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2022 Interim Guidance to Healthcare Providers for Basic and Advanced Cardiac Life Support in Adults, Children, and Neonates with Suspected or Confirmed COVID-19: From the Emergency Cardiovascular Care Committee and Get With the Guidelines®-Resuscitation Adult and Pediatric Task Forces of the American Heart Association in Collaboration with the American Academy of Pediatrics, American Association for Respiratory Care, The Society of Critical Care Anesthesiologists, and American Society of Anesthesiologists

Running Title: *Atkins et al.; 2022 Guidance for BLS/ACLS in COVID-19 Patients*

Dianne L. Atkins, MD[1]; Comilla Sasson, MD, PhD[2]; Antony Hsu, MD[3]; Khalid Aziz, MBBS, BA, MA, Med (IT)[4]; Lance B. Becker, MD[5]; Robert A. Berg, MD[6]; Farhan Bhanji, MD[7]; Steven M. Bradley, MD, MPH[8]; Steven C. Brooks, MD, MHSc[9]; Melissa Chan, MD[10]; Paul S. Chan, MD, MS[11];Adam Cheng, MD[12]; Brian M. Clemency, DO, MBA[13]; Allan de Caen, MD[14]; Jonathan P. Duff, MD, Med[14]; Dana P. Edelson, MD, MS[15]; Gustavo E. Flores, MD, NRP[16]; Susan Fuchs, MD[17]; Saket Girotra, MD, SM[1]; Carl Hinkson, MS, RRT-ACCS[18]; Benny L. Joyner, Jr., MD, MPH[19]; Beena D. Kamath-Rayne, MD, MPH[20]; Monica Kleinman, MD[21]; Peter J. Kudenchuk, MD[22]; Javier J. Lasa, MD[23]; Eric J. Lavonas, MD, MS[24]; Henry C. Lee, MD[25]; Rebecca E. Lehotzky, PhD[2]; Arielle Levy, MD, Med[26]; Mary E. McBride, MD, Med[17]; Garth Meckler MD, MSHS[10]; Raina M. Merchant, MD, MSHP[27]; Vivek K. Moitra, MD, MHA[28]; Vinay Nadkarni, MD, MS[6]; Ashish R. Panchal, MD, PhD[29]; Mary Ann Peberdy, MD[30]; Tia Raymond, MD[31]; Kathryn Roberts, MSN, RN, CCRN-K, CCNS[32]; Michael R. Sayre, MD[22]; Stephen M. Schexnayder, MD[33]; Robert M. Sutton, MD, MSCE[7]; Mark Terry, MPA[34]; Alexis Topjian, MD, MSCE[6]; Brian Walsh, PhD, RRT[35]; David S. Wang, MD[36]; Carolyn M. Zelop, MD[37]; Ryan W. Morgan, MD, MTR[6]; on behalf of the Emergency Cardiovascular Care Committee and Get With the Guidelines-Resuscitation, Adult and Pediatric Task Forces of the American Heart Association in Collaboration With the American Academy of Pediatrics, American Association for Respiratory Care, American Society of Anesthesiologists, and the Society of Critical Care Anesthesiologists

[1]Carver College of Medicine, University of Iowa, Iowa City, IA; [2]American Heart Association, Dallas, TX; [3]St Joseph Mercy Hospital, Ann Arbor, MI; [4]University of Alberta, Edmonton, Canada; [5]Donald and Barbara Zucker School of Medicine at Hofstra Northwell, Hempstead, NY; [6]The Children's Hospital of Philadelphia, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA; [7]McGill University, Montreal, QC, Canada; [8]Minneapolis Heart Institute, Healthcare Delivery Innovation Center, Minneapolis, MN; [9]Queen's University, Kingston, ON, Canada; [10]University of British Columbia, BC Children's Hospital, Vancouver, BC, Canada; [11]Mid America Heart Institute and the University of Missouri-Kansas City, Kansas City, MO; [12]Alberta Children's Hospital, University of Calgary, Calgary, AB, Canada; [13]University at Buffalo, Buffalo, NY; [14]Stollery Children's Hospital, University of Alberta, Edmonton, AB, Canada; [15]University of Chicago, Chicago, IL; [16]Emergency & Critical Care Trainings, San Juan, Puerto Rico; [17]Ann & Robert H. Lurie Children's Hospital, Chicago, IL; [18]Providence Regional Medical Center, Everett, WA; [19]University of North Carolina at Chapel

Hill, Chapel Hill, NC; [20]Global Newborn and Child Health, American Academy of Pediatrics, Itasca, IL; [21]Boston Children's Hospital, Boston, MA; [22]University of Washington, Seattle, WA [23]Texas Children's Hospital, Houston, TX; [24]Denver Health and Hospital Authority, Denver, CO [25]Stanford University, Stanford, CA; [26]Sainte-Justine Hospital University Center, University of Montreal, Montreal, QC, Canada; [27]University of Pennsylvania, Philadelphia, PA; [28]College of Physicians & Surgeons of Columbia University, New York, NY; [29]The Ohio State University Wexner Medical Center, Columbus, OH; [30]Virginia Commonwealth University, Richmond, VA [31]Medical City Children's Hospital, Dallas, TX; [32]Joe DiMaggio Children's Hospital, Hollywood, FL; [33]Arkansas Children's Hospital, Little Rock, AR; [34]National Registry of Emergency Medical Technicians, Columbus, OH; [35]Children's Hospital Colorado, Aurora, CO; [36]Columbia University Irving Medical Center, New York, NY; [37]NYU School of Medicine and The Valley Hospital, New York, NY

Address for Correspondence:
Dianne L. Atkins, MD
Division of Pediatric Cardiology
Stead Family Department of Pediatrics
Carver College of Medicine
University of Iowa
Iowa City, IA 52242
Tel: (319)331-8336
Email: dianne-atkins@uiowa.edu

Introduction

The American Heart Association, along with its collaborating organizations American Academy of Pediatrics, American Association for Respiratory Care, American Society of Anesthesiologists, and the Society of Critical Care Anesthesiologists, is committed to providing the most up-to-date evidence-based guidelines on resuscitation and supporting the healthcare providers that provide these interventions. At times, there is a need for an interim statement based on new data or, in the case of this pandemic, a rapidly changing environment. Interim guidance may arise from a scientific review of a single topic, or the need for a best-practice statement because of new or urgent public health initiatives. Based on evolving epidemiologic reports, emergence of new and more transmissible strains of the coronavirus, declining vaccine effectiveness,[1] as well as recent feedback from the healthcare provider community, it became clear that the guidance developed in the spring of 2021 and published in October 2021[2] needed to be updated to emphasize fully protecting health care providers who perform resuscitation. Our overall guiding principles and goals in providing this interim guidance are to achieve the best possible resuscitation outcomes and simultaneously ensure optimal protection for healthcare providers. Language has been clarified in this updated interim guidance to adhere to this guiding principle. Interim guidance will continue to evolve as the pandemic continues to ensure our guidance reflects the best, most up-to-date science and available evidence to guide best practices.

This guidance is based on available scientific evidence at the time of its development, recommendations from public health organizations, and expert opinion; it should be adapted locally on the basis of current disease burden and resource availability. The interim guidance is not a guidelines statement which is based on a formal evidence review. Thus, the revisions have not undergone a systematic review process and cannot be assigned a Class of Recommendation

or Level of Evidence.[3] This guidance can be considered similar to a best practice statement, . These revisions should always be adapted to changing public health recommendations and local protocols and resources.

The writing group was comprised primarily of authors from the 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care,[3] the Emergency Cardiovascular Care Committee, and the Get With the Guidelines®-Resuscitation Adult and Pediatric Task Forces. Additional writing group members were nominated by the collaborating organizations. Potential conflicts of interest are included in the Disclosures section of this manuscript.

We developed this consensus guidance through conference call of the entire author group, one-to-one and small group conferences, and group/personal email exchanges. The final documents were reviewed by a smaller group of experienced authors who had previously been first authors on AHA statements or guidelines. All authors and organizational liaisons participated in each step of the submission, revision, and final review process. The discussions were centered on healthcare provider protection, reducing provider risk, and appropriate use of personal protective equipment (PPE). The remainder of the 2021 Interim Guidance is included in this document for the convenience of the reader, to have the most current guidance in one document.[2]

The changes in the interim guidance are focused on these three tenets:

1. **Incorporating the most recent Center for Disease Control and Prevention (CDC) and World Health Organization (WHO) guidance:** All healthcare providers should wear a respirator (e.g., N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection, when performing aerosol-generating

procedures (AGP)s or in a setting where AGPs are regularly performed.[4,5] The definition of suspected cases should be consistent with the most current definitions from relevant public health officials as well as local standards and protocols. This includes donning appropriate PPE (including respirator) before performing the components of resuscitation that are aerosol generating, which include but are not limited to: chest compressions, defibrillation, bag-mask ventilation, intubation and positive-pressure ventilation. In the event initial responders are not already wearing appropriate PPE, they should immediately don it and then begin CPR. As PPE recommendations change, healthcare providers should continue to follow the most-up-to-date recommendations from the WHO, CDC and regional health authorities and local institutions.

2. **Reinforce resuscitation best practices:** Cardiac arrest survival rates have decreased dramatically during the COVID-19 pandemic.[6] OHCA survival in 2020 also declined in regions/time frames that did and did not have significant COVID infection rates. The reasons for this decline are both unclear and complex. Cardiac arrest survival is dependent on early initiation of CPR and we continue to recommend chest compressions as soon as is safely possible. We believe patients with confirmed or suspected COVID-19 should receive the best resuscitative efforts possible[7] and we are committed to both the training of healthcare providers, and rigorous evaluation of the evidence to ensure our CPR and First Aid guidelines support best practices.
3. **Ensure adequate PPE supply:** At this time, all healthcare providers should be following appropriate precautions and should have access to PPE in all clinical settings, regardless of the potential of encountering resuscitation events**.** Effective use of PPE is critical for the safety of healthcare providers performing resuscitations. Healthcare organizations

should continue to secure appropriate PPE as available, ensure training regarding appropriate application and use of PPE, reinforce effective use of PPE, and create systems so that health care providers have immediate access to appropriate PPE when emergency care is required.

International data early during the COVID-19 pandemic described worse survival outcomes for both out-of-hospital and in-hospital cardiac arrests compared to prior years.[6, 7, 8, 9, 10] This worsening of outcomes may have been multifactorial; the severity of SARS-CoV-2 related cardiac arrest, the implementation of termination of resuscitation guidance, local crisis standards of care or patient hesitancy to seek medical care contributing to delays in care.[11] The provision of prompt chest compressions and defibrillation may also have been delayed due to the additional time required in donning PPE or securing the airway and the PPE may have accelerated rescuer fatigue resulting in decreased CPR quality.[12, 13] Concerns that resuscitation from cardiac arrest due to COVID-19 may be futile may have led to earlier termination of resuscitative efforts and overwhelmed Emergency Medical Services (EMS) systems may have had insufficient resources to respond to increased number of calls for arrests in regions with high rates of COVID-19.[6, 14] Lastly, significant delays in presentation for medical care, such as a tripling of the time from onset of chest pain to presentation to emergency care, may have contributed to an increase in out-of-hospital cardiac arrests rates during the pandemic as compared to before the pandemic.[15]

With increased scientific knowledge, a more stable PPE supply chain and increasing availability of vaccines for healthcare providers and the general public, application of the best resuscitation science available must be once again assessed and prioritized. The following guidance should be applied to patients with suspected or confirmed COVID-19 infection (Figures 1 through 8).

REDUCE PROVIDER RISK

Rationale

Effective use of PPE is critical for the safety of healthcare providers performing resuscitations. Healthcare organizations should continue to secure appropriate PPE as available, ensure training regarding appropriate application and use of PPE, reinforce effective use of PPE, and create systems so that health care providers have immediate access to appropriate PPE when emergency care is required. Frontline healthcare providers are at significant risk for contracting respiratory illnesses due to frequent contact with symptomatic patients. Adequate PPE including N-95 masks or positive air pressure respirators, especially during AGPs, can reduce the risk of coronavirus transmission.[24] Provider risk may vary based on individual **(**age/ethnicity/comorbidities/vaccination status**)** and system factors. Healthcare providers can significantly reduce their risk of infection, especially severe illness or death, by receiving the vaccine and booster against the SARS-CoV-2 virus.[16, 17,18] The American Heart Association strongly encourages all health care providers to receive the vaccines and comply with updated recommendations for boosters.

REDUCE PROVIDER EXPOSURE *AND* PROVIDE TIMELY CARE

Rationale

The data regarding which procedures are aerosol generating are conflicting and continue to develop. CPR is considered to be aerosol-generating.[25] SARS-CoV-2 is transmitted primarily by respiratory droplets and aerosols, with little transmission by fomites.[5, 26, 27] Rapid initiation of chest compressions is critical for successful resuscitation. Healthcare providers should wear a respirator (e.g., N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection, when performing AGPs or in a setting where AGPs

are regularly performed. This includes donning appropriate PPE (including respirator) before performing the components of resuscitation that are aerosol generating, which include but are not limited to: chest compressions, defibrillation, bag-mask ventilation, intubation and positive-pressure ventilation. In the event initial responders are not already wearing appropriate PPE, they should immediately don it and then begin CPR. As PPE recommendations change, healthcare providers should continue to follow the most-up-to-date recommendations from the WHO, CDC and regional health authorities and local institutions.

The case definitions of suspected and confirmed COVID-19 have changed over time.[28] The incidence of COVID-19 disease has shifted rapidly over time with uneven geographic distribution.[29] The definition of suspected cases should be consistent with the most current definitions from relevant public health officials as well as local standards and protocols. Continuous use of an N-95 respirator and eye protection should be considered when the patient's COVID-19 status is unknown and resuscitation involves AGPs to which compressors and other personnel will be exposed.[4] This may apply to patients who initially tested negative for COVID-19 on admission to the hospital and suffer a cardiac arrest during the hospitalization. Initiate chest compressions without delay or interruption while wearing appropriate PPE. All persons not wearing appropriate PPE should be immediately excused from the room or area. Provided there is sufficient PPE, additional compressors may be required due to increased fatigue or potential for N-95 respirator slippage resulting from compressions.[30, 31, 32] The application of mechanical compression devices can reduce the number of healthcare providers required for compressions; however, these devices may not be appropriate or available for morbidly obese adults, infants, children and small adolescents or for all clinical scenarios.[33] Training and regular practice in the use and rapid application of mechanical compressions devices is required to minimize the early

no-flow time and to ensure proper application and utilization of the device.[23] Although the clinical use of mechanical devices has not demonstrated improvement in outcome compared to manual CPR, it may reduce the number of additional staff who are needed to participate in the resuscitation event.[21, 22]

As not every resuscitation space has negative pressure ventilation, closing the door may help limit contamination of adjacent indoor spaces. In out-of-hospital cardiac arrest, taking measures to better ventilate a confined space such as opening windows or doors may reduce the local concentration of aerosols for healthcare providers if this does not risk contamination of other spaces in the adjacent vicinity. In addition, some healthcare organizations may have continued shortages in PPE supply, low vaccination rates amongst staff, and personnel limitations; this guidance needs to be adapted to local protocols with consideration of current COVID-19 disease burden and resource availability.

Specific additional resuscitation strategies

Rationale

The experimental evidence evaluating the aerosol generating potential of chest compressions and defibrillation is extremely limited, conflicting, based on small human and animal studies.[34, 35,36,37] The CDC considers cardiopulmonary resuscitation and all of its components (e.g., chest compression, ventilation and defibrillation) aerosol generating. Therefore, all healthcare providers should wear appropriate PPE when performing CPR. When actively ventilating using bag-mask ventilation, a supraglottic airway or an endotracheal tube, a HEPA filter on the ventilation exhaust port can capture aerosolized particles. Endotracheal intubation should be timed with having sufficient PPE-protected personnel to perform the procedure.

SITUATION- AND SETTING-SPECIFIC CONSIDERATIONS

Below we describe several specific scenarios related to resuscitation care and their application to the COVID-19 pandemic. We provide these comments covering topics such as prone position, starting/stopping CPR, pregnancy, compression devices, and post-arrest care to give readers insight in to the complex discussion that occurred among committee members during each of the interim guidance documents of 2020 and 2021.[2,38] A comprehensive and evidenced-based review on each of these distinct scenarios is beyond the scope of this interim guidance, but additional discussion on these topics can be found in the AHA 2020 Guidelines.[23]

Pediatric and adult cardiac arrests

- In witnessed, sudden arrest, don appropriate PPE and initiate chest compressions immediately. All persons not wearing appropriate PPE should be immediately excused from the room or area.
- Ventilations, which are prioritized in pediatric arrests, are considered aerosol generating. All rescuers should wear appropriate PPE for AGPs. All persons not wearing appropriate PPE should be immediately excused from the room or area.
- Defibrillate as soon as indicated when providers are wearing appropriate PPE for AGPs.
- A HEPA filter should be securely attached to any manual or mechanical ventilation device along the exhalation port prior to all ventilation devices such as, but not limited to: bag-mask-valve, supraglottic airway devices, endotracheal tubes, and ventilator mechanical circuits. Alternatively, a low-dead space viral filter or a heat and moisture exchanging filter (HMEF) with >99.99% viral filtration efficiency may be placed between the ventilation

device and the airway. The viral filter or the HMEF should remain attached to the airway when changing ventilation devices.

- Secure placement of a supraglottic airway with HEPA filters can help maximize chest compression fraction and control aerosol generation prior to endotracheal intubation.
- Prior to intubation, ventilate with a bag-mask-HEPA filter and a tight seal using practiced 2-person technique, ideally. The second team member can help provide extra support for additional procedures such as compressions once the airway is established.
- Assign the intubator with the highest chance of first pass success using the method the intubator is most comfortable with while protected with appropriate PPE for AGPs. Intubate with a cuffed endotracheal tube to minimize aerosolization of respiratory particles.
- Consider use of video laryngoscopy if available and if the operator is experienced with this technique as this may reduce direct exposure of the intubator to respiratory aerosols. Currently, there is no evidence of a difference in transmission risk using video versus direct laryngoscopy in the setting of providers wearing appropriate PPE for AGPs.
- As in any resuscitation, maximize the chest compression fraction, pausing only to facilitate intubation if needed. Minimizing non-compression time can require team-based instruction including pulse checks, advanced airway placement, and focused ultrasound evaluation coordinated with pulse checks and other necessary interruptions.
- Avoid endotracheal administration of medications; disconnections may be a source of aerosolization due to unfiltered exhalation.

Prearrest

Closely monitor for signs and symptoms of clinical deterioration to minimize the need for emergency intubations which put patients and providers at higher risk.

- Address advanced care directives and goals of care with all patients with suspected or confirmed COVID-19 (or proxy) on hospital arrival and with any subsequent significant change in clinical status.
- If the patient is at risk for cardiac arrest, consider proactively moving the patient to a negative-pressure room/unit, if available, to minimize risk of exposure to rescuers during a resuscitation.
- Close the door, when possible, to prevent airborne contamination of adjacent indoor space. Conversely, for out-of-hospital cardiac arrests, ventilating confined spaces by opening windows or doors may help disperse aerosolized particles if this does not risk exposure of others in the vicinity and not already in an outdoor setting.

Out-of-hospital cardiac arrest

Guidance regarding EMS and lay rescuer is described in detail in other literature.[39, 40]

In-hospital cardiac arrest

Crowd control for effective direction of resuscitation by the minimum number of persons required is advised. Closing the door to the resuscitation area, when possible, may minimize airborne contamination of adjacent indoor space. Healthcare personnel should continue to wear appropriate PPE for clinical care including masks, eye protection and gloves as recommended

by the CDC and WHO.[4, 41] All persons not wearing appropriate PPE should be immediately excused from the room or area.

Patients who are intubated prior to arrest

Consider leaving the patient on a mechanical ventilator with a HEPA filter to maintain a closed circuit and to reduce aerosolization and adjust the ventilator settings to allow asynchronous ventilation with the following suggestions:

- Increase the FiO2 to 1.0
- Use either pressure or volume control ventilation and limit pressure or tidal volume to generate adequate chest rise (4-6 mL/kg ideal body weight is often targeted for adults and neonates, 5-8 mL/kg for children).
- Adjust the trigger settings to prevent the ventilator from auto triggering with chest compressions and possibly prevent hyperventilation and air trapping.
- Adjust respiratory rate to 10 breaths/min for adults, 20 to 30 breaths/min for infants and children and 30 breaths/min for neonates.
- Assess the need to adjust the positive end-expiratory pressure level to balance lung volumes and venous return.
- Adjust ventilator settings to deliver full breaths with asynchronous chest compressions.
- Ensure endotracheal tube/tracheostomy and ventilator circuit continuity to prevent unplanned airway dislodgement or tubing disconnections.

If return of spontaneous circulation is achieved, set ventilator settings as appropriate to the patients' clinical condition and treat the underlying cause of cardiac arrest.

Patients who are in prone position at the time of arrest

Anticipation and preparation are important in rotating patients to a supine position. The very limited evidence for providing CPR in the prone position suggests it may be better than not providing CPR.[23,42] For patients in the prone position with an advanced airway, it may be reasonable to provide manual compressions in the prone position until a patient can be safely transitioned to a supine position with a trained team. If deemed necessary for optimal clinical care, such as assessing endotracheal tube patency and positioning, the following steps for transitioning a patient to a supine position are suggested:

- Provide compressions with hands centered over the T7-T10 vertebral bodies.
- Arrange for sufficient, trained, PPE-protected personnel to achieve safe supination on the first attempt.
- If already intubated, ensure ventilation and vascular tubing continuity and apply the posterior defibrillator pad to the patient's back prior to rotating.
- Immediately resume CPR supine once the patient has been rotated. Confirm tubing and access lines have not been dislodged and are in working order

Additional discussion of CPR in the prone position is available in the AHA 2020 Guidelines.[23]

Post-arrest patients

Healthcare providers wearing appropriate PPE should continue to provide post cardiac arrest care per the 2020 AHA guidelines for CPR and ECC.[23, 43]

Appropriateness of starting and continuing resuscitation

Address and follow the patient's goals of care and commit to ethical and evidence-based organizational policies to guide the determination of initiation and continuing resuscitative efforts. Follow the 2020 AHA guidelines for cardiopulmonary resuscitation and emergency cardiovascular care for termination of resuscitation.[23]

Unsuccessful resuscitations with suspected and confirmed COVID-19

Inquire with the infection control officer or medical examiner if further post-mortem testing is required for epidemiological or contact tracing purposes.[44]

Maternal and Neonatal Considerations

Neonatal resuscitation

Every newborn baby should have a skilled attendant prepared to resuscitate regardless of COVID-19 status. The newborn baby is unlikely to be a source of COVID-19 transmission even when mothers have confirmed COVID-19, but maternal respiratory secretions and fluids may be a potential source of SARS-COV-2 transmission for the neonatal team and newborn.[45] When appropriate, mothers can be encouraged to wear a surgical mask during the delivery. For suspected or confirmed COVID-19 infected mothers, healthcare providers should don appropriate PPE for AGPs to decrease the risk of transmission to themselves and the baby.

- Initial steps: Routine neonatal care and the initial steps of neonatal resuscitation are unlikely to be aerosol generating; they include drying, tactile stimulation, placement into a plastic bag or wrap, assessment of heart rate, and placement of pulse oximetry and electrocardiographic leads.

- Suction: Suction of the airway after delivery should not be performed routinely for clear or meconium-stained amniotic fluid. Suctioning is an AGP and is not indicated for uncomplicated deliveries, regardless of COVID-19 status.
- Endotracheal medications: Endotracheal instillation of medications such as surfactant or epinephrine is an aerosol-generating procedure, especially via an uncuffed tube. Intravenous delivery of epinephrine via a low-lying umbilical venous catheter is the preferred route of administration during neonatal resuscitation, regardless of COVID-19 status.
- Positive pressure ventilation remains the main resuscitation strategy for newborns for apnea, ineffective breathing (gasping), and bradycardia. Chest compressions occur later in the resuscitation algorithm.
- Delayed cord clamping and skin-to-skin contact may be practiced in the setting of a suspected or confirmed COVID-19 positive mother in stable neonates provided the mother is appropriately masked.
- Until confirmed to be COVID-19 negative, suspected or confirmed COVID-19 positive mothers should practice hand and breast hygiene and wear a mask during care and feeding.
- Closed incubators: Closed incubator transfer and care (with appropriate distancing) should be used for neonatal intensive care patients when possible but incubators do not protect against aerosolized particles.

Maternal cardiac arrest

Symptomatic pregnant patients with COVID-19 are at increased risk of more severe illness compared with nonpregnant peers. Although the absolute risk for severe COVID-19 is low, data

indicate an increased risk of ICU admission, need for mechanical ventilation and ventilatory support, and death in pregnant women with symptomatic COVID-19 infection.[46]

- If return of spontaneous circulation is not achieved, complete perimortem cesarean delivery ideally within 5 minutes after time of arrest. We recommend calling multidisciplinary team members early in the resuscitation process for maternal cardiac arrest to allow time for PPE donning before they enter the resuscitation area.
- Oxygenation with intubation should be prioritized earlier in pregnant women with symptomatic COVID-19 who suffer cardiac arrest. Provide chest compressions with concurrent left lateral uterine displacement when the uterine fundus is at the level of the umbilicus or greater.

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References

1. Aydogdu MO, Rohn JL, Jafari NV, Brako F, Homer-Vanniasinkam S, Edirisinghe M. Severe Acute Respiratory Syndrome Type 2-Causing Coronavirus: Variants and Preventive Strategies. *Adv Sci (Weinh)*. Published online January 17, 2022. doi: 10.1002/advs.202104495.
2. Hsu A, Sasson C, Kudenchuk PJ, Atkins DL, Aziz K, Becker LB, Berg RA, Bhanji F, Bradley SM, Brooks SC, et al. 2021 Interim Guidance to Health Care Providers for Basic and Advanced Cardiac Life Support in Adults, Children, and Neonates With Suspected or Confirmed COVID-19. *Circ Cardiovasc Qual Outcomes*. 2021;14:e008396. doi:10.1161/circoutcomes.121.008396.
3. Merchant RM, Topjian AA, Panchal AR, Cheng A, Aziz K, Berg KM, Lavonas EJ, Magid DJ. Part 1: Executive Summary: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2020;142(16 suppl 2):S337–S357. doi:10.1161/cir.0000000000000918.

4. World Health Organization. WHO recommendations on mask use by health workers, in light of the Omicron variant of concern: WHO interim guidelines, 22 December 2021. www.who.int. Available at https://www.who.int/publications/i/item/WHO-2019-nCoV-IPC_Masks-Health_Workers-Omicron_variant-2021.1. Accessed January 6, 2022.
5. Centers for Disease Control and Prevention. Interim Infection Prevention and Control Recommendations for Healthcare Personnel During the Coronavirus Disease 2019 (COVID-19) Pandemic. Available at https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html.
6. Chan PS, Girotra S, Tang Y, Al-Araji R, Nallamothu BK, McNally B. Outcomes for Out-of-Hospital Cardiac Arrest in the United States During the Coronavirus Disease 2019 Pandemic. *JAMA Cardiology*. 2021;6:296–303.
7. Gupta K, Girotra S, Nallamothu BK, Kennedy K, Starks MA, Chan PS. Impact of the three COVID-19 surges in 2020 on in-hospital cardiac arrest survival in the United States. *Resuscitation*. 2022;170:134–140.
8. Baert V, Jaeger D, Hubert H, Lascarrou J-B, Debaty G, Chouihed T, Javaudin F. Assessment of changes in cardiopulmonary resuscitation practices and outcomes on 1005 victims of out-of-hospital cardiac arrest during the COVID-19 outbreak: registry-based study. *Scand J of Trauma Resusc Emerg Med*. 2020;28:119. doi:10.1186/s13049-020-00813-x.
9. Baldi E, Sechi GM, Mare C, Canevari F, Brancaglione A, Primi R, Palo A, Contri E, Ronchi V, Beretta G, et al. Treatment of out-of-hospital cardiac arrest in the COVID-19 era: A 100 days experience from the Lombardy region. *PLoS One*. 2020;15:e0241028.
10. Ball J, Nehme Z, Bernard S, Stub D, Stephenson M, Smith K. Collateral damage: Hidden impact of the COVID-19 pandemic on the out-of-hospital cardiac arrest system-of-care. *Resuscitation*. 2020;156:157–163.
11. Sun C, Dyer S, Salvia J, Segal L, Levi R. Worse Cardiac Arrest Outcomes During The COVID-19 Pandemic In Boston Can Be Attributed To Patient Reluctance To Seek Care. *Health Aff (Millwood)*. 2021;40:10.1377/hlthaff.
12. Miles JA, Mejia M, Rios S, Sokol SI, Langston M, Hahn S, Leiderman E, Salgunan R, Soghier I, Gulani P, et al. Characteristics and Outcomes of In-Hospital Cardiac Arrest Events During the COVID-19 Pandemic. *Circ Cardiovasc Qual Outcomes*. 2020;13: e007303. doi:10.1161/circoutcomes.120.007303.
13. Chen J, Lu K-Z, Yi B, Chen Y. Chest Compression With Personal Protective Equipment During Cardiopulmonary Resuscitation. *Medicine (Baltimore)*. 2016;95:e3262.
14. Hayek SS, Brenner SK, Azam TU, Shadid HR, Anderson E, Berlin H, Pan M, Meloche C, Feroz R, O'Hayer P, et al. In-hospital cardiac arrest in critically ill patients with covid-19: multicenter cohort study. *BMJ*. 2020;371:m3513. doi:10.1136/bmj.m3513.
15. Aldujeli A, Hamadeh A, Briedis K, Tecson KM, Rutland J, Krivickas Z, Stiklioraitis S, Briede K, Aldujeili M, Unikas R, et al. Delays in Presentation in Patients With Acute Myocardial Infarction During the COVID-19 Pandemic. *Cardiol Res*. 2020;11:386–391.
16. American Heart Association. Heart disease and stroke medical experts urge public to get COVID-19 vaccinations. American Heart Association. Available at https://newsroom.heart.org/news/heart-disease-and-stroke-medical-experts-urge-public-to-get-covid-19-vaccinations.
17. Keehner J, Horton LE, Pfeffer MA, Longhurst CA, Schooley RT, Currier JS, Abeles SR, Torriani FJ. SARS-CoV-2 Infection after Vaccination in Health Care Workers in California. *N Engl J Med*. 2021;384:1774–1775.

18. Thompson MG. Interim Estimates of Vaccine Effectiveness of BNT162b2 and mRNA-1273 COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Health Care Personnel, First Responders, and Other Essential and Frontline Workers — Eight U.S. Locations, December 2020–March 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70. doi:10.15585/mmwr.mm7013e3.
19. U.S. Food and Drug Administration. Protective Barrier Enclosures Without Negative Pressure Used During the COVID-19 Pandemic May Increase Risk to Patients and Health Care Providers - Letter to Health Care Providers. Available at https://www.fda.gov/medical-devices/letters-health-care-providers/protective-barrier-enclosures-without-negative-pressure-used-during-covid-19-pandemic-may-increase.
20. Begley JL, Lavery KE, Nickson CP, Brewster DJ. The aerosol box for intubation in coronavirus disease 2019 patients: an in-situ simulation crossover study. *Anaesthesia*. 2020;75:1014–1021.
21. Wang PL, Brooks SC. Mechanical versus manual chest compressions for cardiac arrest. *Cochrane Database Syst Rev*. 2018;8:CD007260.
22. Bhatnagar A, Khraishah H, Lee J, Hsu D, Hayes M, Joseph B, Moskowitz A. Rapid implementation of a mechanical chest compression device for in-hospital cardiac arrest during the COVID-19 pandemic. *Resuscitation*. 2020;156:4–5.
23. Panchal AR, Bartos JA, Cabañas JG, Donnino MW, Drennan IR, Hirsch KG, Kudenchuk PJ, Kurz MC, Lavonas EJ, Morley PT, et al. Part 3: Adult Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2020;142(16 suppl 2):S366–S468. doi:10.1161/cir.0000000000000916.
24. Brown A, Schwarcz L, Counts CR, Barnard LM, Yang BY, Emert JM, Latimer A, Drucker C, Lynch J, Kudenchuk PJ, et al. Risk for Acquiring Coronavirus Disease Illness among Emergency Medical Service Personnel Exposed to Aerosol-Generating Procedures. *Emerg Infect Dis*. 2021;27:2340–2348.
25. Centers for Disease Control and Prevention. Infection Control - Which procedures are considered aerosol generating procedures in healthcare settings? Available at https://www.cdc.gov/coronavirus/2019-ncov/hcp/faq.html.
26. Horoho S, Musik S, Bryant D, Brooks W, Porter IM. Questioning COVID-19 Surface Stability and Fomite Spreading in Three Aeromedical Cases: A Case Series. *Mil Med*. 2020;186:e832–e835.
27. Centers for Disease Control and Prevention. Science Brief: SARS-CoV-2 and Surface (Fomite) Transmission for Indoor Community Environments. Available at https://www.cdc.gov/coronavirus/2019-ncov/more/science-and-research/surface-transmission.html.
28. Centers for Disease Control and Prevention. Coronavirus Disease 2019 (COVID-19) | 2020 Interim Case Definition, Approved August 5, 2020. Available at https://ndc.services.cdc.gov/conditions/coronavirus-disease-2019-covid-19/.
29. Johns Hopkins University. COVID-19 Dashboard. Available at https://coronavirus.jhu.edu/map.html. Accessed January 19, 2022.
30. Tian Y, Tu X, Zhou X, Yu J, Luo S, Ma L, Liu C, Zhao Y, Jin X. Wearing a N95 mask increases rescuer's fatigue and decreases chest compression quality in simulated cardiopulmonary resuscitation. *American J Emerg Med*. 2020;44:434–438.
31. Kienbacher CL, Grafeneder J, Tscherny K, Krammel M, Fuhrmann V, Niederer M, Neudorfsky S, Herbich K, Schreiber W, Herkner H, et al. The use of personal protection

equipment does not impair the quality of cardiopulmonary resuscitation. *Resuscitation*. 2021;160:79–83.
32. Malysz M, Dabrowski M, Böttiger BW, Smereka J, Kulak K, Szarpak A, Jaguszewski M, Filipiak KJ, Ladny JR, Ruetzler K, et al. Resuscitation of the patient with suspected/confirmed COVID-19 when wearing personal protective equipment: A randomized multicenter crossover simulation trial. *Cardiol J*. 2020;27:497–506.
33. Kim HT, Kim JG, Jang YS, Kang GH, Kim W, Choi HY, Jun GS. Comparison of in-hospital use of mechanical chest compression devices for out-of-hospital cardiac arrest patients. *Medicine (Baltimore)*. 2019;98:e17881.
34. Hsu CH, Tiba MH, Boehman AL, McCracken BM, Leander DC, Francalancia SC, Pickell Z, Sanderson TH, Ward KR, Neumar RW. Aerosol generation during chest compression and defibrillation in a swine cardiac arrest model. *Resuscitation*. 2021;159:28–34.
35. Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol Generating Procedures and Risk of Transmission of Acute Respiratory Infections to Healthcare Workers: A Systematic Review. *PLoS ONE*. 2012;7:e35797.
36. McDannold R, Bobrow BJ, Chikani V, Silver A, Spaite DW, Vadeboncoeur T. Quantification of ventilation volumes produced by compressions during emergency department cardiopulmonary resuscitation. *Am J Emerg Med*. 2018;36:1640–1644.
37. Deakin CD, O'Neill JF, Tabor T. Does compression-only cardiopulmonary resuscitation generate adequate passive ventilation during cardiac arrest? *Resuscitation*. 2007;75:53–59.
38. Edelson DP, Sasson C, Chan PS, Atkins DL, Aziz K, Becker LB, Berg RA, Bradley SM, Brooks SC, Cheng A, Escobedo M, Flores GE, Girotra S, Hsu A, Kamath-Rayne BD, Lee HC, Lehotsky RE, Mancini ME, Merchant RM, Nadkarni VM, Panchal AR, Peberdy MAR, Raymond TT, Walsh B, Wang DS, Zelop CM, Topjian AA; American Heart Association ECC Interim COVID Guidance Authors. Interim Guidance for Basic and Advanced Life Support in Adults, Children, and Neonates With Suspected or Confirmed COVID-19: From the Emergency Cardiovascular Care Committee and Get With The Guidelines-Resuscitation Adult and Pediatric Task Forces of the American Heart Association. Circulation. 2020 Jun 23;141(25):e933-e943. doi: 10.1161/CIRCULATIONAHA.120.047463. Epub 2020 Apr 9. PMID: 32270695; PMCID: PMC7302067.
39. Sayre MR, Barnard LM, Counts CR, Drucker CJ, Kudenchuk PJ, Rea TD, Eisenberg MS. Prevalence of COVID-19 in Out-of-Hospital Cardiac Arrest: Implications for Bystander CPR. *Circulation*. 2020;142:507–509.
40. Goodloe JM, Topjian A, Hsu A, Dunne R, Panchal AR, Levy M, McEvoy M, Vaillancourt C, Cabanas JG, Eisenberg MS, et al. Interim Guidance for Emergency Medical Services Management of Out-of-Hospital Cardiac Arrest During the COVID-19 Pandemic. *Circ Cardiovasc Qual Outcomes*. 2021;14:e007666. doi:10.1161/circoutcomes.120.007666.
41. Centers for Disease Control and Prevention. Strategies for Optimizing the Supply of N95 Respirators. Available at https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirators-strategy.
42. Hsu CH, Considine J, Pawar RD, Cellini J, Schexnayder SM, Soar J, Olasveengen TM, Berg KM; Advanced Life Support, Basic Life Support, Paediatric Life Support Task Forces at the International Liaison Committee on Resuscitation ILCOR. Cardiopulmonary resuscitation and defibrillation for cardiac arrest when patients are in the prone position: A systematic review. Resusc Plus. 2021 Dec 4;8:100186. doi: 10.1016/j.resplu.2021.100186. PMID: 34934996; PMCID: PMC8654624.
43. Topjian AA, Raymond TT, Atkins D, Chan M, Duff JP, Joyner BL, Lasa JJ, Lavonas EJ,

Levy A, Mahgoub M, et al. Part 4: Pediatric Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2020;142(16 suppl 2):S469–S523. doi:10.1161/cir.0000000000000901.
44. Centers for Disease Control and Prevention. Collection and Submission of Postmortem Specimens from Deceased Persons with Confirmed or Suspected COVID-19. Available at https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-postmortem-specimens.html.
45. Vivanti AJ, Vauloup-Fellous C, Prevot S, Zupan V, Suffee C, Do Cao J, Benachi A, De Luca D. Transplacental transmission of SARS-CoV-2 infection. *Nat Commun*. 2020;11:3572.
46. Zambrano LD. Update: Characteristics of Symptomatic Women of Reproductive Age with Laboratory-Confirmed SARS-CoV-2 Infection by Pregnancy Status — United States, January 22–October 3, 2020. *MMWR Morb and Mortal Wkly Rep*. 2020;69:1641–1647. doi:10.15585/mmwr.mm6944e3.

Figure Legends

Figure 1. Summary of adjustments to cardiopulmonary resuscitation (CPR) algorithms in patients with suspected or confirmed coronavirus disease 2019 (COVID-19). HEPA=high-efficiency particulate air; PPE=personal protective equipment; AGP=aerosol generating procedure; AED=Automated External Defibrillator

Figure 2. Frequently asked questions. AGP indicates aerosol generating procedure; and COVID-19, coronavirus disease 2019.

Figure 3. Adult Basic Life Support Algorithm for Healthcare Providers for Suspected or Confirmed COVID-19

Figure 4. Adult Cardiac Arrest Algorithm for Patients With Suspected or Confirmed COVID-19 (VF/pVT/Asystole/PEA)

Figure 5. Cardiac Arrest in Pregnancy In-Hospital ACLS Algorithm for Patients With Suspected or Confirmed COVID-19

Figure 6. Pediatric Basic Life Support Algorithm for Healthcare Provider—Single Rescuer for Suspected or Confirmed COVID-19

Figure 7. Pediatric Basic Life Support Algorithm for Healthcare Providers—2 or More Rescuers for Suspected or Confirmed COVID-19

Figure 8. Pediatric Cardiac Arrest Algorithm for Patients With Suspected or Confirmed COVID-19

Figure 1.

Reduce provider risk

- Effective use of PPE is critical for the safety of healthcare providers performing resuscitations. Healthcare organizations should continue to secure appropriate PPE as available, ensure training regarding appropriate application and use of PPE, reinforce effective use of PPE, and create systems so that health care providers have immediate access to appropriate PPE when emergency care is required.
- Healthcare providers can significantly reduce their risk of infection, especially severe illness or death, by receiving the vaccine and booster against the SARS-CoV-2 virus [16,17,18]

Reduce provider exposure *and* provide timely care

- All healthcare providers should wear a respirator (e.g., N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection, when performing aerosol-generating procedures (AGP)s or in a setting where AGPs are regularly performed. CPR is considered an AGP. Suspected cases of COVID-19 are defined by most current definitions as well as local standards and protocols.
- Initiate chest compressions without delay or interruption while wearing appropriate PPE.
- All persons not wearing appropriate PPE should be immediately excused from the room or area
- Consider using mechanical CPR devices if available and personnel are already trained
- Communicate COVID-19 status of the patient to any new providers and clearly communicate expectations of appropriate PPE

Specific additional resuscitation strategies

Pediatric and adult cardiac arrest

- Defibrillate as soon as indicated if healthcare providers are wearing appropriate PPE for AGPs

- For agonal breathing, consider passive oxygenation until HEPA filtered ventilation can be provided
- Securely attach a HEPA filter to any ventilation device
- Ventilate with a bag-mask-HEPA filter with tight seal until a supraglottic or endotracheal airway is placed
- Engage the intubator with the highest chance of first pass success
- Consider use of video laryngoscopy, if available and personnel are already trained
- Maximize chest compression fraction, pausing to intubate pausing only to facilitate intubation if needed.
- Minimize endotracheal administration of medication to avoid aerosol generation
- Minimize closed ventilation circuit disconnections
- Commit to ethical and evidence-based termination of resuscitation policies

Out-of-hospital cardiac arrest

- For adults, prioritize chest compressions and defibrillation when indicated
- For pediatrics, prioritize oxygenation and HEPA filtered ventilation with chest compressions

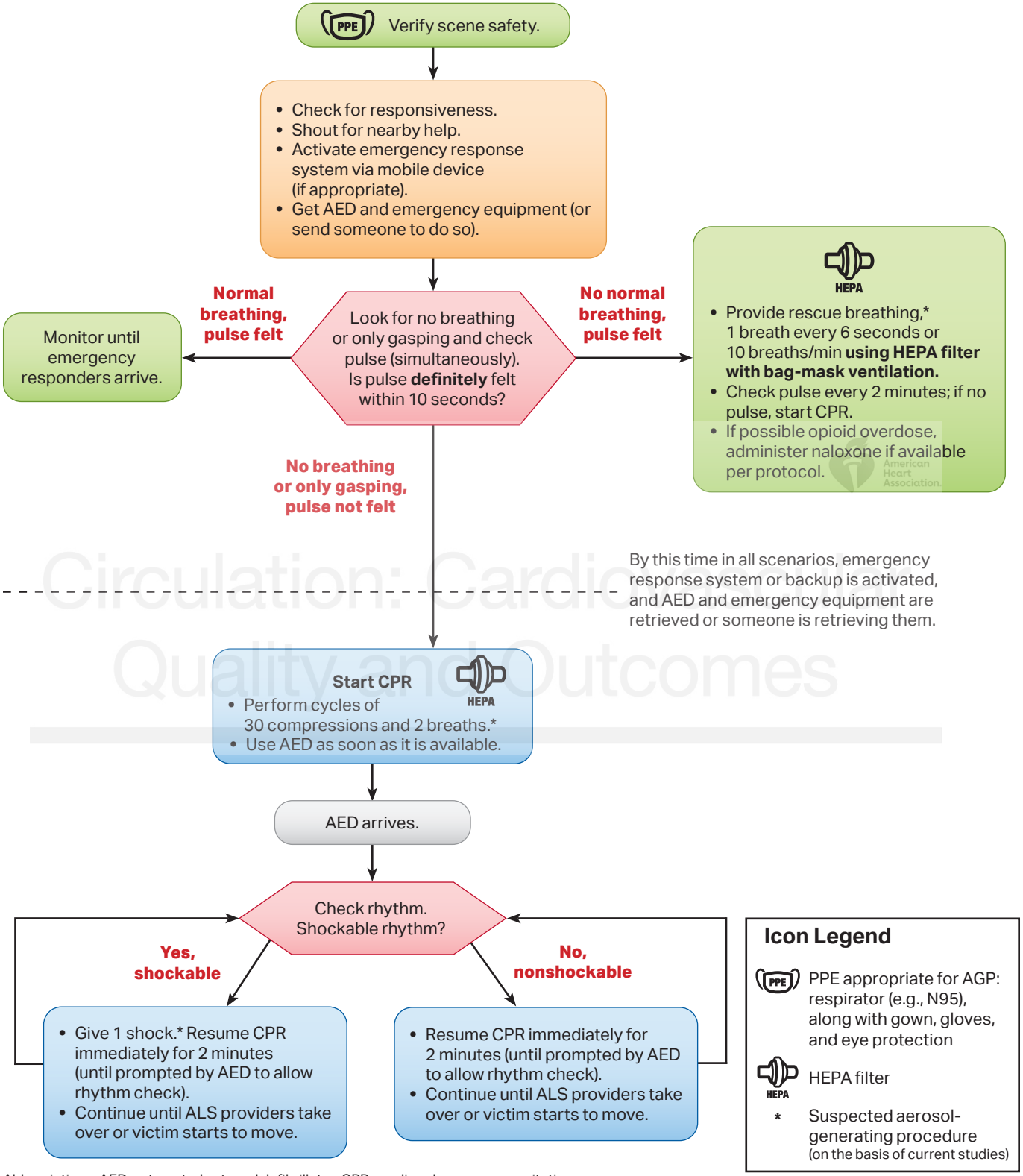
Maternal and neonatal cardiac arrest

- If return of spontaneous circulation is not achieved, complete perimortem cesarean delivery ideally within 5 minutes after time of arrest. We recommend calling multidisciplinary team members early in the resuscitation process for maternal cardiac arrest to allow time for PPE donning before they enter the resuscitation area
- Newborn babies are unlikely to be a source of SARS-CoV-2 transmission
- For newborns, bag-mask or T-piece / mask ventilation with appropriate PPE is safe
- Maternal respiratory secretions and fluids may be potential sources of SARS-CoV-2 transmission for the neonatal team and newborn

Figure 2.

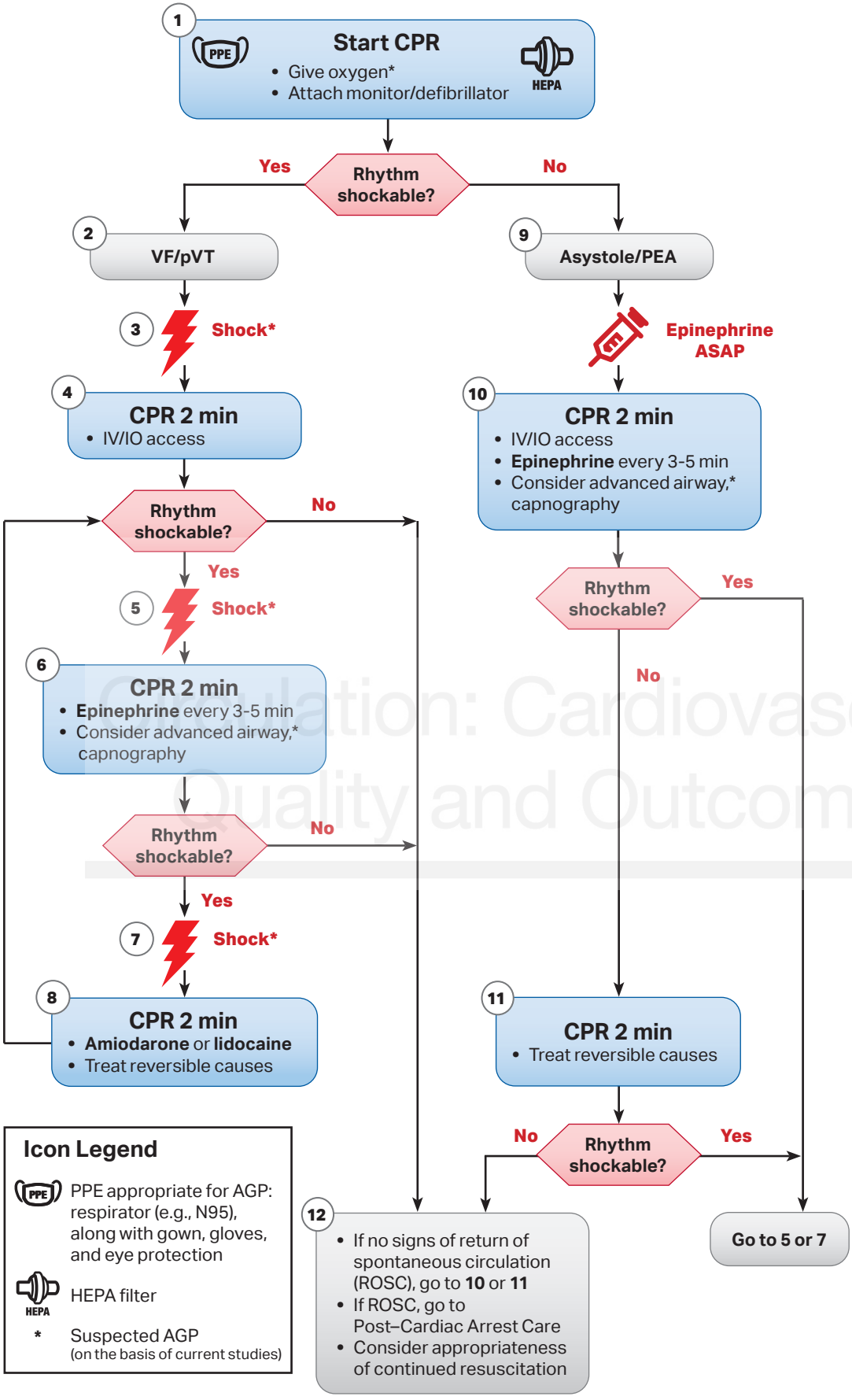
Is CPR aerosol generating?	The CDC considers cardiopulmonary resuscitation and all of its components (e.g., chest compression, ventilation and defibrillation) aerosol generating. Therefore, all healthcare providers should wear appropriate PPE when performing CPR.
Do health care providers need to don PPE for their safety?	All healthcare providers should wear a respirator (e.g., N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection, when performing AGPs or in a setting where AGPs are regularly performed.
Are 'intubation boxes' useful in controlling aerosolization?	Evidence regarding using a protective barrier enclosure around the patient's head and neck for intubations is still developing. Their use may be considered in scenarios where there is appropriate negative pressure applied and when the intubator is familiar with the technique.[19] In cardiac arrest resuscitations, logistical considerations affecting chest compressions and other critical care may limit the use of an intubation box. Unless there is intubator and institutional experience with use of an intubation box during resuscitations, there is insufficient evidence to support their use at this time. [20]
Do mechanical compression devices help during resuscitations?	For institutions that have systems in place, timely implementation of mechanical compression devices can reduce the number of personnel required for chest compressions and maintain quality compressions but are not superior to manual compressions in survival to discharge with intact neurologic function. [21,22] Additional information is available in the AHA 2020 Guidelines.[23]

Adult Basic Life Support Algorithm for Healthcare Providers for Suspected or Confirmed COVID-19



Abbreviations: AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; HEPA, high-efficiency particulate air; PPE, personal protective equipment.

Adult Cardiac Arrest Algorithm for Patients With Suspected or Confirmed COVID-19 (VF/pVT/Asystole/PEA)



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

- **Rapidly apply PPE before AGPs.**
- Provide endotracheal intubation or supraglottic advanced airway.
- **For all ventilation, use a HEPA filter.**
- 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.

Return of Spontaneous Circulation (ROSC)

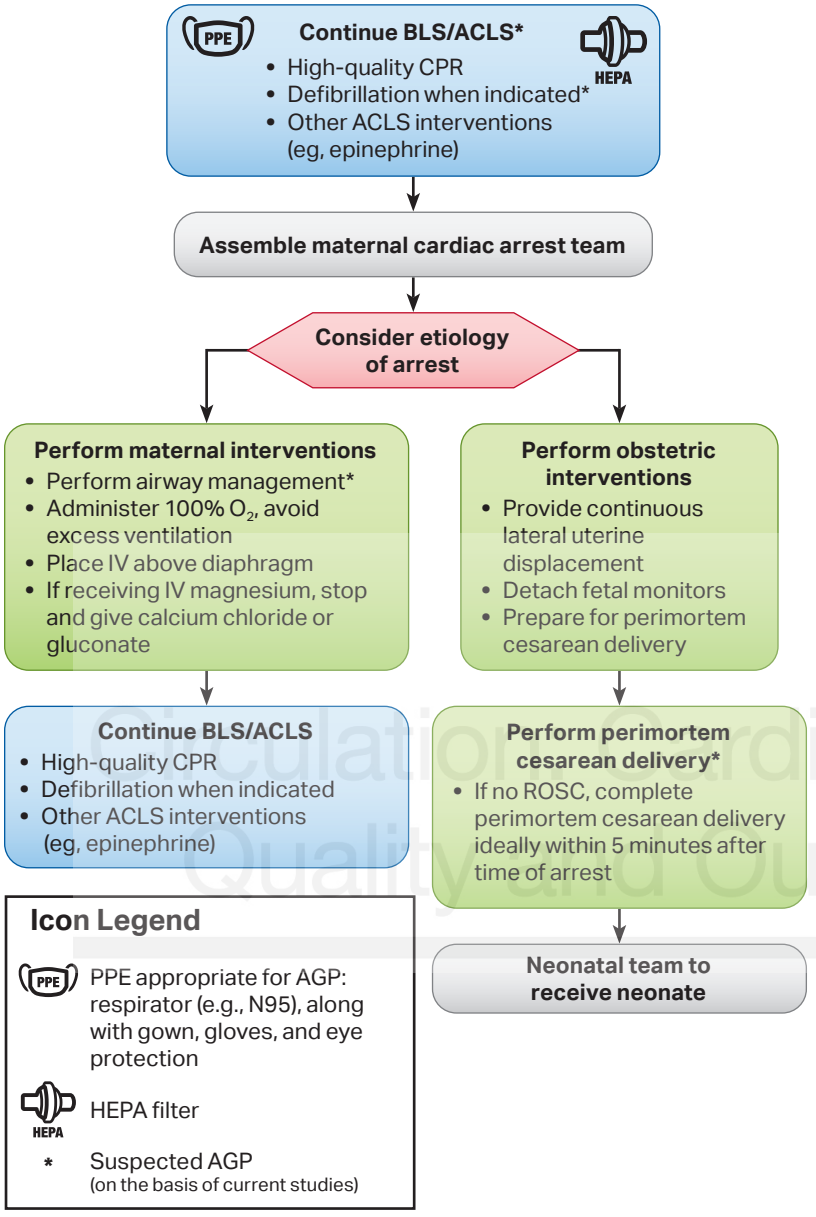
- Pulse and blood pressure
- Abrupt sustained increase in $PETCO_2$ (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

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

Abbreviations: AGP, aerosol-generating procedure; CPR, cardiopulmonary resuscitation; ET, endotracheal; HEPA, high-efficiency particulate air; IO, intraosseous; IV, intravenous; PEA, pulseless electrical activity; PPE, personal protective equipment; ROSC, return of spontaneous circulation; VF, ventricular fibrillation; pVT, pulseless ventricular tachycardia.

Cardiac Arrest in Pregnancy In-Hospital ACLS Algorithm for Patients With Suspected or Confirmed COVID-19



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

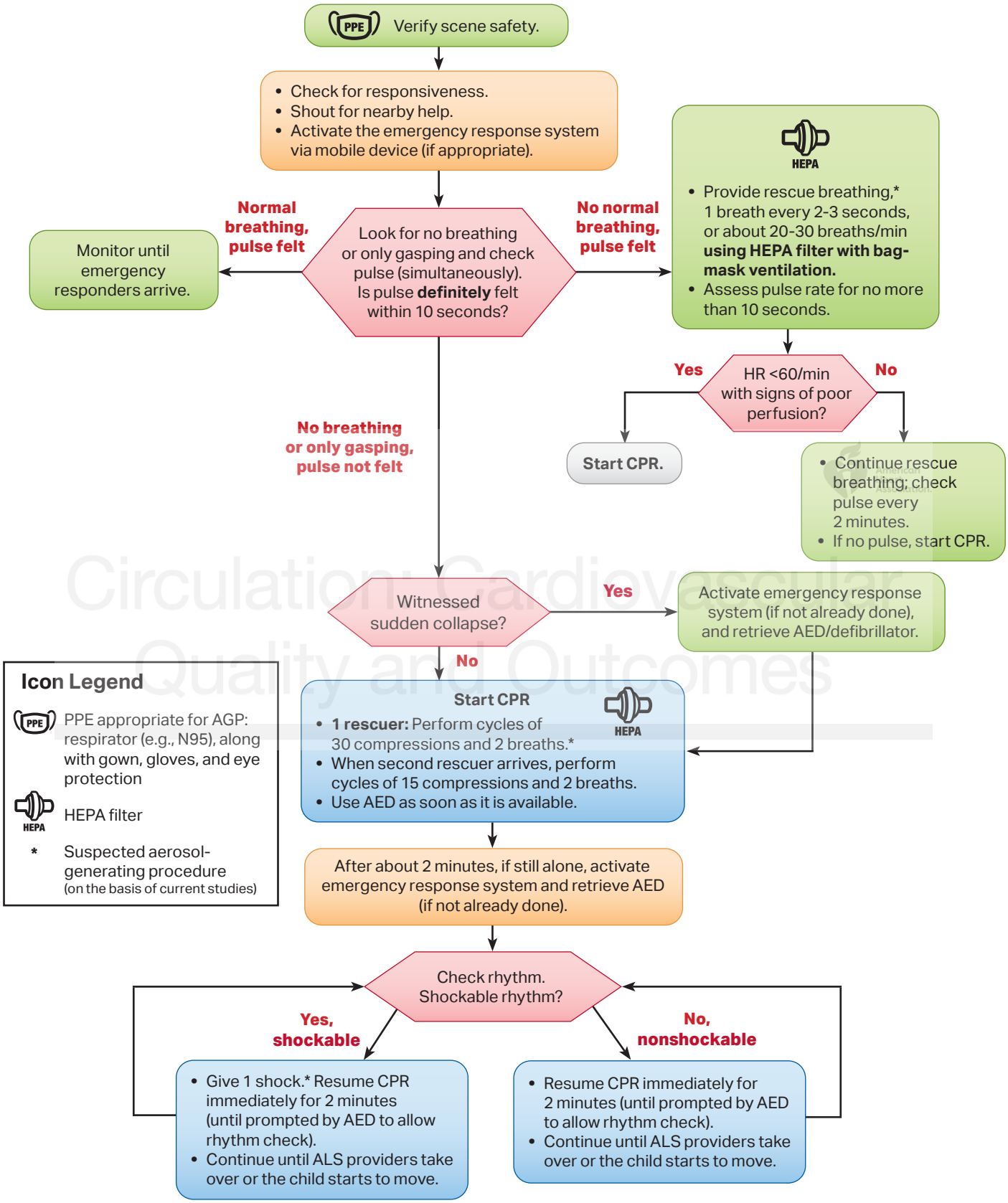
- **Rapidly apply PPE before AGPs.**
- In pregnancy, a difficult airway is common. Use the most experienced provider.
- Provide endotracheal intubation or supraglottic advanced airway.
- Perform waveform capnography or capnometry to confirm and monitor ET tube placement.
- **For all ventilation, use a HEPA filter.**
- 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

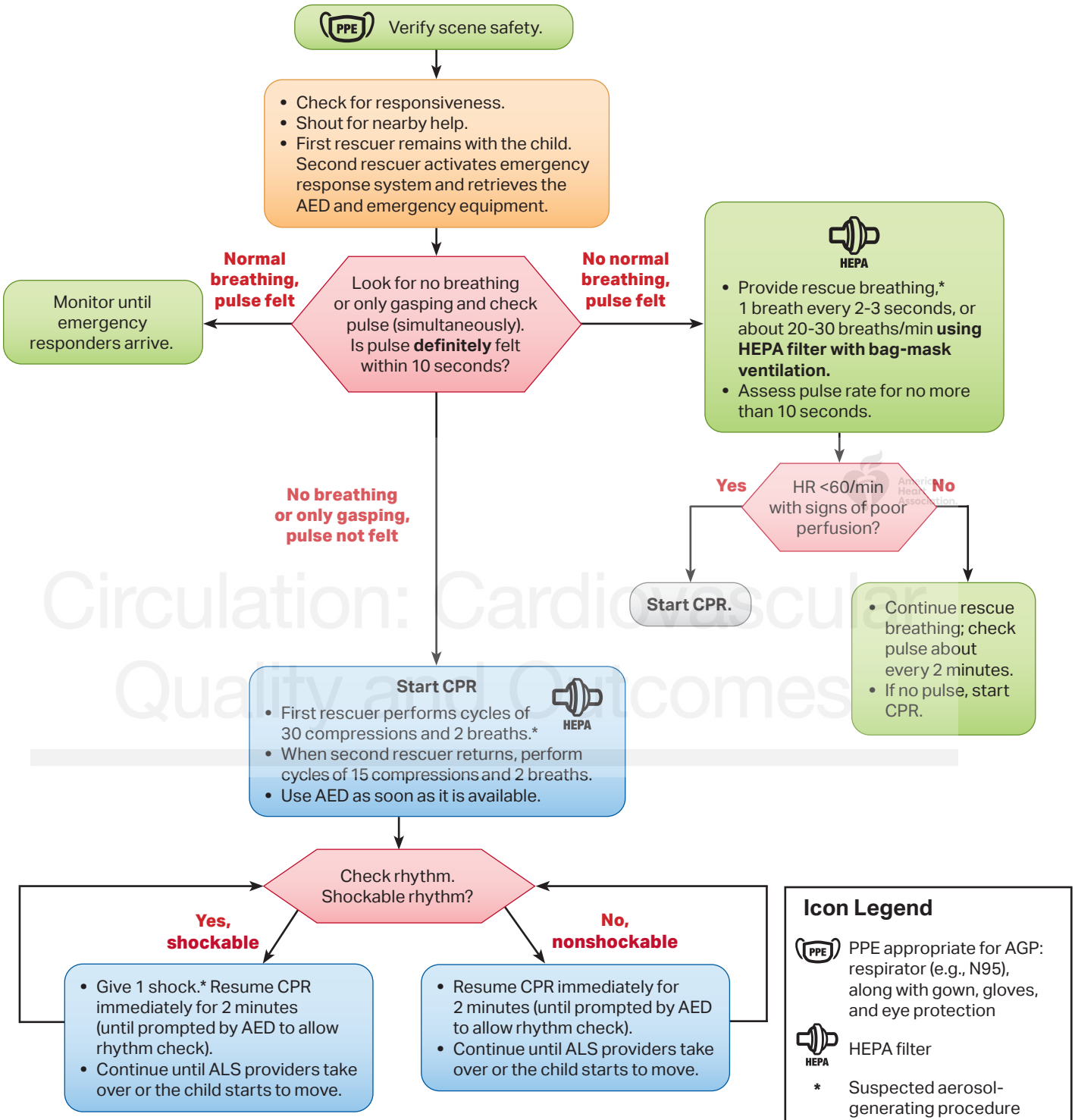
Abbreviations: ACLS, advanced cardiovascular life support; AGP, aerosol-generating procedure; BLS, basic life support; CPR, cardiopulmonary resuscitation; ET, endotracheal; HEPA, high-efficiency particulate air; IV, intravenous; PPE, personal protective equipment; ROSC, return of spontaneous circulation.

Pediatric Basic Life Support Algorithm for Healthcare Provider—Single Rescuer for Suspected or Confirmed COVID-19



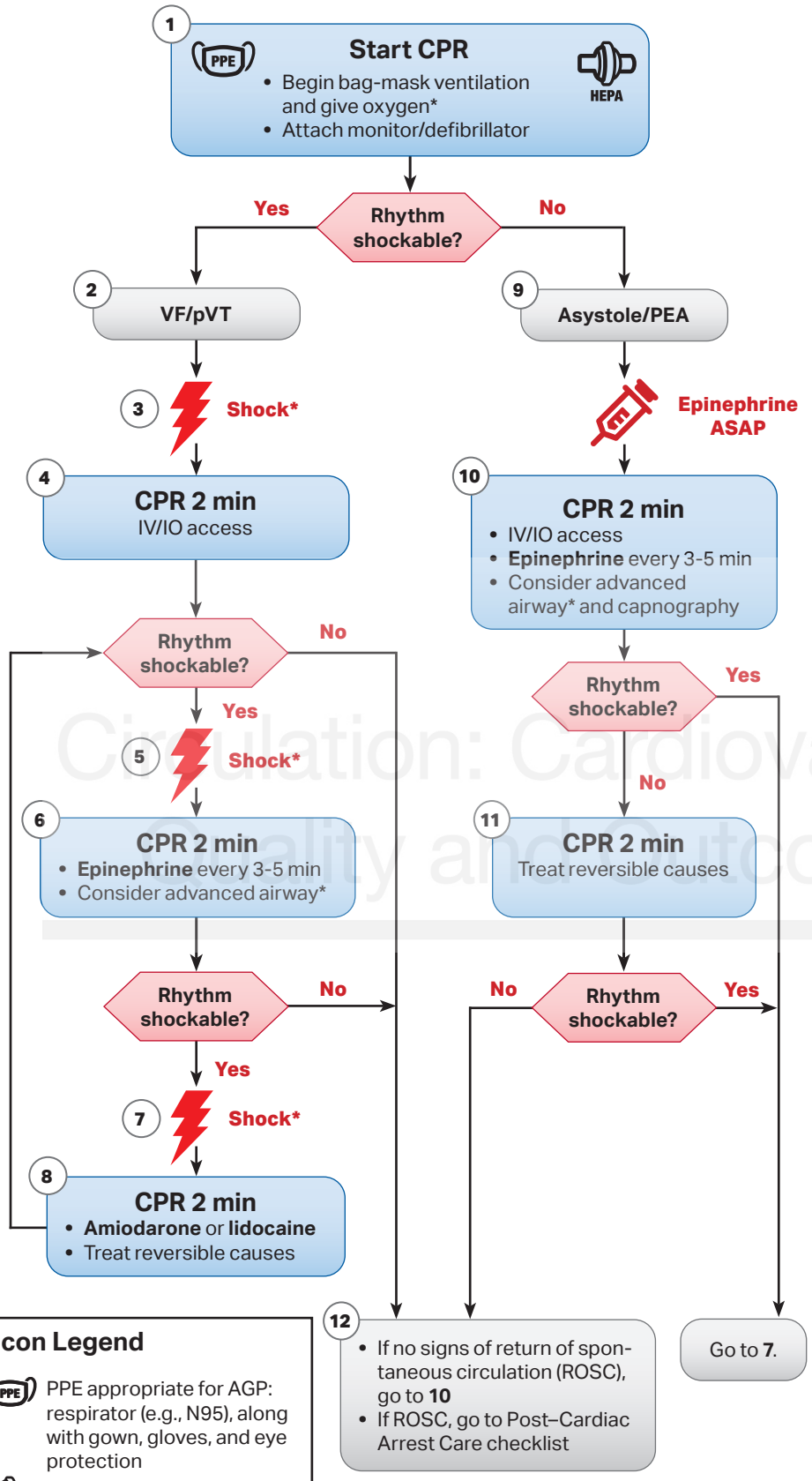
Abbreviations: AED, automated external defibrillator; ALS, advanced life support; CPR, cardiopulmonary resuscitation; HEPA, high-efficiency particulate air; HR, heart rate; PPE, personal protective equipment.

Pediatric Basic Life Support Algorithm for Healthcare Providers—2 or More Rescuers for Suspected or Confirmed COVID-19



Abbreviations: AED, automated external defibrillation; ALS, advanced life support; CPR, cardiopulmonary resuscitation; HEPA, high-efficiency particulate air; HR, heart rate; PPE, personal protective equipment.

Pediatric Cardiac Arrest Algorithm for Patients With Suspected or Confirmed COVID-19



CPR Quality

- Push hard (≥⅓ of anteroposterior diameter of chest) and fast (100-120/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Change compressor every 2 minutes, or sooner if fatigued
- If no advanced airway, 15:2 compression-ventilation ratio
- If advanced airway, provide continuous compressions and give a breath every 2-3 seconds

Shock Energy for Defibrillation

- First shock 2 J/kg
- Second shock 4 J/kg
- Subsequent shocks ≥4 J/kg, maximum 10 J/kg or adult dose

Drug Therapy

- **Epinephrine IV/IO dose:** 0.01 mg/kg (0.1 mL/kg of the 0.1 mg/mL concentration). Max dose 1 mg. Repeat every 3-5 minutes. If no IV/IO access, may give endotracheal dose: 0.1 mg/kg (0.1 mL/kg of the 1 mg/mL concentration).
- **Amiodarone IV/IO dose:** 5 mg/kg bolus during cardiac arrest. May repeat up to 3 total doses for refractory VF/pulseless VT
  or
  Lidocaine IV/IO dose: Initial: 1 mg/kg loading dose

Advanced Airway

- **Rapidly apply PPE before AGPs.**
- Provide endotracheal intubation or supraglottic advanced airway.
- Perform waveform capnography or capnometry to confirm and monitor ET tube placement.
- **For all ventilation, use a HEPA filter.**

Reversible Causes

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

Icon Legend

- PPE: PPE appropriate for AGP: respirator (e.g., N95), along with gown, gloves, and eye protection
- HEPA: HEPA filter
- *: Suspected AGP (on the basis of current studies)

Abbreviations: AGP, aerosol-generating procedure; CPR, cardiopulmonary resuscitation; ET, endotracheal; HEPA, high-efficiency particulate air; IO, intraosseous; IV, intravenous; PEA, pulseless electrical activity; PPE, personal protective equipment; ROSC, return of spontaneous circulation; VF, ventricular fibrillation; pVT, pulseless ventricular tachycardia.