

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 in Collaboration with the American Academy of Pediatrics, American Association for Respiratory Care, American College of Emergency Physicians, The Society of Critical Care Anesthesiologists, and American Society of Anesthesiologists:
Supporting Organizations: American Association of Critical Care Nurses and National EMS Physicians

Running Title: *Edelson et al.: Interim Guidance for Life Support for COVID-19*

Dana P. Edelson, MD, MS¹; Comilla Sasson, MD, PhD²; Paul S. Chan, MD, MS³; Dianne L. Atkins, MD⁴; Khalid Aziz, MBBS, BA, MA, Med (IT)⁵; Lance B. Becker, MD⁶; Robert A. Berg, MD⁷; Steven M. Bradley, MD, MPH, FAHA⁸; Steven C. Brooks, MD, MHSc⁹; Adam Cheng, MD, FRCPC, FAAP¹⁰; Marilyn Escobedo, MD¹¹; Gustavo E. Flores, MD, NRP¹²; Saket Girotra, MD, SM⁴; Antony Hsu, MD¹³; Beena D. Kamath-Rayne, MD, MPH¹⁴; Henry C. Lee, MD¹⁵; Rebecca E. Lehotsky, PhD²; Mary E. Mancini, RN, PhD, NE-BC¹⁶; Raina M. Merchant, MD, MSHP¹⁷; Vinay M. Nadkarni, MD, MS⁷; Ashish R. Panchal, MD, PhD¹⁸; Mary Ann R. Peberdy, MD¹⁹; Tia T. Raymond, MD²⁰; Brian Walsh, PhD, RRT²¹; David S. Wang, MD²²; Carolyn M. Zelop, MD²³; Alexis Topjian, MD, MSCE⁷

¹University of Chicago, Chicago, IL; ²American Heart Association, Dallas, TX; ³Mid America Heart Institute and the University of Missouri-Kansas City, Kansas City, MO; ⁴Carver College of Medicine, University of Iowa, Iowa City, IA; ⁵University of Alberta, Edmonton, Alberta, Canada; ⁶Donald and Barbara Zucker School of Medicine at Hofstra Northwell, Hempstead, NY; ⁷The Children's Hospital of Philadelphia, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA; ⁸Minneapolis Heart Institute, Healthcare Delivery Innovation Center, Minneapolis, MN; ⁹Queen's University, Kingston, Ontario, Canada; ¹⁰Alberta Children's Hospital, University of Calgary, Calgary, Alberta, Canada; ¹¹University of Oklahoma, Norman, OK; ¹²Emergency & Critical Care Trainings, San Juan, Puerto Rico; ¹³St Joseph Mercy, Ann Arbor, MI; ¹⁴Global Newborn and Child Health American Academy of Pediatrics, Itasca, IL; ¹⁵Stanford University, Stanford, CA; ¹⁶The University of Texas at Arlington, Arlington, TX; ¹⁷University of Pennsylvania, Philadelphia, PA; ¹⁸The Ohio State University Wexner Medical Center, Columbus, OH; ¹⁹Virginia Commonwealth University, Richmond, VA; ²⁰Medical City Children's Hospital, Dallas, TX; ²¹Liberty University, Lynchburg, VA; ²²Columbia University Irving Medical Center, New York, NY; ²³NYU School of Medicine, New York, NY

Address for Correspondence:

Comilla Sasson, MD, PhD
 12401 E. 17th Ave., B215, Leprino Building
 Dallas, TX 80045
 Tel: 847-502-2341
 Email: Comilla.sasson@heart.org

Background

Existing American Heart Association (AHA) cardiopulmonary resuscitation (CPR) guidelines do not address the challenges of providing resuscitation in the setting of the COVID-19 global pandemic, wherein rescuers must continuously balance the immediate needs of the victims with their own safety. To address this gap, the AHA, in collaboration with the American Academy of Pediatrics, American Association for Respiratory Care, American College of Emergency Physicians, The Society of Critical Care Anesthesiologists, and American Society of Anesthesiologists, and with the support of the American Association of Critical Care Nurses and National EMS Physicians, has compiled interim guidance to help rescuers treat victims of cardiac arrest with suspected or confirmed COVID-19.

Over the last 2 decades, there has been a steady improvement in cardiac arrest survival occurring both inside and outside of the hospital.¹ That success has relied on initiating proven resuscitation interventions, such as high-quality chest compressions and defibrillation, within seconds to minutes. The evolving and expanding outbreak of SARS-CoV2 infections has created important challenges to such resuscitation efforts and requires potential modifications of established processes and practices. The challenge is to ensure that patients with or without COVID-19 who experience cardiac arrest get the best possible chance of survival without compromising the safety of rescuers, who will be needed to care for future patients. Complicating the emergent response to both out-of-hospital and in-hospital cardiac arrest is that COVID-19 is highly transmissible, particularly during resuscitation, and carries a high morbidity and mortality.

Approximately 12%-19% of COVID-positive patients require hospital admission and 3%-6% become critically ill.²⁻⁴ Hypoxemic respiratory failure secondary to acute respiratory distress syndrome (ARDS), myocardial injury, ventricular arrhythmias, and shock are common among critically ill patients and predispose them to cardiac arrest,⁵⁻⁸ as do some of the proposed treatments, such as hydroxychloroquine and azithromycin, which can prolong the QT.⁹ With infections currently growing exponentially in the United States and internationally, the percentage of cardiac arrests with COVID-19 is likely to increase.

Healthcare workers are already the highest risk profession for contracting the disease.¹⁰ This risk is compounded by worldwide shortages of personal protective equipment (PPE). Resuscitations carry added risk to healthcare workers for many reasons. First, the administration of CPR involves performing numerous aerosol-generating procedures, including chest compressions, positive pressure ventilation, and establishment of an advanced airway. During those procedures, viral particles can remain suspended in the air with a half-life of approximately 1 hour and be inhaled by those nearby.¹¹ Second, resuscitation efforts require numerous providers to work in close proximity to one another and the patient. Finally, these are high-stress emergent events in which the immediate needs of the patient requiring resuscitation may result in lapses in infection-control practices.

In arriving at this interim guidance, we reviewed existing AHA CPR recommendations in the context of the COVID-19 pandemic and considered the unique pathophysiology of COVID-19 with reversal of hypoxemia as a central goal. We sought to balance the competing interests of providing timely and high-quality resuscitation to patients while simultaneously protecting

rescuers. This statement applies to all adult, pediatric, and neonatal resuscitations in patients with suspected or confirmed COVID-19 infection unless otherwise noted. The guidance contained herein is based on expert opinion and needs to be adapted locally based on current disease burden and resource availability.

General Principles for Resuscitation in Suspected and Confirmed COVID-19 Patients

Reduce provider exposure to COVID-19

- **Rationale:** It is essential that providers protect themselves and their colleagues from unnecessary exposure. Exposed providers who contract COVID-19 further decrease the already strained workforce available to respond and have the potential to add additional strain if they become critically ill.
- **Strategies:**
 1. Before entering the scene, all rescuers should don PPE to guard against contact with both airborne and droplet particles. Consult individual health or emergency medical services (EMS) system standards as PPE recommendations may vary considerably on the basis of current epidemiologic data and availability.
 2. Limit personnel in the room or on the scene to only those essential for patient care.
 3. In settings with protocols and expertise in place for their use, consider replacing manual chest compressions with mechanical CPR devices to reduce the number of rescuers required for adults and adolescents who meet the manufacturers height and weight criteria.
 4. Clearly communicate COVID-19 status to any new providers before their arrival on the scene or receipt of the patient when transferring to a second setting.

Prioritize oxygenation and ventilation strategies with lower aerosolization risk.

- **Rationale:** While the procedure of intubation carries a high risk of aerosolization, if the patient is intubated with a cuffed endotracheal tube and connected to a ventilator with a high-efficiency particulate air (HEPA) filter in the path of exhaled gas and an in-line suction catheter, the resulting closed circuit carries a lower risk of aerosolization than any other form of positive-pressure ventilation.¹²
- **Strategies:**
 5. Attach a HEPA filter securely, if available, to any manual or mechanical ventilation device in the path of exhaled gas before administering any breaths.
 6. After healthcare providers assess the rhythm and defibrillate any ventricular arrhythmias, patients in cardiac arrest should be intubated with a cuffed tube, at the earliest feasible opportunity. Connect the endotracheal tube to a ventilator with a HEPA filter, when available.
 7. Minimize the likelihood of failed intubation attempts by
 - a) Assigning the provider and approach with the best chance of first-pass success to intubate
 - b) Pausing chest compressions to intubate
 8. Video laryngoscopy may reduce intubator exposure to aerosolized particles and should be considered, if available.

9. Before intubation, use a bag-mask device (or T-piece in neonates) with a HEPA filter and a tight seal, or, for adults, consider passive oxygenation with nonrebreathing face mask (NRFM), covered by a surgical mask.
10. If intubation is delayed, consider manual ventilation with a supraglottic airway or bag-mask device with a HEPA filter.
11. Once on a closed circuit, minimize disconnections to reduce aerosolization.

Consider the appropriateness of starting and continuing resuscitation.

- Rationale: Cardiopulmonary resuscitation is a high-intensity team effort that diverts rescuer attention away from other patients.¹³ In the context of COVID-19, the risk to the clinical team is increased and resources can be profoundly more limited, particularly in regions that are experiencing a high burden of disease. While the outcomes for cardiac arrest in COVID-19 are as of yet unknown, the mortality for critically ill COVID-19 patients is high and rises with increasing age and comorbidities, particularly cardiovascular disease.^{2, 5-8} Therefore, it is reasonable to consider age, comorbidities, and severity of illness in determining the appropriateness of resuscitation and balance the likelihood of success against the risk to rescuers and patients from whom resources are being diverted.¹⁴
- Strategies:
 12. Address goals of care with COVID-19 patients (or proxy) in anticipation of the potential need for increased levels of care.
 13. Healthcare systems and EMS agencies should institute policies to guide front-line providers in determining the appropriateness of starting and terminating CPR for patients with COVID-19, taking into account patient risk factors to estimate the likelihood of survival. Risk stratification and policies should be communicated to patients (or proxy) during goals of care discussions.
 14. There is insufficient data to support extracorporeal cardiopulmonary resuscitation (E-CPR) for COVID-19 patients.

(Figure 1)

Algorithms With Key Changes

Figures 2-6 reflect COVID-19 specific updates to the current Basic Life Support (BLS), Advanced Cardiovascular Life Support (ACLS), Pediatric Basic Life Support, and Pediatric Cardiac Arrest algorithms and are meant to replace the standard algorithms in patients with suspected or confirmed COVID-19 disease. In COVID-19 negative patients, or where COVID-19 is not suspected, cardiac arrest resuscitations should proceed according to the standard algorithms. New boxes specific to COVID-19 are in yellow, and new guidance specific to COVID-19 is bolded and underlined.

(Figure 2)

(Figure 3)

(Figure 4)

(Figure 5)

(Figure 6)

Situation- and Setting-Specific Considerations

Out-of-Hospital Cardiac Arrest (OHCA)

Below are specific considerations for cardiac arrest in victims with suspected or confirmed COVID-19 occurring outside of the hospital. Depending on local prevalence of disease and evidence of community spread, it may be reasonable to suspect COVID-19 in all OHCA, by default.

- Lay rescuers:

Bystander CPR has consistently been shown to improve the likelihood of survival from OHCA, which decreases with every minute that CPR and defibrillation are delayed.¹⁵⁻¹⁷ Rescuers in the community are unlikely to have access to adequate PPE and, therefore, are at increased risk of exposure to COVID-19 during CPR, compared to healthcare providers with adequate PPE. Rescuers with increasing age and the presence of comorbid conditions, such as heart disease, diabetes, hypertension, and chronic lung disease,⁴ are at increased risk of becoming critically ill if infected with SARS-CoV2. However, when the cardiac arrest occurs at home (as has been reported in 70% of OHCA¹⁷ before the recent wide-spread shelter-at-home ordinances) lay rescuers are likely to already have been exposed to COVID-19.
- Chest compressions
 - **For adults:** Lay rescuers should perform at least hands-only CPR after recognition of a cardiac arrest event, if willing and able, especially if they are household members who have been exposed to the victim at home. A face mask or cloth covering the mouth and nose of the rescuer and/or victim may reduce the risk of transmission to a non-household bystander.
 - **For children:** Lay rescuers should perform chest compressions and consider mouth-to-mouth ventilation, if willing and able, given the higher incidence of respiratory arrest in children,¹⁷ especially if they are household members who have been exposed to the victim at home. A face mask or cloth covering the mouth and nose of the rescuer and/or victim may reduce the risk of transmission to a non-household bystander if unable or unwilling to perform mouth-to-mouth ventilation.
- Public access defibrillation
 - Because defibrillation is not expected to be a highly aerosolizing procedure, lay rescuers should use an automated external defibrillator, if available, to assess and treat victims of OHCA.
- EMS

- Telecommunication (Dispatch):
 - Telecommunicators, consistent with local protocols, should screen all calls for COVID-19 symptoms (eg, fever, cough, shortness of breath) or known COVID-19 infection in the victim or any recent contacts, including any household members.
 - For lay rescuers, telecommunicators should provide guidance about risk of exposure to COVID-19 for rescuers and instructions for compression-only CPR, as above.
 - For EMS, telecommunicators should alert dispatched EMS teams to don PPE if there is any suspicion for COVID-19 infection.
- Transport
 - Family members and other contacts of patients with suspected or confirmed COVID-19 should not ride in the transport vehicle.
 - If return of spontaneous circulation (ROSC) has not been achieved after appropriate resuscitation efforts in the field, consider not transferring to hospital given the low likelihood of survival for the patient,¹⁷ balanced against the added risk of additional exposure to prehospital and hospital providers.

In-Hospital Cardiac Arrest (IHCA)

Below are specific considerations for patients with suspected or confirmed COVID-19 in the hospital setting. These interim guidelines do not apply to patients who are known to be COVID-19 negative. Those patients should receive standard basic and advanced life support. However, it may be reasonable to reduce personnel in the room for all resuscitations during the pandemic for social distancing purposes.

- Prearrest
 - Address advanced care directives and goals of care with all suspected or confirmed COVID-19 patients (or proxy) on hospital arrival and with any significant change in clinical status, such as an increase in level of care.
 - Closely monitor for signs and symptoms of clinical deterioration to minimize the need for emergent intubations that put patients and providers at higher risk.
 - 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.
- Intubated patients at the time of cardiac arrest
 - Consider leaving the patient on a mechanical ventilator with HEPA filter to maintain a closed circuit and reduce aerosolization.
 - Adjust the ventilator settings to allow for asynchronous ventilation (time chest compressions with ventilation in newborns). Consider the following suggestions:
 - Increase the FIO₂ to 1.0.
 - Change mode to Pressure Control Ventilation (Assist Control) and limit pressure as needed to generate adequate chest rise (6 mL/kg ideal body weight is often targeted, 4-6 mL/kg for neonates).

- Adjust the trigger to Off to prevent the ventilator from auto-triggering with chest compressions and possibly prevent hyperventilation and air trapping.
- Adjust respiratory rate to 10/min for adults and pediatrics and 30/min for neonates.
- Assess the need to adjust positive end-expiratory pressure level to balance lung volumes and venous return.
- Adjust alarms to prevent alarm fatigue.
- Ensure endotracheal tube/tracheostomy and ventilator circuit security to prevent unplanned extubation.
- If return of spontaneous circulation is achieved, set ventilator settings as appropriate to patients' clinical condition.
- **Proned patients at the time of arrest**
 - For suspected or confirmed COVID-19 patients who are in a prone position without an advanced airway, attempt to place in the supine position for continued resuscitation.
 - While the effectiveness of CPR in the prone position is not completely known, for those patients who are in the prone position with an advanced airway, avoid turning the patient to the supine position unless able to do so without risk of equipment disconnections and aerosolization. Instead, consider placing defibrillator pads in the anterior-posterior position and provide CPR with the patient remaining prone with hands in the standard position over the T7/10 vertebral bodies.¹⁸
- **Post-arrest patients**
 - Consult local infection control practices regarding transport after resuscitation.

Maternal and Neonatal Considerations

Neonatal resuscitation: Every newly born baby should have a skilled attendant prepared to resuscitate irrespective of COVID-19 status. Although it remains unclear if newly born babies are infected or likely to be infectious when mothers have suspected or confirmed COVID-19, providers should don appropriate PPE. The mother is a potential source of aerosolization for the neonatal team.

- **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, placement of pulse oximetry and electrocardiograph leads.
- **Suction:** Suction of the airway after delivery should not be performed routinely for clear or meconium-stained amniotic fluid. Suctioning is an aerosol-generating procedure and is not indicated for uncomplicated deliveries.
- **Endotracheal medications:** Endotracheal instillation of medications, such as surfactant or epinephrine, are aerosol-generating procedures, 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.

- Closed incubators: Closed incubator transfer and care (with appropriate distancing) should be used for neonatal intensive care patients when possible but do not protect from aerosolization of virus.

Maternal cardiac arrest: The tenets of maternal cardiac arrest are unchanged for women with suspected or confirmed COVID-19.

- The cardiopulmonary physiological changes of pregnancy may increase the risk of acute decompensation in critically ill pregnant patients with COVID-19.
- Preparation for perimortem delivery, to occur after 4 minutes of resuscitation, should be initiated early in the resuscitation algorithm to allow the assembly of obstetrical and neonatal teams with PPE even if ROSC is achieved and perimortem delivery is not required.



Circulation

Disclosures

DPE reports personal fees from AgileMD, grants and non-financial support from EarlySense, and grants, personal fees, and non-financial support from Philips Healthcare outside the submitted work; in addition, Dr Edelson has a patent to ARCD.P0535US.P2 pending.

CS: None

PSC reports grants from NHLBI and grants from American Heart Association during the conduct of the study.

DLA: None

KA reports 1. Past chair and member (academic role, without remuneration) of the Alberta coordinating committee for NRP and ACoRN that oversees neonatal life support education for perinatal sites in Alberta. 2. Just completed term as member of the ILCOR Neonatal Task Force. LBB reports grants from Philips, grants from NIH, grants from Zoll, grants and other from Nihon Kohden, grants from PCORI, other from BrainCool, and grants from United Therapeutics outside the submitted work; in addition, Dr Becker has a patent to Cooling technology issued and a patent to Reperfusion methodology issued.

RAB: None

SMB: None

SCB reports non-financial support from Action First Aid and SaveStation outside the submitted work; in addition, Dr Brooks has a patent to A SYSTEM AND METHOD FOR AN EMERGENCY COMMUNICATION AND REMOTELY ACTIVATED EMERGENCY ASSISTANCE DEVICE pending.

AC: None

ME: None

GEF: None

SG: None

AH: None

BDK reports AHA and AAP (where they work) have financial relationships related to the Neonatal Resuscitation Program and Pediatric Advanced Life Support, where these programs are co-branded and our organizations pay each other royalties based on revenue from these programs. BDK personally does not benefit from these relationships.

HL: None

REL: None

MEM reports personal fees from Stryker outside the submitted work.

RMM: None

VMN reports grants from Zoll Medical Corp, grants from American Heart Association/Resuscitation Quality Improvement Program, grants from Nihon Kohden Corporation, grants from National Institutes of Health, and grants from Agency for Healthcare Quality Improvement outside the submitted work.

ARP: None

MARP: None

TTR: None

BW: None

DSW: None

CMZ reports personal fees from uptodate outside the submitted work.

AT: None

References

1. Virani SS, Alonso A, Benjamin EJ, Bittencourt MS, Callaway CW, Carson AP, Chamberlain AM, Chang AR, Cheng S, Delling FN, Djousse L, Elkind MSV, Ferguson JF, Fornage M, Khan SS, Kissela BM, Knutson KL, Kwan TW, Lackland DT, Lewis TT, Lichtman JH, Longenecker CT, Loop MS, Lutsey PL, Martin SS, Matsushita K, Moran AE, Mussolino ME, Perak AM, Rosamond WD, Roth GA, Sampson UKA, Satou GM, Schroeder EB, Shah SH, Shay CM, Spartano NL, Stokes A, Tirschwell DL, VanWagner LB and Tsao CW. Heart Disease and Stroke Statistics-2020 Update: A Report From the American Heart Association. *Circulation*. 2020;141:e139-e596.
2. Centers for Disease Control and Prevention. Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) - United States, February 12-March 16, 2020. *MMWR Morbidity and mortality weekly report*. 2020;69:343-346.
3. Wu Z and McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72314 Cases From the Chinese Center for Disease Control and Prevention. *Jama*. 2020 323:1239-1242. doi:10.1001/jama.2020.2648.
4. Guan W-j, Ni Z-y, Hu Y, Liang W-h, Ou C-q, He J-x, Liu L, Shan H, Lei C-l, Hui DSC, Du B, Li L-j, Zeng G, Yuen K-Y, Chen R-c, Tang C-l, Wang T, Chen P-y, Xiang J, Li S-y, Wang J-l, Liang Z-j, Peng Y-x, Wei L, Liu Y, Hu Y-h, Peng P, Wang J-m, Liu J-y, Chen Z, Li G, Zheng Z-j, Qiu S-q, Luo J, Ye C-j, Zhu S-y and Zhong N-s. Clinical Characteristics of Coronavirus Disease 2019 in China. *New Eng J Med*. Feb 28, 2020. doi: 10.1056/NEJMoa2002032. [epub ahead of print].
5. Bhatraju PK, Ghassemieh BJ, Nichols M, Kim R, Jerome KR, Nalla AK, Greninger AL, Pipavath S, Wurfel MM, Evans L, Kritek PA, West TE, Luks A, Gerbino A, Dale CR, Goldman JD, O'Mahony S and Mikacenic C. Covid-19 in Critically Ill Patients in the Seattle Region — Case Series. *New Eng J Med*. March 30, 2020. doi: 10.1056/NEJMoa2004500. [epub ahead of print].
6. Guo T, Fan Y, Chen M, Wu X, Zhang L, He T, Wang H, Wan J, Wang X and Lu Z. Cardiovascular Implications of Fatal Outcomes of Patients With Coronavirus Disease 2019 (COVID-19). *JAMA Cardiol*. March 27, 2020. doi: 10.1001/jamacardio.2020.1017. [epub ahead of print].
7. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z, Yu T, Xia J, Wei Y, Wu W, Xie X, Yin W, Li H, Liu M, Xiao Y, Gao H, Guo L, Xie J, Wang G, Jiang R, Gao Z, Jin Q, Wang J and Cao B. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet*. 2020;395:497-506.
8. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y, Li Y, Wang X and Peng Z. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus–Infected Pneumonia in Wuhan, China. *Jama*. 2020;323:1061-1069.
9. Centers for Disease Control and Prevention. Information for Clinicians on Therapeutic Options for COVID-19 Patients. Updated April 7, 2020. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/therapeutic-options.html/>. Accessed April 8, 2020.
10. Gamio L. The Workers Who Face the Greatest Coronavirus Risk. *New York Times*. 2020.
11. van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, Tamin A, Harcourt JL, Thornburg NJ, Gerber SI, Lloyd-Smith JO, de Wit E and Munster VJ. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *New Eng J Med*. March 17, 2020. doi: 10.1056/NEJMc2004973. [epub ahead of print].

12. ECRI Institute. Mechanical ventilation of SARS patients: lessons from the 2003 SARS outbreak. Health Devices. Feb 18, 2020.
<https://www.ecri.org/components/HDJournal/Pages/Mechanical-Ventilation-of-SARS-Patients-2003-SARS-Outbreak.aspx#>
13. Volchenbom SL, Mayampurath A, Goksu-Gursoy G, Edelson DP, Howell MD and Churpek MM. Association Between In-Hospital Critical Illness Events and Outcomes in Patients on the Same Ward. *Jama*. 2016;316:2674-2675.
14. Emanuel EJ, Persad G, Upshur R, Thome B, Parker M, Glickman A, Zhang C, Boyle C, Smith M and Phillips JP. Fair Allocation of Scarce Medical Resources in the Time of Covid-19. *New Eng J Med*. March 23, 2020. doi: 10.1056/NEJMs2005114. [epub ahead of print].
15. Kragholm K, Wissenberg M, Mortensen RN, Hansen SM, Malta Hansen C, Thorsteinsson K, Rajan S, Lippert F, Folke F, Gislason G, Kober L, Fonager K, Jensen SE, Gerds TA, Torp-Pedersen C and Rasmussen BS. Bystander Efforts and 1-Year Outcomes in Out-of-Hospital Cardiac Arrest. *New Eng J Med*. 2017;376:1737-1747.
16. Pollack RA, Brown SP, Rea T, Aufderheide T, Barbic D, Buick JE, Christenson J, Idris AH, Jasti J, Kampp M, Kudenchuk P, May S, Muhr M, Nichol G, Ornato JP, Sopko G, Vaillancourt C, Morrison L and Weisfeldt M. Impact of Bystander Automated External Defibrillator Use on Survival and Functional Outcomes in Shockable Observed Public Cardiac Arrests. *Circulation*. 2018;137:2104-2113.
17. CARES: Cardiac Arrest Registry to Enhance Survival. 2018 Annual Report.
https://mycares.net/sitepages/uploads/2019/2018_flipbook/index.html?page=16
18. Mazer SP, Weisfeldt M, Bai D, Cardinale C, Arora R, Ma C, Sciacca RR, Chong D and Rabbani LE. Reverse CPR: a pilot study of CPR in the prone position. *Resuscitation*. 2003;57:279-285.



Circulation

Figure Legends

Figure 1. Summary of adjustments to CPR algorithms in suspected or confirmed COVID-19 patients.

Figure 2. BLS Healthcare Provider Adult Cardiac Arrest Algorithm for Suspected or Confirmed COVID-19 Patients

Figure 3. ACLS Cardiac Arrest Algorithm for Suspected or Confirmed COVID-19 Patients

Figure 4. BLS Healthcare Provider Pediatric Cardiac Arrest Algorithm for the Single Rescuer for Suspected or Confirmed COVID-19 Patients

Figure 5. BLS Healthcare Provider Pediatric Cardiac Arrest Algorithm for 2 or More Rescuers for Suspected or Confirmed COVID-19 Patients

Figure 6. Pediatric Cardiac Arrest Algorithm for Suspected or Confirmed COVID-19 Patients



Circulation

Figure 1. Summary of adjustments to CPR algorithms in suspected or confirmed COVID-19 patients.

Reduce provider exposure

- Don PPE before entering the room/scene
- Limit personnel
- Consider using mechanical CPR devices for adults and adolescents who meet height and weight criteria
- Communicate COVID-19 status to any new providers

Prioritize oxygenation and ventilation strategies with lower aerosolization risk

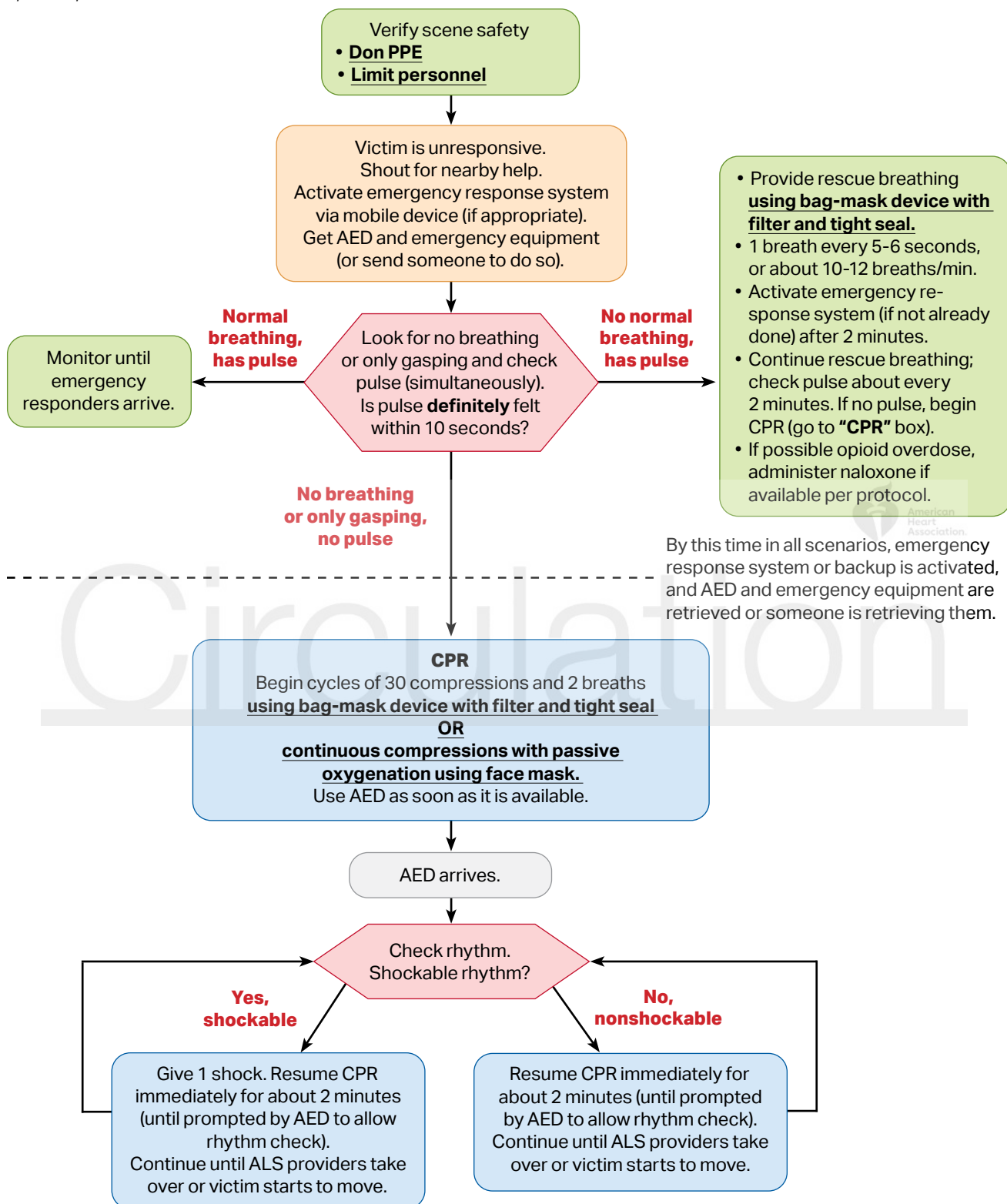
- Use a HEPA filter, if available, for all ventilation
- Intubate early with a cuffed tube, if possible, and connect to mechanical ventilator, when able
- Engage the intubator with highest chance of first-pass success
- Pause chest compressions to intubate
- Consider use of video laryngoscopy, if available
- Before intubation, use a bag-mask device (or T-piece in neonates) with a HEPA filter and a tight seal
- For adults, consider passive oxygenation with nonrebreathing face mask as alternative to bag-mask device for short duration
- If intubation delayed, consider supraglottic airway
- Minimize closed circuit disconnections

Consider resuscitation appropriateness

- Address goals of care
- Adopt policies to guide determination, taking into account patient risk factors for survival

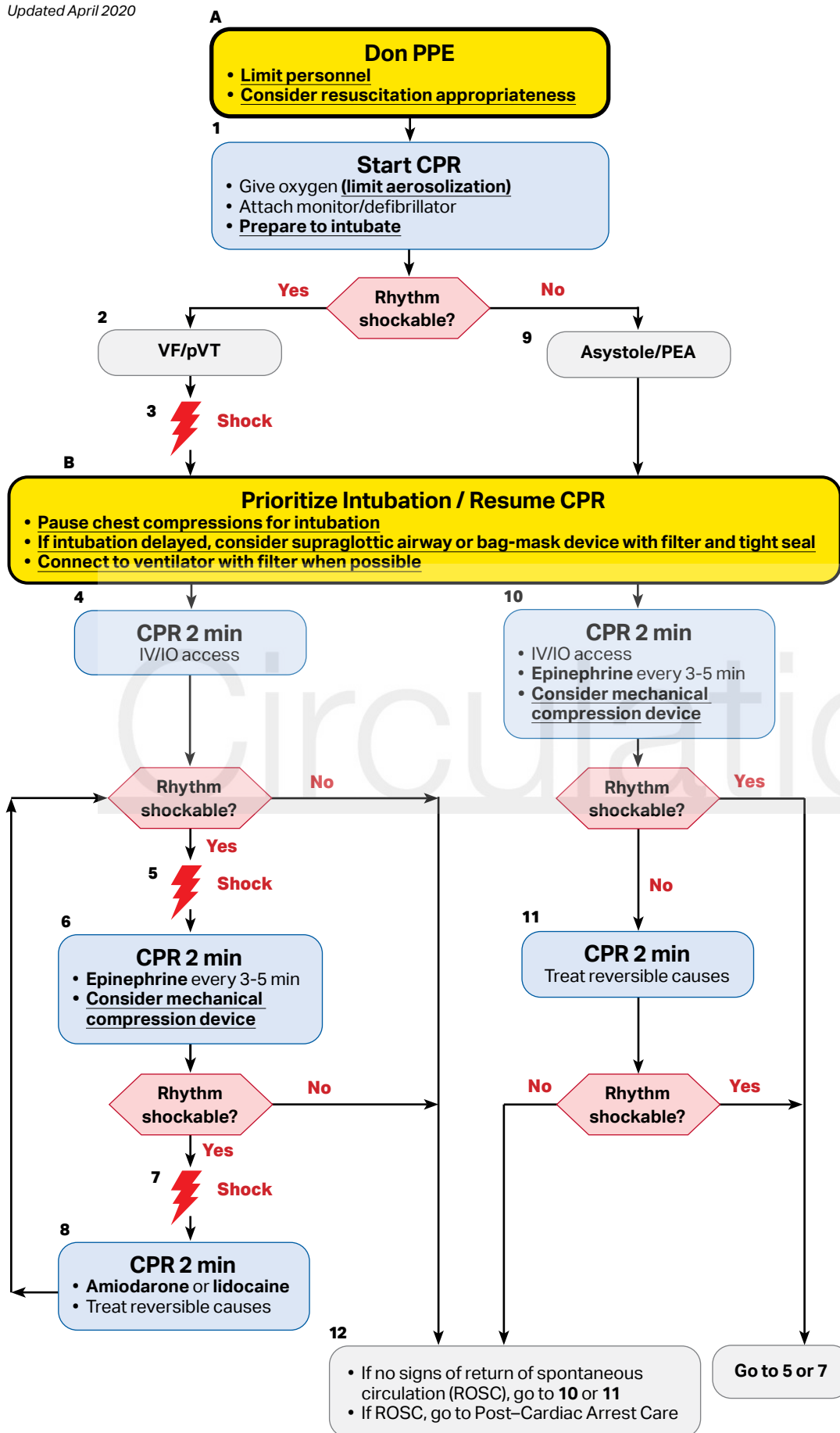
BLS Healthcare Provider Adult Cardiac Arrest Algorithm for Suspected or Confirmed COVID-19 Patients

Updated April 2020



ACLS Cardiac Arrest Algorithm for Suspected or Confirmed COVID-19 Patients

Updated April 2020



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 PETCO₂ <10 mm Hg, attempt to improve CPR quality.
- Intra-arterial pressure
 - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve 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

Advanced Airway

- Minimize closed-circuit disconnection
- Use intubator with highest likelihood of first pass success
- Consider video laryngoscopy
- 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

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.

Return of Spontaneous Circulation (ROSC)

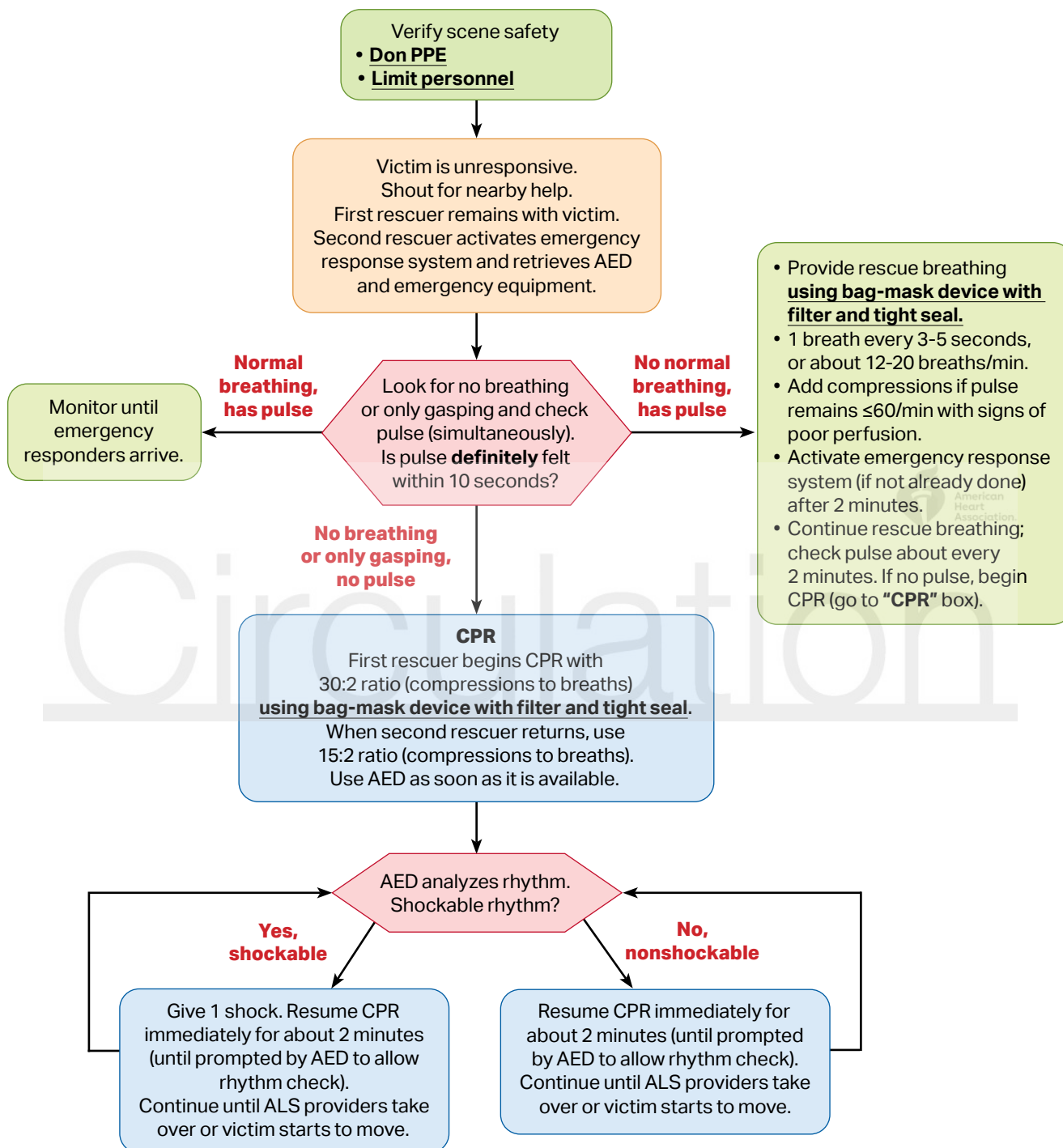
- Pulse and blood pressure
- Abrupt sustained increase in PETCO₂ (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypo-/hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

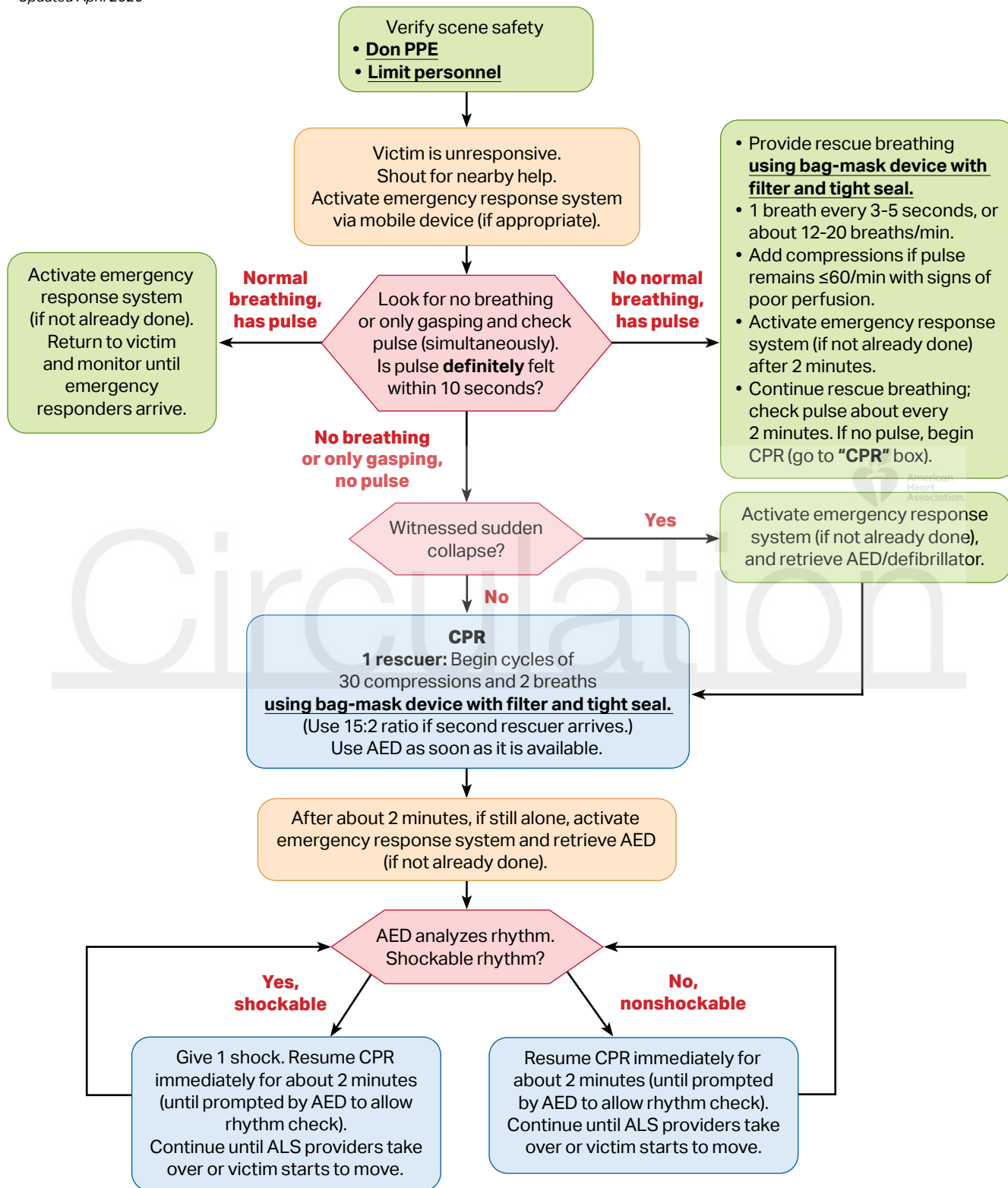
BLS Healthcare Provider Pediatric Cardiac Arrest Algorithm for 2 or More Rescuers for Suspected or Confirmed COVID-19 Patients

Updated April 2020



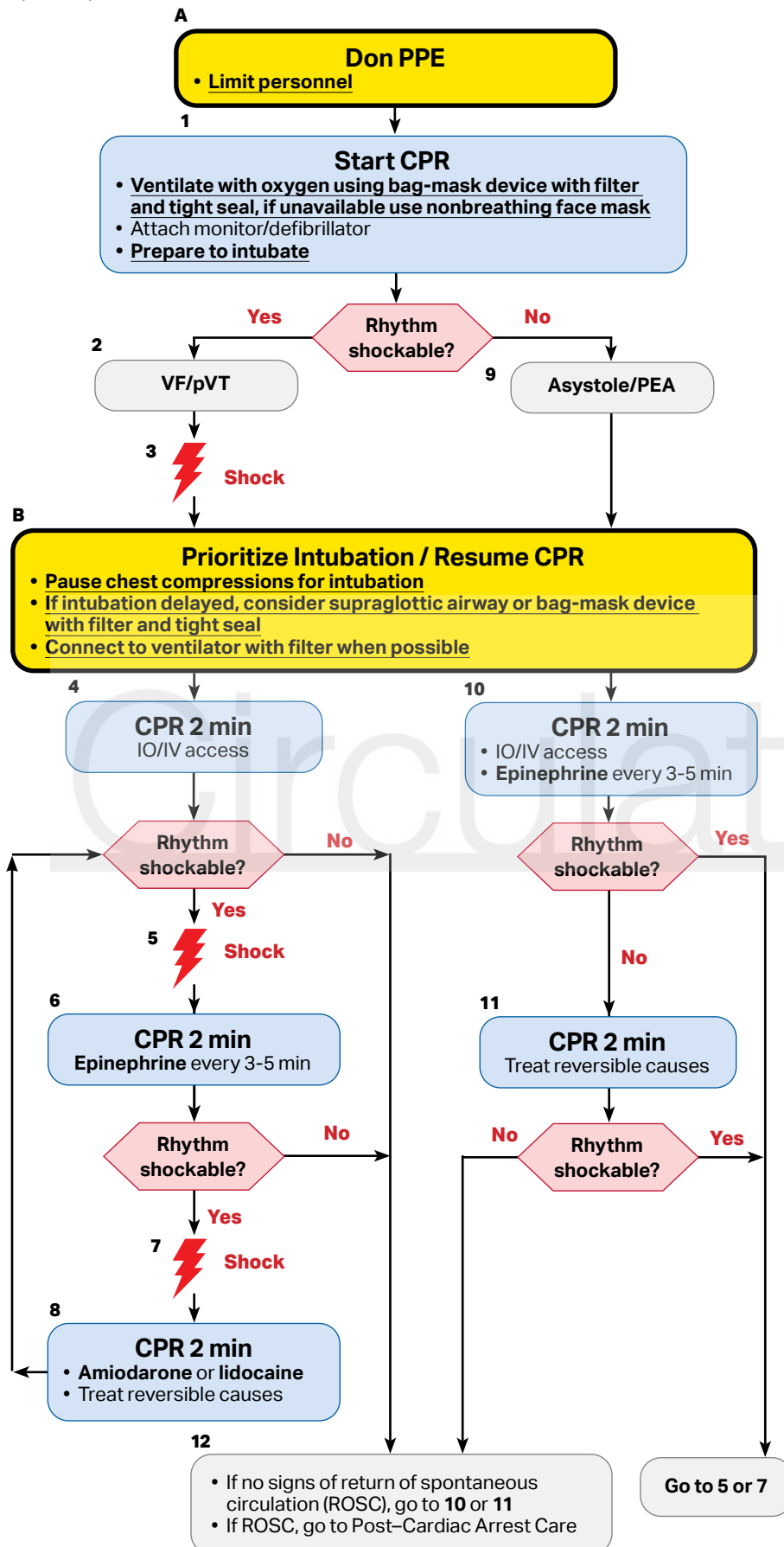
BLS Healthcare Provider Pediatric Cardiac Arrest Algorithm for the Single Rescuer for Suspected or Confirmed COVID-19 Patients

Updated April 2020



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

Updated April 2020



CPR Quality

- Push hard ($\geq \frac{1}{3}$ of anteroposterior diameter of chest) 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, 15:2 compression-ventilation ratio.

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

Advanced Airway

- Minimize closed-circuit disconnection
- Use intubator with highest likelihood of first pass success
- Consider video laryngoscopy
- Prefer cuffed endotracheal tube if available
- 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

Drug Therapy

- **Epinephrine IO/IV dose:** 0.01 mg/kg (0.1 mL/kg of the 0.1 mg/mL concentration). Repeat every 3-5 minutes.
- **Amiodarone IO/IV dose:** 5 mg/kg bolus during cardiac arrest. May repeat up to 2 times for refractory VF/pulseless VT.
- **Lidocaine IO/IV dose:** Initial: 1 mg/kg loading dose. Maintenance: 20-50 mcg/kg per minute infusion (repeat bolus dose if infusion initiated >15 minutes after initial bolus therapy).

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypoglycemia
- Hypo-/hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary