2: Evidence Evaluation and Guidelines Development.” 3.4Class of Recommendation and Level of Evidence As with all AHA guidelines, each 2020 recommendation is assigned a Class of Recommendation (COR) based on the strength and consistency of the evidence, alternative treatment options, and the impact on patients and society (Table 1(link opens in new window)). The Level of Evidence (LOE) is based on the quality, quantity, relevance, and consistency of the available evidence. For each recommendation, the writing group discussed and approved specific recommendation wording and the COR and LOE assignments. In determining the COR, the writing group considered the LOE and other factors, including systems issues, economic factors, and ethical factors such as equity, acceptability, and feasibility. These evidence- review methods, including specific criteria used to determine COR and LOE, are described more fully in “Part 2: Evidence Evaluation and Guidelines Development.” The Adult Basic and Advanced Life Support Writing Group members had final authority over and formally approved these recommendations. Unfortunately, despite improvements in the design and funding support for resuscitation research, the overall certainty of the evidence base for resuscitation science is low. Of the 250 recommendations in these guidelines, only 2 recommendations are supported by Level A evidence (high-quality evidence from more than 1 randomized controlled trial [RCT], or 1 or more RCT corroborated by high-quality registry studies.) Thirty-seven recommendations are supported by Level B-Randomized Evidence (moderate evidence from 1 or more RCTs) and 57 by Level B-Nonrandomized evidence. The majority of recommendations are based on Level C evidence, including those based on limited data (123 recommendations) and expert opinion (31 recommendations). Accordingly, the strength of recommendations is weaker than optimal: 78 Class 1 (strong) recommendations, 57 Class 2a (moderate) recommendations, and 89 Class 2b (weak) recommendations are included in these guidelines. In addition, 15 recommendations are designated Class 3: No Benefit, and 11 recommendations are Class 3: Harm. Clinical trials in resuscitation are sorely needed. 3.5Guideline Structure The 2020 Guidelines are organized into knowledge chunks, grouped into discrete modules of information on specific topics or management issues.5 Each modular knowledge chunk includes a table of recommendations that uses standard AHA nomenclature of COR and LOE. A brief introduction or short synopsis is provided to put the recommendations into context with important background information and overarching management or treatment concepts. Recommendation-specific text clarifies the rationale and key study data supporting the recommendations. When appropriate, flow diagrams or additional tables are included. Hyperlinked references are provided to facilitate quick access and review. 3.6Document Review and Approval Each of the 2020 Guidelines documents were submitted for blinded peer review to 5 subject-matter experts nominated by the AHA. Before appointment, all peer reviewers were required to disclose relationships with industry and any other conflicts of interest, and all disclosures were reviewed by AHA staff. Peer reviewer feedback was provided for guidelines in draft format and again in final format. All guidelines were reviewed and approved for publication by the AHA Science Advisory and Coordinating Committee and the AHA Executive Committee. Disclosure information for peer reviewers is listed in Appendix 2(link opens in new window). 3.7Abbreviations Abbreviations ACD active compression-decompression ACLS advanced cardiovascular life support ADC apparent diffusion coefficient AED automated external defibrillator AHA American Heart Association ALS advanced life support aOR adjusted odds ratio AV atrioventricular BLS basic life support COR Class of Recommendation CoSTR International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations CPR cardiopulmonary resuscitation CT computed tomography DWI diffusion-weighted imaging ECG electrocardiogram ECPR extracorporeal cardiopulmonary resuscitation EEG electroencephalogram EMS emergency medical services ETCO2 (partial pressure of) end-tidal carbon dioxide ETI endotracheal intubation GWR gray-white ratio ICU intensive care unit IHCA in-hospital cardiac arrest ILCOR International Liaison Committee on Resuscitation IO intraosseous ITD impedance threshold device IV intravenous LAST local anesthetic systemic toxicity LOE Level of Evidence MAP mean arterial pressure MRI magnetic resonance imaging NSE neuron-specific enolase OHCA out-of-hospital cardiac arrest Paco2 arterial partial pressure of carbon dioxide PCI percutaneous coronary intervention PE pulmonary embolism PMCD perimortem cesarean delivery pVT pulseless ventricular tachycardia RCT randomized controlled trial ROSC return of spontaneous circulation S100B S100 calcium binding protein SGA supraglottic airway SSEP somatosensory evoked potential STEMI ST-segment elevation myocardial infarction SVT supraventricular tachycardia TCA tricyclic antidepressant TOR termination of resuscitation TTM targeted temperature management VF ventricular fibrillation VT ventricular tachycardia 4Major Concepts 4.1Overview Concepts of Adult Cardiac Arrest Survival and recovery from adult cardiac arrest depend on a complex system working together to secure the best outcome for the victim. The main focus in adult cardiac arrest events includes rapid recognition, prompt provision of CPR, defibrillation of malignant shockable rhythms, and post-ROSC supportive care and treatment of underlying causes. This approach recognizes that most sudden cardiac arrest in adults is of cardiac cause, particularly myocardial infarction and electric disturbances. Arrests without a primary cardiac origin (eg, from respiratory failure, toxic ingestion, pulmonary embolism [PE], or drowning) are also common, however, and in such cases, treatment for reversible underlying causes is important for the rescuer to consider.1 Some noncardiac etiologies may be particularly common in the in-hospital setting. Others, such as opioid overdose, are sharply on the rise in the out-of-hospital setting.2 For any cardiac arrest, rescuers are instructed to call for help, perform CPR to restore coronary and cerebral blood flow, and apply an AED to directly treat ventricular fibrillation (VF) or ventricular tachycardia (VT), if present. Although the majority of resuscitation success is achieved by provision of high-quality CPR and defibrillation, other specific treatments for likely underlying causes may be helpful in some cases. 4.2Adult Chain of Survival The primary focus of cardiac arrest management for providers is the optimization of all critical steps required to improve outcomes. These include activation of the emergency response, provision of high-quality CPR and early defibrillation, ALS interventions, effective post-ROSC care including careful prognostication, and support during recovery and survivorship. All of these activities require organizational infrastructures to support the education, training, equipment, supplies, and communication that enable each survival. Thus, we recognize that each of these diverse aspects of care contributes to the ultimate functional survival of the cardiac arrest victim. Resuscitation causes, processes, and outcomes are very different for OHCA and IHCA, which are reflected in their respective Chains of Survival (Figure 1). In OHCA, the care of the victim depends on community engagement and response. It is critical for community members to recognize cardiac arrest, phone 9-1-1 (or the local emergency response number), perform CPR (including, for untrained lay rescuers, compression-only CPR), and use an AED.3,4 Emergency medical personnel are then called to the scene, continue resuscitation, and transport the patient for stabilization and definitive management. In comparison, surveillance and prevention are critical aspects of IHCA. When an arrest occurs in the hospital, a strong multidisciplinary approach includes teams of medical professionals who respond, provide CPR, promptly defibrillate, begin ALS measures, and continue post-ROSC care. Outcomes from IHCA are overall superior to those from OHCA,5 likely because of reduced delays in initiation of effective resuscitation. The Adult OHCA and IHCA Chains of Survival have been updated to better highlight the evolution of systems of care and the critical role of recovery and survivorship with the addition of a new link. This Recovery link highlights the enormous recovery and survivorship journey, from the end of acute treatment for critical illness through multimodal rehabilitation (both short- and long-term), for both survivors and families after cardiac arrest. This new link acknowledges the need for the system of care to support recovery, discuss expectations, and provide plans that address treatment, surveillance, and rehabilitation for cardiac arrest survivors and their caregivers as they transition care from the hospital to home and return to role and social function. 5Sequence of Resuscitation 5.1Recognition of Cardiac Arrest Recommendations for Recognition of Cardiac Arrest COR LOE Recommendations 1 C-LD 1. If a victim is unconscious/unresponsive, with absent or abnormal breathing (ie, only gasping), the lay rescuer should assume the victim is in cardiac arrest. 1 C-LD 2. If a victim is unconscious/unresponsive, with absent or abnormal breathing (ie, only gasping), the healthcare provider should check for a pulse for no more than 10 s and, if no definite pulse is felt, should assume the victim is in cardiac arrest. Lay rescuer CPR improves survival from cardiac arrest by 2- to 3-fold.1 The benefit of providing CPR to a patient in cardiac arrest outweighs any potential risk of providing chest compressions to someone who is unconscious but not in cardiac arrest. It has been shown that the risk of injury from CPR is low in these patients.2 It has been shown previously that all rescuers may have difficulty detecting a pulse, leading to delays in CPR, or in some cases CPR not being performed at all for patients in cardiac arrest.3 Recognition of cardiac arrest by lay rescuers, therefore, is determined on the basis of level of consciousness and the respiratory effort of the victim. Recognition of cardiac arrest by healthcare providers includes a pulse check, but the importance of not prolonging efforts to detect a pulse is emphasized. Recommendation-Specific Supportive Text Agonal breathing is characterized by slow, irregular gasping respirations that are ineffective for ventilation. Agonal breathing is described by lay rescuers with a variety of terms including, abnormal breathing, snoring respirations, and gasping.4 Agonal breathing is common, reported as being present in up to 40% to 60% of victims of OHCA.5 The presence of agonal breathing is cited as a common reason for lay rescuers to misdiagnose a patient as not being in cardiac arrest.6 In patients who are unresponsive, with absent or abnormal breathing, lay rescuers should assume the patient is in cardiac arrest, call for help, and promptly initiate CPR. These 2 criteria (patient responsiveness and assessment of breathing) have been shown to rapidly identify a significant proportion of patients who are in cardiac arrest, allowing for immediate initiation of lay rescuer CPR. Further, initiation of chest compressions in patients who are unconscious but not in cardiac arrest is associated with low rates of significant adverse events.2 The adverse events noted included pain in the area of chest compressions (8.7%), bone fracture (ribs and clavicle) (1.7%), and rhabdomyolysis (0.3%), with no visceral injuries described.2 Protracted delays in CPR can occur when checking for a pulse at the outset of resuscitation efforts as well as between successive cycles of CPR. Healthcare providers often take too long to check for a pulse7,8 and have difficulty determining if a pulse is present or absent.7–9 There is no evidence, however, that checking for breathing, coughing, or movement is superior to a pulse check for detection of circulation.10 Thus, healthcare providers are directed to quickly check for a pulse and to promptly start compressions when a pulse is not definitively palpated.9,11 This topic last received formal evidence review in 2010.3 5.2Initiation of Resuscitation Recommendations for Initiation of Resuscitation: Lay Rescuer (Untrained or Trained) COR LOE Recommendations 1 B-NR 1. All lay rescuers should, at minimum, provide chest compressions for victims of cardiac arrest. 1 C-LD 2. After identifying a cardiac arrest, a lone responder should activate the emergency response system first and immediately begin CPR. 1 C-LD 3. We recommend that laypersons initiate CPR for presumed cardiac arrest, because the risk of harm to the patient is low if the patient is not in cardiac arrest. 2a C-LD 4. For lay rescuers trained in CPR using chest compressions and ventilation (rescue breaths), it is reasonable to provide ventilation (rescue breaths) in addition to chest compressions for the adult in OHCA After cardiac arrest is recognized, the Chain of Survival continues with activation of the emergency response system and initiation of CPR. The prompt initiation of CPR is perhaps the most important intervention to improve survival and neurological outcomes. Ideally, activation of the emergency response system and initiation of CPR occur simultaneously. In the current era of widespread mobile device usage and accessibility, a lone responder can activate the emergency response system simultaneously with starting CPR by dialing for help, placing the phone on speaker mode to continue communication, and immediately commencing CPR. In the rare situation when a lone rescuer must leave the victim to dial EMS, the priority should be on prompt EMS activation followed by immediate return to the victim to initiate CPR. Existing evidence suggests that the potential harm from CPR in a patient who has been incorrectly identified as having cardiac arrest is low.1 Overall, the benefits of initiation of CPR in cardiac arrest outweigh the relatively low risk of injury for patients not in cardiac arrest. The initial phases of resuscitation once cardiac arrest is recognized are similar between lay responders and healthcare providers, with early CPR representing the priority. Lay rescuers may provide chest compression– only CPR to simplify the process and encourage CPR initiation, whereas healthcare providers may provide chest compressions and ventilation (Figures 2–4). Recommendation-Specific Supportive Text CPR is the single-most important intervention for a patient in cardiac arrest, and chest compressions should be provided promptly. Chest compressions are the most critical component of CPR, and a chest compression–only approach is appropriate if lay rescuers are untrained or unwilling to provide respirations. Beginning the CPR sequence with compression.2–4 Nationwide dissemination of chest compression–only CPR for lay rescuers was associated with an increase in the incidence of survival with favorable neurological outcome after OHCAs in Japan, likely due to an increase in lay rescuers providing CPR.5 Chest compressions should be provided as soon as possible, without the need to remove the victim’s clothing first. The optimal timing of CPR initiation and emergency response system activation was evaluated by an ILCOR systematic review in 2020.1 An observational study of over 17 000 OHCA events reported similar results from either a “call-first” strategy or a “CPR-first” strategy.6 In the current era of ubiquitous mobile devices, ideally both the call to activate EMS and the initiation of CPR can occur simultaneously. Four observational studies7–10 reported outcomes from patients who were not in cardiac arrest and received CPR by lay rescuers. No serious harm from CPR was found in patients when they were later determined not to have been in cardiac arrest.1 This is in contrast to the significant risk of withholding CPR when a patient is in cardiac arrest, making the risk:benefit ratio strongly in favor of providing CPR for presumed cardiac arrest. In some observational studies, improved outcomes have been noted in victims of cardiac arrest who received conventional CPR (compressions and ventilation) compared with those who received chest compressions only.5,11,12 Other studies have reported no difference in outcomes for patients receiving conventional versus compression-only CPR.11,13–21 Given the potential benefit of conventional CPR, if lay rescuers are appropriately trained, they should be encouraged to concurrently deliver ventilation with compressions. A thorough review of the data concerning the ratio of compressions to ventilation when performing conventional CPR is discussed in Ventilation and Compression-to-Ventilation Ratio. These recommendations are supported by the 2020 ILCOR Consensus on CPR and Emergency Cardiovascular Care Science With Treatment Recommendations (CoSTR).1 Recommendations for Initiation of Resuscitation: Healthcare Provider COR LOE Recommendations 1 C-LD 1. A lone healthcare provider should commence with chest compressions rather than with ventilation. 2a C-LD 2. It is reasonable for healthcare providers to perform chest compressions and ventilation for all adult patients in cardiac arrest from either a cardiac or noncardiac cause. The 2010 Guidelines for CPR and Emergency Cardiovascular Care included a major change for trained rescuers, who were instructed to begin the CPR sequence with chest compressions rather than with breaths (circulation, airway, and breathing versus airway, breathing, and circulation) to minimize the time to initiation of chest compressions. This approach is resupported by new literature, summarized in a 2020 ILCOR systematic review (Table 2).1–4 In the recommended sequence, once chest compressions have been started, a single trained rescuer delivers rescue breaths by mouth to mask or by bag-mask device to provide oxygenation and ventilation. Manikin studies demonstrate that starting with chest compressions rather than with ventilation is associated with faster times to chest compressions,3,23 rescue breaths,4 and completion of the first CPR cycle.4 Healthcare providers are trained to deliver both compressions and ventilation. Delivery of chest compressions without assisted ventilation for prolonged periods could be less effective than conventional CPR (compressions plus ventilation) because arterial oxygen content decreases as CPR duration increases. This concern is especially pertinent in the setting of asphyxial cardiac arrest.11 Healthcare providers, with their training and understanding, can realistically tailor the sequence of subsequent rescue actions to the most likely cause of arrest. These recommendations are supported by the 2020 CoSTR for BLS.1 Table 2. Adult BLS Sequence22 Step Lay Rescuer Not Trained Lay Rescuer Trained Healthcare Provider 1 Ensure scene safety. Ensure scene safety. Ensure scene safety. 2 Check for response. Check for response. Check for response. 3 Shout for nearby help. Phone or ask someone to phone 9-1-1 (the phone or caller with the phone remains at the victim's side, with the phone on speaker mode). Shout for nearby help and activate the emergency response system (9-1-1, emergency response). If someone responds, ensure that the phone is at the side of the victim if at all possible. Shout for nearby help/activate the resuscitation team; the provider can activate the resuscitation team at this time or after checking for breathing and pulse. 4 Follow the telecommunicator’s* instructions. Check for no breathing or only gasping; if none, begin CPR with compressions. Check for no breathing or only gasping and check pulse (ideally simultaneously). Activation and retrieval of the AED/emergency equipment by the lone healthcare provider or by the second person sent by the rescuer must occur no later than immediately after the check for no normal breathing and no pulse identifies cardiac arrest. 5 Look for no breathing or only gasping, at the direction of the telecommunicator. Answer the dispatcher’s questions, and follow the telecommunicator’s instructions. Immediately begin CPR, and use the AED/ defibrillator when available 6 Follow the telecommunicator’s instructions. Send the second person to retrieve an AED, if one is available. When the second rescuer arrives, provide 2-rescuer CPR and use the AED/defibrillator. AED indicates automated external defibrillator; BLS, basic life support; and CPR, cardiopulmonary resuscitation. *Telecommunicator and dispatcher are terms often used interchangeably. 5.3Opening the Airway A patent airway is essential to facilitate proper ventilation and oxygenation. Although there is no high-quality evidence favoring one technique over another for establishment and maintenance of a patient’s airway, rescuers should be aware of the advantages and disadvantages and maintain proficiency in the skills required for each technique. Rescuers should recognize that multiple approaches may be required to establish an adequate airway. Patients should be monitored constantly to verify airway patency and adequate ventilation and oxygenation. There are no studies comparing different strategies of opening the airway in cardiac arrest patients. Much of the evidence examining the effectiveness of airway strategies comes from radiographic and cadaver studies. Recommendations for Opening the Airway COR LOE Recommendations 1 C-EO 1. A healthcare provider should use the head tilt–chin lift maneuver to open the airway of a patient when no cervical spine injury is suspected. 1 C-EO 2. The trained lay rescuer who feels confident in performing both compressions and ventilation should open the airway using a head tilt–chin lift maneuver when no cervical spine injury is suspected. 2b C-EO 3. The use of an airway adjunct (eg, oropharyngeal and/or nasopharyngeal airway) may be reasonable in unconscious (unresponsive) patients with no cough or gag reflex to facilitate delivery of ventilation with a bag-mask device. 2a C-EO 4. In the presence of known or suspected basal skull fracture or severe coagulopathy, an oral airway is preferred compared with a nasopharyngeal airway. 3: No Benefit C-LD 5. The routine use of cricoid pressure in adult cardiac arrest is not recommended and 2. The head tilt–chin lift has been shown to be effective in establishing an airway in noncardiac arrest and radiological studies.2–5 No studies have compared head tilt–chin lift with other airway maneuvers to establish an airway during cardiac arrest. Although there is no evidence examining the effectiveness of their use during cardiac arrest, oropharyngeal and nasopharyngeal airways can be used to maintain a patent airway and facilitate appropriate ventilation by preventing the tongue from occluding the airway. Incorrect placement, however, can cause an airway obstruction by displacing the tongue to the back of the oropharynx.6,7 The benefit of an oropharyngeal compared with a nasopharyngeal airway in the presence of a known or suspected basilar skull fracture or severe coagulopathy has not been assessed in clinical trials. However, an oral airway is preferred because of the risk of trauma with a nasopharyngeal airway. Multiple case reports have observed intracranial placement of nasopharyngeal airways in patients with basilar skull fractures.8,9 There is no evidence that cricoid pressure facilitates ventilation or reduces the risk of aspiration in cardiac arrest patients. There is some evidence that in non–cardiac arrest patients, cricoid pressure may protect against aspiration and gastric insufflation during bag-mask ventilation.10–13 However, cricoid pressure may also impede ventilation and the placement of a supraglottic airway (SGA) or intubation,14–20 and increase the risk of airway trauma during intubation.21 This topic last received formal evidence review in 2010.22 Healthcare providers should consider the possibility of a spinal injury before opening the airway. If a spinal injury is suspected or cannot be ruled out, providers should open the airway by using a jaw thrust instead of head tilt–chin lift.2 Maintaining a patent airway and providing adequate ventilation and oxygenation are priorities during CPR. If a jaw thrust and/or insertion of an airway adjunct are ineffective in opening the airway and allowing ventilation to occur, a head tilt–chin lift may be the only way to open the airway. In these cases, this maneuver should be used even in cases of potential spinal injury because the need to open the airway outweighs the risk of further spinal damage in the cardiac arrest patient. When spinal injury is suspected or cannot be ruled out, rescuers should maintain manual spinal motion restriction and not use immobilization devices. Manual stabilization can decrease movement of the cervical spine during patient care while allowing for proper ventilation and airway control.23,24 Spinal immobilization devices may make it more difficult to maintain airway patency25,26 and provide adequate ventilation. This topic last received formal evidence review in 2010.22 5.4Metrics for High-Quality CPR High-quality CPR is, along with defibrillation for those with shockable rhythms, the most important lifesaving intervention for a patient in cardiac arrest. The evidence for what constitutes optimal CPR continues to evolve as research emerges. A number of key components have been defined for high-quality CPR, including minimizing interruptions in chest compressions, providing compressions of adequate rate and depth, avoiding leaning on the chest between compressions, and avoiding excessive ventilation.1 However, controlled studies are relatively lacking, and observational evidence is at times conflicting. The effect of individual CPR quality metrics or interventions is difficult to evaluate because so many happen concurrently and may interact with each other in their effect. Compression rate and compression depth, for example, have both been associated with better outcomes, yet these variables have been found to be inversely correlated with each other so that improving one may worsen the other.1–3 CPR quality interventions are often applied in “bundles,” making the benefit of any one specific measure difficult to ascertain. As more and more centers and EMS systems are using feedback devices and collecting data on CPR measures such as compression depth and chest compression fraction, these data will enable ongoing updates to these recommendations. Recommendations for Positioning and Location for CPR COR LOE Recommendations 1 C-LD 1. When providing chest compressions, the rescuer should place the heel of one hand on the center (middle) of the victim’s chest (the lower half of the sternum) and the heel of the other hand on top of the first so that the hands are overlapped. 1 C-EO 2. Resuscitation should generally be conducted where the victim is found, as long as high-quality CPR can be administered safely and effectively in that location. 2a C-LD 3. It is preferred to perform CPR on a firm surface and with the victim in the supine position, when feasible. 2b C-LD 4. When the victim cannot be placed in the supine position, it may be reasonable for rescuers to provide CPR with the victim in the prone position, particularly in hospitalized patients with an advanced airway in place. A 2020 ILCOR systematic review identified 3 studies involving 57 total patients that investigated the effect of hand positioning on resuscitation process and outcomes.4 Although no difference in resuscitation outcomes was noted, 2 studies found better physiological parameters (peak arterial pressure, mean arterial pressure [MAP], end-tidal carbon dioxide [ETCO2]) when compression was performed over the lower third of the sternum compared with the middle of the sternum.5,6 A third study found no difference.7 Radiographic studies show the left ventricle is typically located inferior to the internipple line, corresponding with the lower half of the sternum.8 However, hand placement inferior to the internipple line may result in compression over the xiphoid.9 Although data from manikin studies conflict, it does not appear to matter whether the dominant or nondominant hand is placed in contact with the sternum.10,11 The primary considerations when determining if a victim needs to be moved before starting resuscitation are feasibility and safety of providing high-quality CPR in the location and position in which the victim is found. This is a separate question from the decision of if or when to transport a patient to the hospital with resuscitation ongoing. The effectiveness of CPR appears to be maximized with the victim in a supine position and the rescuer kneeling beside the victim’s chest (eg, out-of-hospital) or standing beside the bed (eg, in-hospital).12 It is thought that optimal chest compressions are best delivered with the victim on a firm surface.13,14 Manikin studies show generally acceptable thoracic compression with CPR performed on a hospital mattress. An older systematic review identified 22 case reports of CPR being performed in the prone position (21 in the operating room, 1 in the intensive care unit [ICU]), with 10/22 patients surviving.15 In a small case series of 6 patients with refractory IHCA, prone positioning with the use of a board with sandbag to compress the sternum improved hemodynamics during CPR but did not result in ROSC.16 The efficacy of CPR in the prone position is not established, but the very limited evidence suggests it may be better than providing no CPR, when a patient cannot be placed in supine position, or until this can be done safely. Recommendations 1, 2, and 3 are supported by the 2020 CoSTR for BLS.4 Recommendation 4 last received formal evidence review in 2010.17 Recommendations for Compression Fraction and Pauses COR LOE Recommendations 1 C-LD 1. In adult cardiac arrest, total preshock and postshock pauses in chest compressions should be as short as possible. 1 C-LD 2. The healthcare provider should minimize the time taken to check for a pulse (no more than 10 s) during a rhythm check, and if the rescuer does not definitely feel a pulse, chest compressions should be resumed. 2a B-R 3. When 2 or more rescuers are available, it is reasonable to switch chest compressors approximately every 2 min (or after about 5 cycles of compressions and ventilation at a ratio of 30:2) to prevent decreases in the quality of compressions. 2a B-R 4. It is reasonable to immediately resume chest compressions after shock delivery for adults in cardiac arrest in any setting. 2a C-LD 5. For adults in cardiac arrest receiving CPR without an advanced airway, it is reasonable to pause compressions to deliver 2 breaths, each given over 1 s. 2b C-LD 6. In adult cardiac arrest, it may be reasonable to perform CPR with a chest compression fraction of at least 60%. Observational evidence suggests improved outcomes with increased chest compression fraction in patients with shockable rhythms.18,19 Specifically, studies have also reported increased ROSC with shorter perishock pauses.20–22 This recommendation is based on the overall principle of minimizing interruptions to CPR and maintaining a chest compression fraction of at least 60%, which studies have reported to be associated with better outcome.18,19,23 Chest compression depth begins to decrease after 90 to 120 seconds of CPR, although compression rates do not decrease significantly over that time window.24 A randomized trial using manikins found no difference in the percentage of high-quality compressions when rotating every 1 minute compared with every 2 minutes.25 Rotating the designated chest compressor every 2 minutes is sensible because this approach maintains chest compression quality and takes advantage of when CPR would ordinarily be paused for rhythm analysis. Two RCTs enrolling more than 1000 patients did not find any increase in survival when pausing CPR to analyze rhythm after defibrillation.26,27 Observational studies show decreased ROSC when chest compressions are not resumed immediately after shock.28,29 Because chest compression fraction of at least 60% is associated with better resuscitation outcomes, compression pauses for ventilation should be as short as possible.18,19,23 A 2015 systematic review reported significant heterogeneity among studies, with some studies, but not all, reporting better rates of survival to hospital discharge associated with higher chest compression fractions.18,19,23 In 2 studies, higher chest compression fraction was associated with lower odds of survival.2,30 Compression rate and depth and cointerventions such as defibrillation, airway management, and medications, are also important and may interact with chest compression fraction. High-performing EMS systems target at least 60%, with 80% or higher being a frequent goal. Recommendations 1 and 4 are supported by the 2020 CoSTR for BLS.4 Recommendations 2, 3, 5, and 6 last received formal evidence review in 2015.31 Recommendations for Compression Depth and Rate COR LOE Recommendations 1 B-NR 1. During manual CPR, rescuers should perform chest compressions to a depth of at least 2 inches, or 5 cm, for an average adult while avoiding excessive chest compression depths (greater than 2.4 inches, or 6 cm). 2a B-NR 2. In adult victims of cardiac arrest, it is reasonable for rescuers to perform chest compressions at a rate of 100 to 120/min. 2a C-LD 3. It can be beneficial for rescuers to avoid leaning on the chest between compressions to allow complete chest wall recoil for adults in cardiac arrest. 2b C-EO 4. It may be reasonable to perform chest compressions so that chest compression and recoil/relaxation times are approximately equal. A 2020 ILCOR scoping review32 identified 12 studies, including over 12 500 patients, looking at chest compression components. Several studies found better outcomes, including survival to hospital discharge and defibrillation success, when compression depth was at least 5 cm compared with less than 4 cm.3,20,33,34 The same review32 identified 13 studies, involving 15 000 patients, that looked at compression rate. Results were somewhat inconsistent across studies, with only 3 observational studies in adults showing an association between higher compression rate and outcomes.1,35,36 The only RCT identified included 292 patients and compared a rate of 100 to a rate of 120, finding no difference in outcomes.37 There is no evidence to suggest altering the suggested compression rate of 100 to 120/min in adults. Three studies have reported that depth decreases as rate increases, highlighting the pitfalls of evaluating a single CPR quality metric in isolation.1–3 The ILCOR review32 identified 2 observational studies that provided inconsistent results on the association between chest compression release velocity and survival, with 1 study finding no association and the other finding that faster release velocity was associated with increased survival.38,39 Not allowing complete chest wall recoil has been associated with increased intrathoracic pressure and decreased coronary perfusion.40,41 CPR duty cycle refers to the proportion of time spent in compression relative to the total time of the compression plus decompression cycle. The 2010 Guidelines recommended a 50% duty cycle, in which the time spent in compression and decompression was equal, mainly on the basis of its perceived ease of being achieved in practice. Notably, in a clinical study in adults with out-of- hospital VF arrest (of whom 43% survived to hospital discharge), the mean duty cycle observed during resuscitation was 39%.42 A study in children also found the mean duty cycle was 40%, suggesting that shorter duty cycles may be the norm in clinical practice.43 Although many animal studies have observed higher blood flows and better outcomes when the duty cycle was less than 50%, the optimal duty cycle is not known. Currently, there is insufficient evidence to warrant a change from the existing recommendation, which remains a knowledge gap that requires further investigation. Recommendations 1, 2, and 3 are supported by the 2020 CoSTR for BLS.4 Recommendation 4 last received formal evidence review in 2010.44 Recommendations for CPR Feedback and Monitoring COR LOE Recommendations 2b B-R 1. It may be reasonable to use audiovisual feedback devices during CPR for real-time optimization of CPR performance. 2b C-LD 2. It may be reasonable to use physiological parameters such as arterial blood pressure or end-tidal CO2 when feasible to monitor and optimize CPR quality. A 2020 ILCOR systematic review found that most studies did not find a significant association between real-time feedback and improved patient outcomes.4 However, no studies identified significant harm, and some demonstrated clinically important improvement in survival. One recent RCT reported a 25.6% increase in survival to hospital discharge from IHCA with audio feedback on compression depth and recoil (54% versus 28.4%; P