Adult Basic and Advanced Life Support

Summary of Key Issues and Major Changes

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. Despite recent gains, less than 40% of adults receive layperson-initiated CPR, and fewer than 12% have an automated external defibrillator (AED) applied before EMS arrival. After significant improvements, survival from OHCA has plateaued since 2012.

In addition, approximately 1.2% of adults admitted to US hospitals suffer in-hospital cardiac arrest (IHCA). Outcomes from IHCA are significantly better than outcomes from OHCA, and IHCA outcomes continue to improve.

Recommendations for adult basic life support (BLS) and advanced cardiovascular life support (ACLS) are combined in the 2020 Guidelines. Major new changes include the following:

- Enhanced algorithms and visual aids provide easy-to-remember guidance for BLS and ACLS resuscitation scenarios.
- The importance of early initiation of CPR by lay rescuers has been re-emphasized.
- Previous recommendations about epinephrine administration have been reaffirmed, with emphasis on early epinephrine administration.
- Use of real-time audiovisual feedback is suggested as a means to maintain CPR quality.
- Continuously measuring arterial blood pressure and end-tidal carbon dioxide ($ETCO_2$) during ACLS resuscitation may be useful to improve CPR quality.
- On the basis of the most recent evidence, routine use of double sequential defibrillation is not recommended.
- Intravenous (IV) access is the preferred route of medication administration during ACLS resuscitation. Intraosseous (IO) access is acceptable if IV access is not available.
- Care of the patient after return of spontaneous circulation (ROSC) requires close attention to oxygenation, blood pressure control, evaluation for percutaneous coronary intervention, targeted temperature management, and multimodal neuroprognostication.
- Because recovery from cardiac arrest continues long after the initial hospitalization, patients should have formal assessment and support for their physical, cognitive, and psychosocial needs.
- After a resuscitation, debriefing for lay rescuers, EMS providers, and hospital-based healthcare workers may be beneficial to support their mental health and well-being.
- Management of cardiac arrest in pregnancy focuses on maternal resuscitation, with preparation for early perimortem cesarean delivery if necessary to save the infant and improve the chances of successful resuscitation of the mother.

Algorithms and Visual Aids

The writing group reviewed all algorithms and made focused improvements to visual training aids to ensure their utility as point-of-care tools and reflect the latest science. The major changes to algorithms and other performance aids include the following:

- A sixth link, Recovery, was added to the IHCA and OHCA Chains of Survival (Figure 3).
- The universal Adult Cardiac Arrest Algorithm was modified to emphasize the role of early epinephrine administration for patients with nonshockable rhythms (Figure 4).
- Two new Opioid-Associated Emergency Algorithms have been added for lay rescuers and trained rescuers (Figures 5 and 6).
- The Post–Cardiac Arrest Care Algorithm was updated to emphasize the need to prevent hyperoxia, hypoxemia, and hypotension (Figure 7).
- A new diagram has been added to guide and inform neuroprognostication (Figure 8).
- A new Cardiac Arrest in Pregnancy Algorithm has been added to address these special cases (Figure 9).

Despite recent gains, less than 40% of adults receive layperson-initiated CPR, and fewer than 12% have an AED applied before EMS arrival.

Figure 3. AHA Chains of Survival for adult IHCA and OHCA.

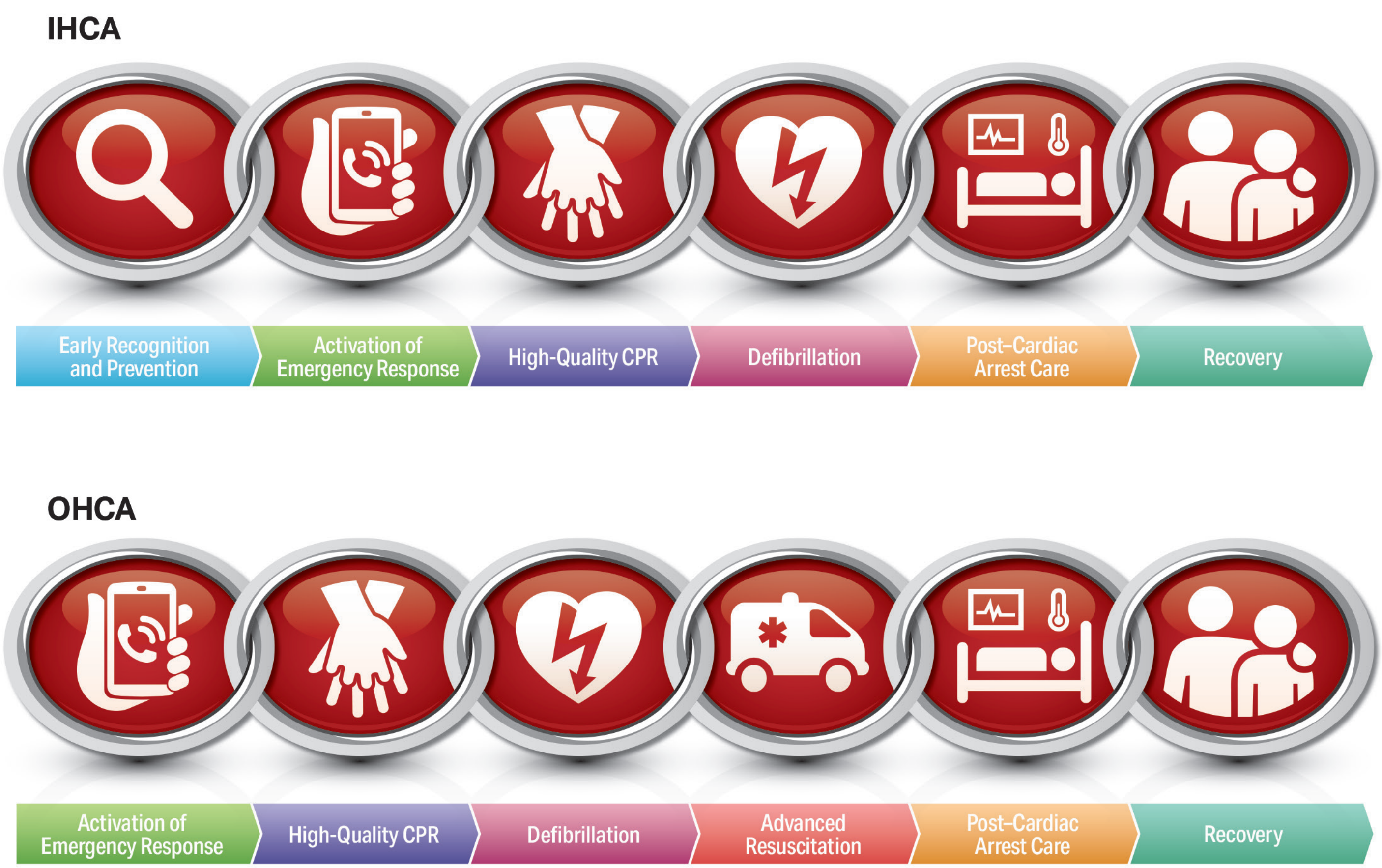
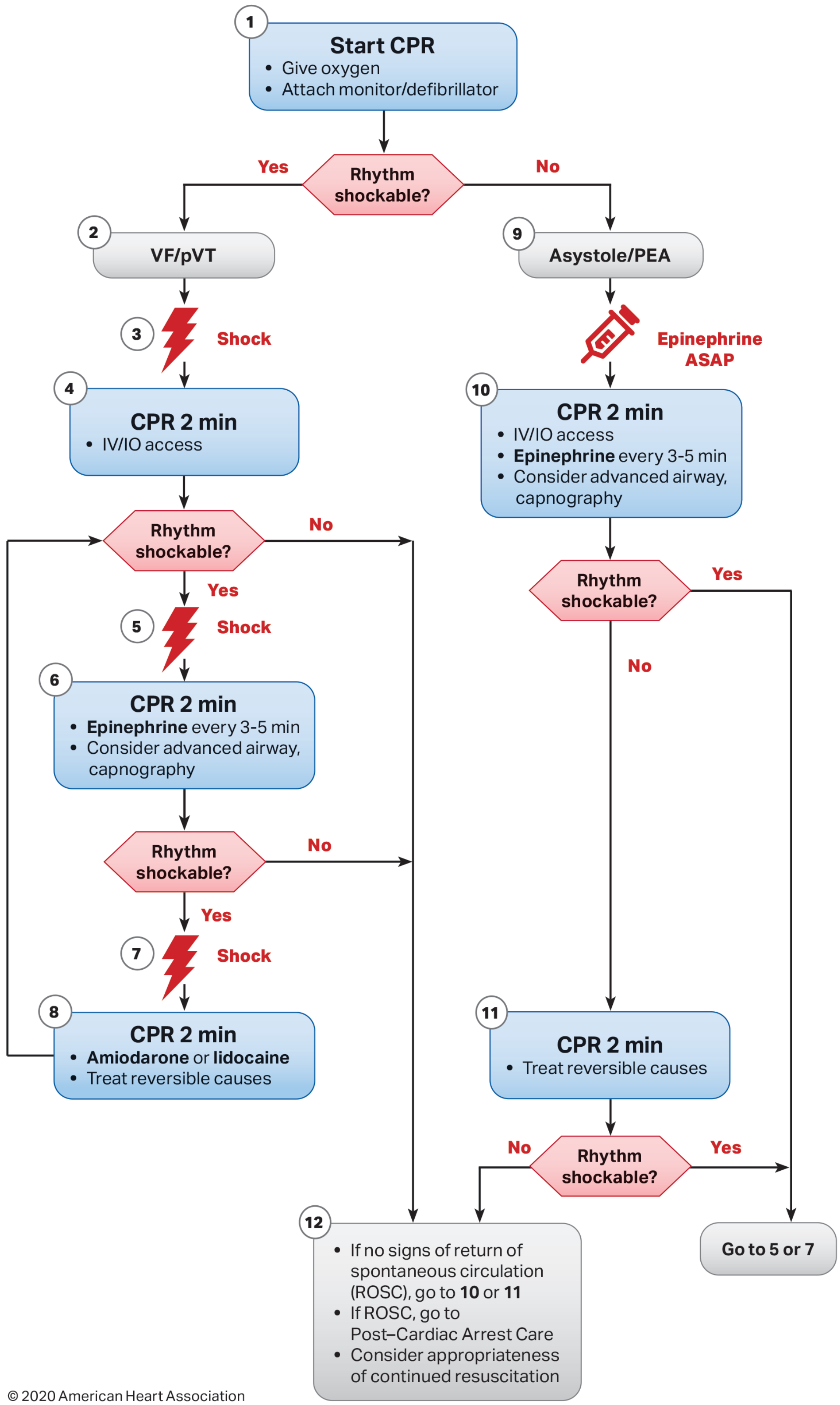


Figure 4. Adult Cardiac Arrest Algorithm.



CPR Quality

- Push hard (at least 2 inches [5 cm]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Change compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If PETCO_2 is low or decreasing, reassess CPR quality.

Shock Energy for Defibrillation

- **Biphasic**: Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic**: 360 J

Drug Therapy

- **Epinephrine IV/IO dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO dose:** First dose: 300 mg bolus. Second dose: 150 mg.
  or
  Lidocaine IV/IO dose: First dose: 1-1.5 mg/kg. Second dose: 0.5-0.75 mg/kg.

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

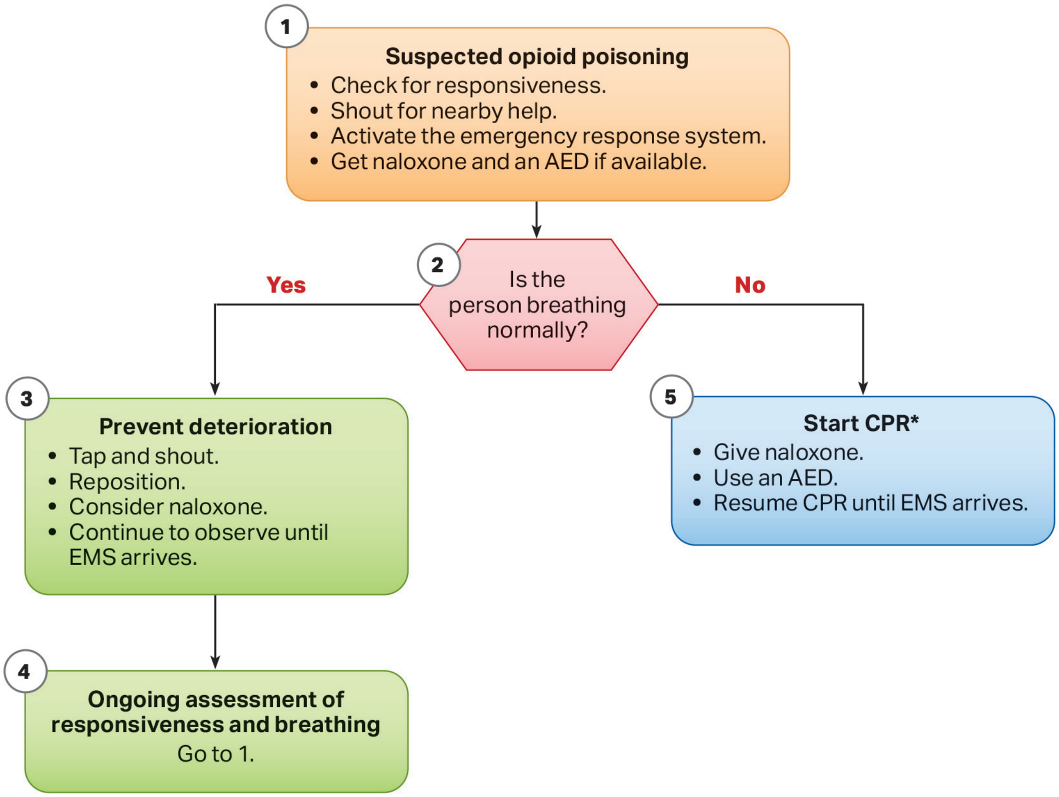
Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Abrupt sustained increase in PETCO_2 (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

Figure 5. Opioid-Associated Emergency for Lay Responders Algorithm.



*For adult and adolescent victims, responders should perform compressions and rescue breaths for opioid-associated emergencies if they are trained and perform Hands-Only CPR if not trained to perform rescue breaths. For infants and children, CPR should include compressions with rescue breaths.

Figure 6. Opioid-Associated Emergency for Healthcare Providers Algorithm.

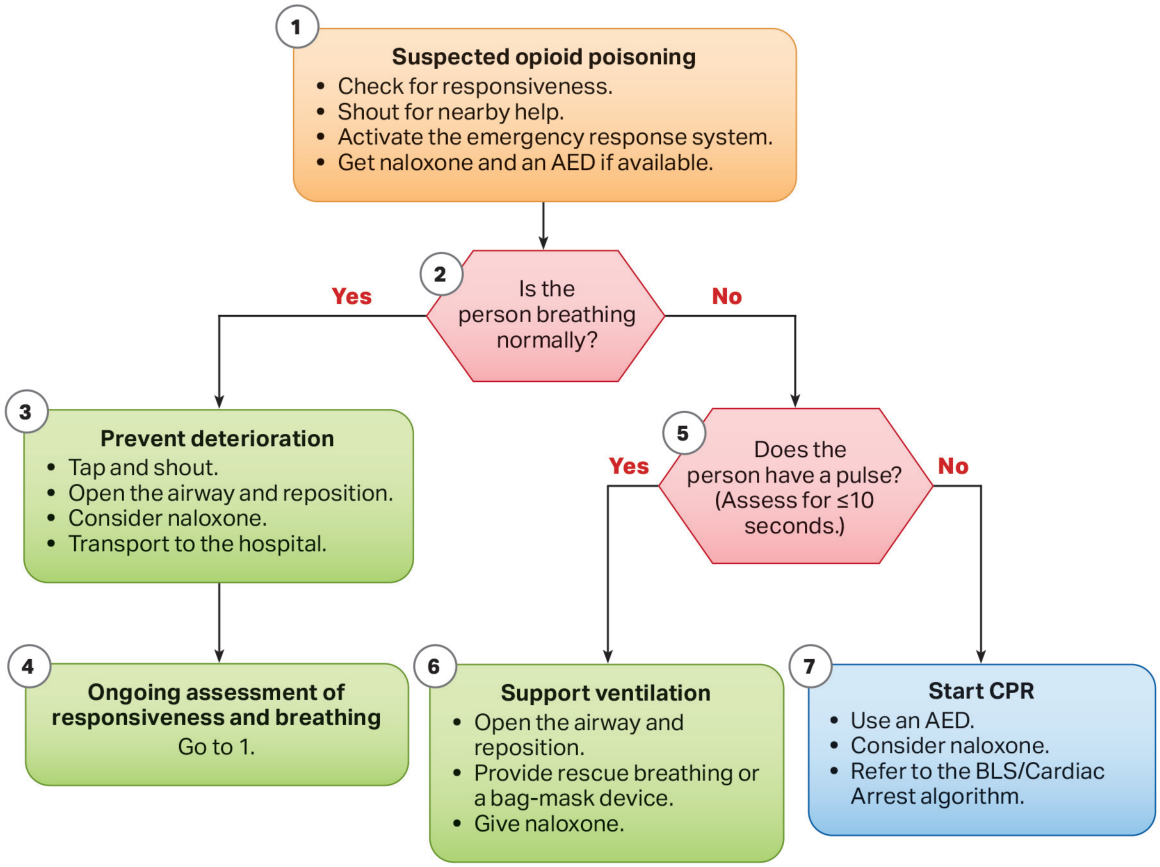
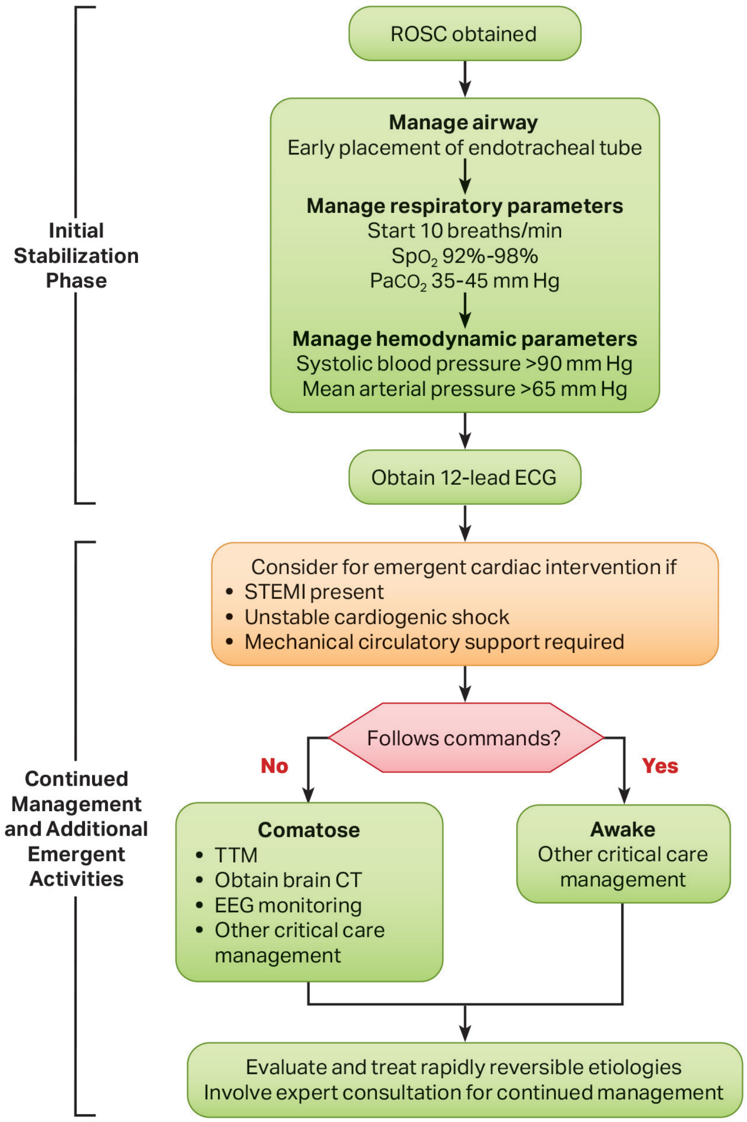


Figure 7. Adult Post–Cardiac Arrest Care Algorithm.



Initial Stabilization Phase

Resuscitation is ongoing during the post-ROSC phase, and many of these activities can occur concurrently. However, if prioritization is necessary, follow these steps:

- Airway management: Waveform capnography or capnometry to confirm and monitor endotracheal tube placement
- Manage respiratory parameters: Titrate FIO_2 for SpO_2 92%-98%; start at 10 breaths/min; titrate to $PaCO_2$ of 35-45 mm Hg
- Manage hemodynamic parameters: Administer crystalloid and/or vasopressor or inotrope for goal systolic blood pressure >90 mm Hg or mean arterial pressure >65 mm Hg

Continued Management and Additional Emergent Activities

These evaluations should be done concurrently so that decisions on targeted temperature management (TTM) receive high priority as cardiac interventions.

- Emergent cardiac intervention: Early evaluation of 12-lead electrocardiogram (ECG); consider hemodynamics for decision on cardiac intervention
- TTM: If patient is not following commands, start TTM as soon as possible; begin at 32-36°C for 24 hours by using a cooling device with feedback loop
- Other critical care management
  - Continuously monitor core temperature (esophageal, rectal, bladder)
  - Maintain normoxia, normocapnia, euglycemia
  - Provide continuous or intermittent electroencephalogram (EEG) monitoring
  - Provide lung-protective ventilation

H's and T's

Hypovolemia
Hypoxia
Hydrogen ion (acidosis)
Hypokalemia/**h**yperkalemia
Hypothermia
Tension pneumothorax
Tamponade, cardiac
Toxins
Thrombosis, pulmonary
Thrombosis, coronary

Figure 8. Recommended approach to multimodal neuroprognostication in adult patients after cardiac arrest.

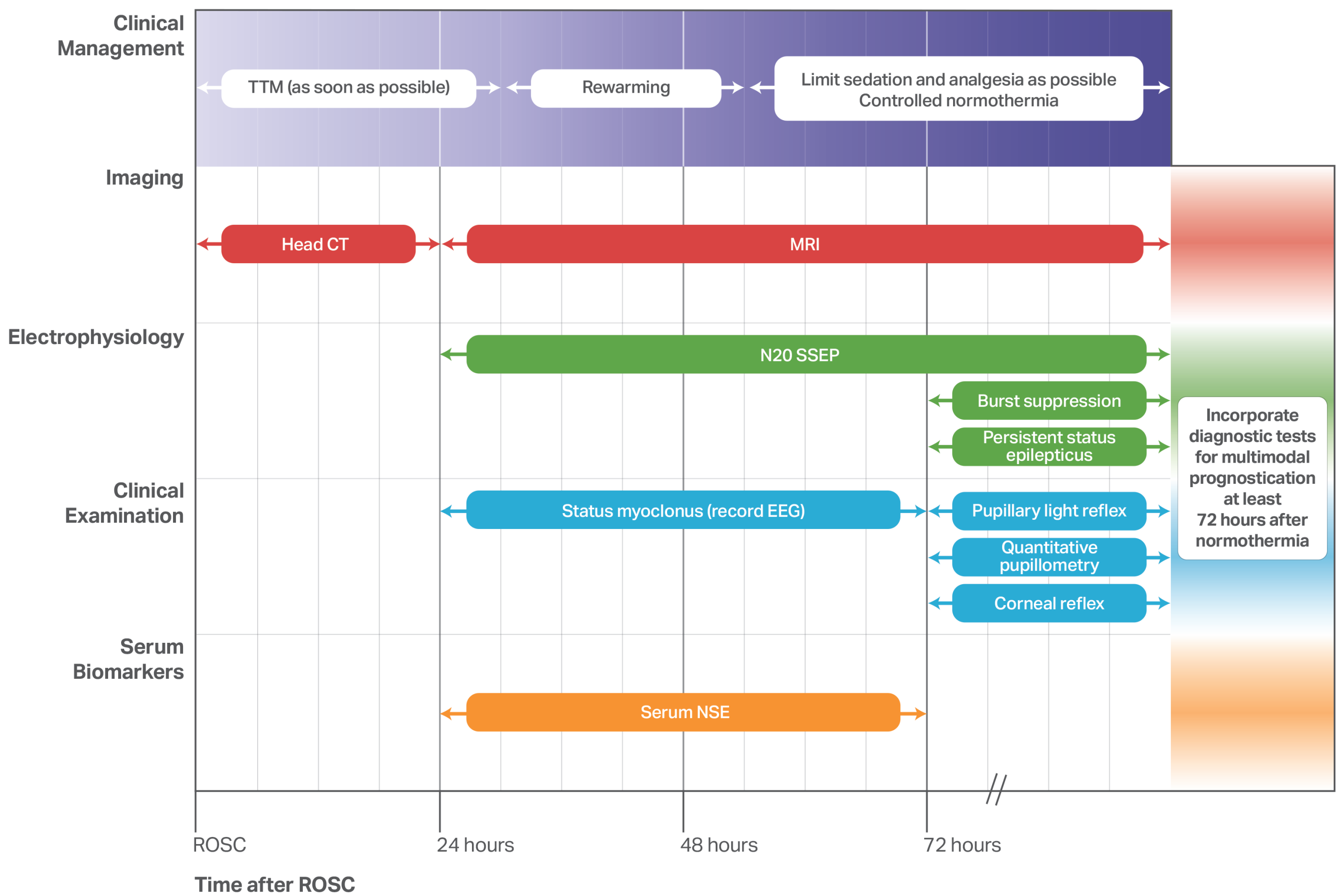
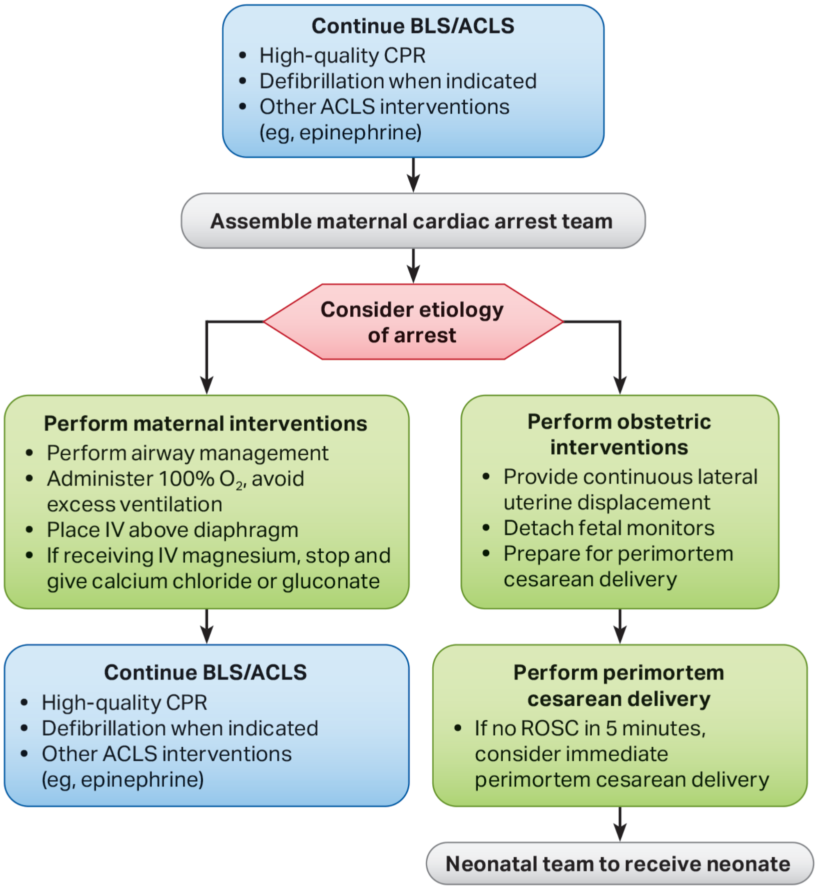


Figure 9. Cardiac Arrest in Pregnancy In-Hospital ACLS Algorithm.



Maternal Cardiac Arrest

- Team planning should be done in collaboration with the obstetric, neonatal, emergency, anesthesiology, intensive care, and cardiac arrest services.
- Priorities for pregnant women in cardiac arrest should include provision of high-quality CPR and relief of aortocaval compression with lateral uterine displacement.
- The goal of perimortem cesarean delivery is to improve maternal and fetal outcomes.
- Ideally, perform perimortem cesarean delivery in 5 minutes, depending on provider resources and skill sets.

Advanced Airway

- In pregnancy, a difficult airway is common. Use the most experienced provider.
- Provide endotracheal intubation or supraglottic advanced airway.
- Perform waveform capnography or capnometry to confirm and monitor ET tube placement.
- Once advanced airway is in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions.

Potential Etiology of Maternal Cardiac Arrest

A Anesthetic complications
B Bleeding
C Cardiovascular
D Drugs
E Embolic
F Fever
G General nonobstetric causes of cardiac arrest (H's and T's)
H Hypertension

Major New and Updated Recommendations

Early Initiation of CPR by Lay Rescuers

2020 (Updated): 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.

2010 (Old): The lay rescuer should not check for a pulse and should assume that cardiac arrest is present if an adult suddenly collapses or an unresponsive victim is not breathing normally. The healthcare provider should take no more than 10 seconds to check for a pulse and, if the rescuer does not definitely feel a pulse within that time period, the rescuer should start chest compressions.

Why: New evidence shows that the risk of harm to a victim who receives chest compressions when not in cardiac arrest is low. Lay rescuers are not able to determine with accuracy whether a victim has a pulse, and the risk of withholding CPR from a pulseless victim exceeds the harm from unneeded chest compressions.

Early Administration of Epinephrine

2020 (Unchanged/Reaffirmed): With respect to timing, for cardiac arrest with a nonshockable rhythm, it is reasonable to administer epinephrine as soon as feasible.

2020 (Unchanged/Reaffirmed): With respect to timing, for cardiac arrest with a shockable rhythm, it may be reasonable to administer epinephrine after initial defibrillation attempts have failed.

Why: The suggestion to administer epinephrine early was strengthened to a recommendation on the basis of a systematic review and meta-analysis, which included results of 2 randomized trials of epinephrine enrolling more than 8500 patients with OHCA, showing that epinephrine increased ROSC and survival. At 3 months, the time point felt to be most meaningful for neurologic recovery, there was a nonsignificant increase in survivors with both favorable and unfavorable neurologic outcome in the epinephrine group.

Of 16 observational studies on timing in the recent systematic review, all found an association between earlier epinephrine and ROSC for patients with nonshockable rhythms, although improvements in survival were not universally seen. For patients with shockable rhythm, the literature supports prioritizing defibrillation and CPR initially and giving epinephrine if initial attempts with CPR and defibrillation are not successful.

Any drug that increases the rate of ROSC and survival but is given after several minutes of downtime will likely increase both favorable and unfavorable neurologic outcome. Therefore, the most beneficial approach seems to be continuing to use a drug that has been shown to increase survival while focusing broader efforts on shortening time to drug for all patients; by doing so, more survivors will have a favorable neurologic outcome.

Real-Time Audiovisual Feedback

2020 (Unchanged/Reaffirmed): It may be reasonable to use audiovisual feedback devices during CPR for real-time optimization of CPR performance.

Why: A recent RCT reported a 25% increase in survival to hospital discharge from IHCA with audio feedback on compression depth and recoil.

Physiologic Monitoring of CPR Quality

2020 (Updated): It may be reasonable to use physiologic parameters such as arterial blood pressure or $ETCO_2$ when feasible to monitor and optimize CPR quality.

2015 (Old): Although no clinical study has examined whether titrating resuscitative efforts to physiologic parameters during CPR improves outcome, it may be reasonable to use physiologic parameters (quantitative waveform capnography, arterial relaxation diastolic pressure, arterial pressure monitoring, and central venous oxygen saturation) when feasible to monitor and optimize CPR quality, guide vasopressor therapy, and detect ROSC.

Why: Although the use of physiologic monitoring such as arterial blood pressure and $ETCO_2$ to monitor CPR quality is an established concept, new data support its inclusion in the guidelines. Data from the AHA's Get With The Guidelines®-Resuscitation registry show higher likelihood of ROSC when CPR quality is monitored using either $ETCO_2$ or diastolic blood pressure.

This monitoring depends on the presence of an endotracheal tube (ETT) or arterial line, respectively. Targeting compressions to an $ETCO_2$ value of at least 10 mm Hg, and ideally 20 mm Hg or greater, may be useful as a marker of CPR quality. An ideal target has not been identified.

Double Sequential Defibrillation Not Supported

2020 (New): The usefulness of double sequential defibrillation for refractory shockable rhythm has not been established.

Why: Double sequential defibrillation is the practice of applying near-simultaneous shocks using 2 defibrillators. Although some case reports have shown good outcomes, a 2020 ILCOR systematic review found no evidence to support double sequential defibrillation and recommended against its routine use. Existing studies are subject to multiple forms of bias, and observational studies do not show improvements in outcome.

A recent pilot RCT suggests that changing the direction of defibrillation current by repositioning the pads may be as effective as double sequential defibrillation while avoiding the risks of harm from increased energy and damage to defibrillators. On the basis of current evidence, it is not known whether double sequential defibrillation is beneficial.

IV Access Preferred Over IO

2020 (New): It is reasonable for providers to first attempt establishing IV access for drug administration in cardiac arrest.

2020 (Updated): IO access may be considered if attempts at IV access are unsuccessful or not feasible.

2010 (Old): It is reasonable for providers to establish intraosseous (IO) access if intravenous (IV) access is not readily available.

Why: A 2020 ILCOR systematic review comparing IV versus IO (principally pretibial placement) drug administration during cardiac arrest found that the IV route was associated with better clinical outcomes in 5 retrospective studies; subgroup analyses of RCTs that focused on other clinical questions found comparable outcomes when IV or IO were used for drug administration. Although IV access is preferred, for situations in which IV access is difficult, IO access is a reasonable option.

Post–Cardiac Arrest Care and Neuroprognostication

The 2020 Guidelines contain significant new clinical data about optimal care in the days after cardiac arrest. Recommendations from the *2015 AHA Guidelines Update for CPR and ECC* about treatment of hypotension, titrating oxygen to avoid both hypoxia and hyperoxia, detection and treatment of seizures, and targeted temperature management were reaffirmed with new supporting evidence.

In some cases, the LOE was upgraded to reflect the availability of new data from RCTs and high-quality observational studies, and the post–cardiac arrest care algorithm has been updated to emphasize these important components of care. To be reliable, neuroprognostication should be performed no sooner than 72 hours after return to normothermia, and prognostic decisions should be based on multiple modes of patient assessment.

The 2020 Guidelines evaluate 19 different modalities and specific findings and present the evidence for each. A new diagram presents this multimodal approach to neuroprognostication.

Care and Support During Recovery

2020 (New): We recommend that cardiac arrest survivors have multimodal rehabilitation assessment and treatment for physical, neurologic, cardiopulmonary, and cognitive impairments before discharge from the hospital.

2020 (New): We recommend that cardiac arrest survivors and their caregivers receive comprehensive, multidisciplinary discharge planning, to include medical and rehabilitative treatment recommendations and return to activity/work expectations.

2020 (New): We recommend structured assessment for anxiety, depression, posttraumatic stress, and fatigue for cardiac arrest survivors and their caregivers.

Why: The process of recovering from cardiac arrest extends long after the initial hospitalization. Support is needed during recovery to ensure optimal physical, cognitive, and emotional well-being and return to social/role functioning. This process should be initiated during the initial hospitalization and continue as long as needed. These themes are explored in greater detail in a 2020 AHA scientific statement.[6]

Debriefings for Rescuers

2020 (New): Debriefings and referral for follow up for emotional support for lay rescuers, EMS providers, and hospital-based healthcare workers after a cardiac arrest event may be beneficial.

Why: Rescuers may experience anxiety or posttraumatic stress about providing or not providing BLS. Hospital-based care providers may also experience emotional or psychological effects of caring for a patient with cardiac arrest. Team debriefings may allow a review of team performance (education, quality improvement) as well as recognition of the natural stressors associated with caring for a patient near death. An AHA scientific statement devoted to this topic is expected in early 2021.

Cardiac Arrest in Pregnancy

2020 (New): Because pregnant patients are more prone to hypoxia, oxygenation and airway management should be prioritized during resuscitation from cardiac arrest in pregnancy.

2020 (New): Because of potential interference with maternal resuscitation, fetal monitoring should not be undertaken during cardiac arrest in pregnancy.

2020 (New): We recommend targeted temperature management for pregnant women who remain comatose after resuscitation from cardiac arrest.

2020 (New): During targeted temperature management of the pregnant patient, it is recommended that the fetus be continuously monitored for bradycardia as a potential complication, and obstetric and neonatal consultation should be sought.

Why: Recommendations for managing cardiac arrest in pregnancy were reviewed in the 2015 Guidelines Update and a 2015 AHA scientific statement.[7] Airway, ventilation, and oxygenation are particularly important in the setting of pregnancy because of an increase in maternal metabolism, a decrease in functional reserve capacity due to the gravid uterus, and the risk of fetal brain injury from hypoxemia.

Evaluation of the fetal heart is not helpful during maternal cardiac arrest, and it may distract from necessary resuscitation elements. In the absence of data to the contrary, pregnant women who survive cardiac arrest should receive targeted temperature management just as any other survivors would, with consideration for the status of the fetus that may remain in utero.