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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*

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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

<u>Out-of-Hospital Cardiac Arrest (OHCA)</u>

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 OHCAs, 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 OHCAs [17] 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 F_{IO_2} 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.

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- 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.

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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.
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GEF: None
SG: None
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BW: None
DSW: None
CMZ reports personal fees from uptodate outside the submitted work.
AT: None

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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

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

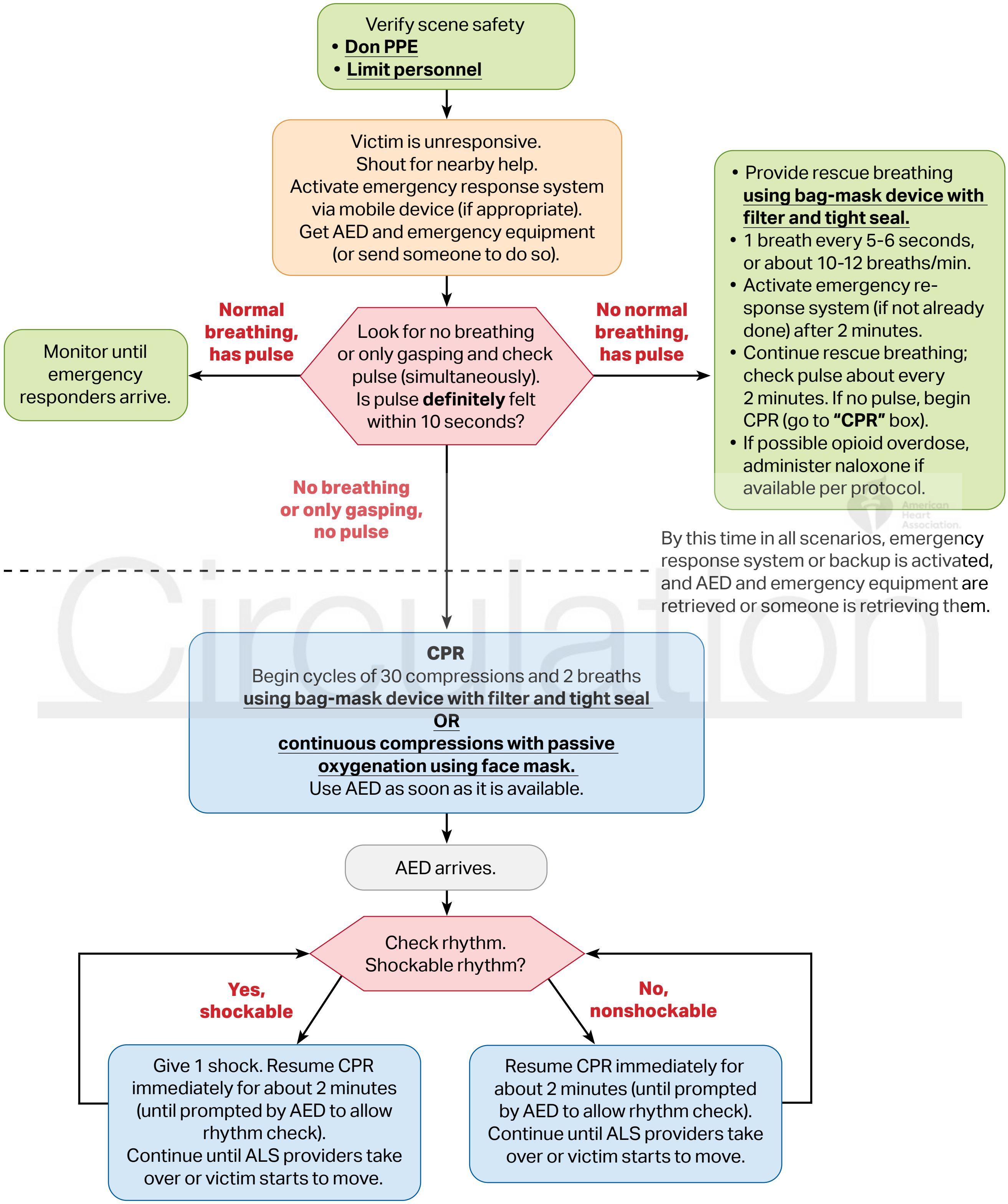
- Use a HEPA filter, if available, for all ventilation
- Intubate early with a cuffed tube, if possible, and connect to mechanical ventilator, when able
- Engage the intubator with highest chance of first-pass success
- Pause chest compressions to intubate
- Consider use of video laryngoscopy, if available
- 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

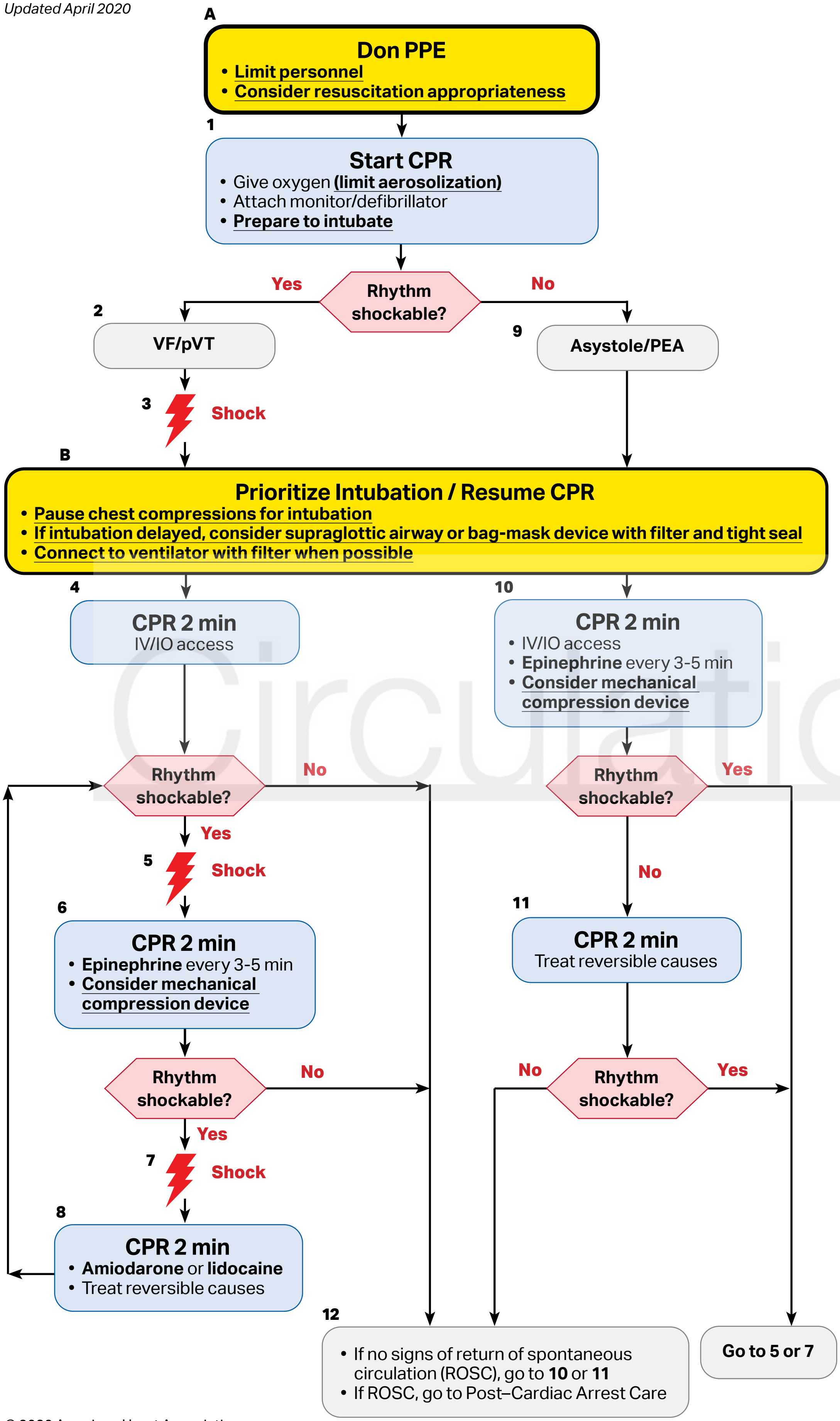
BLS Healthcare Provider Adult Cardiac Arrest Algorithm for Suspected or Confirmed COVID-19 Patients

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 P_{ETCO_2} <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)

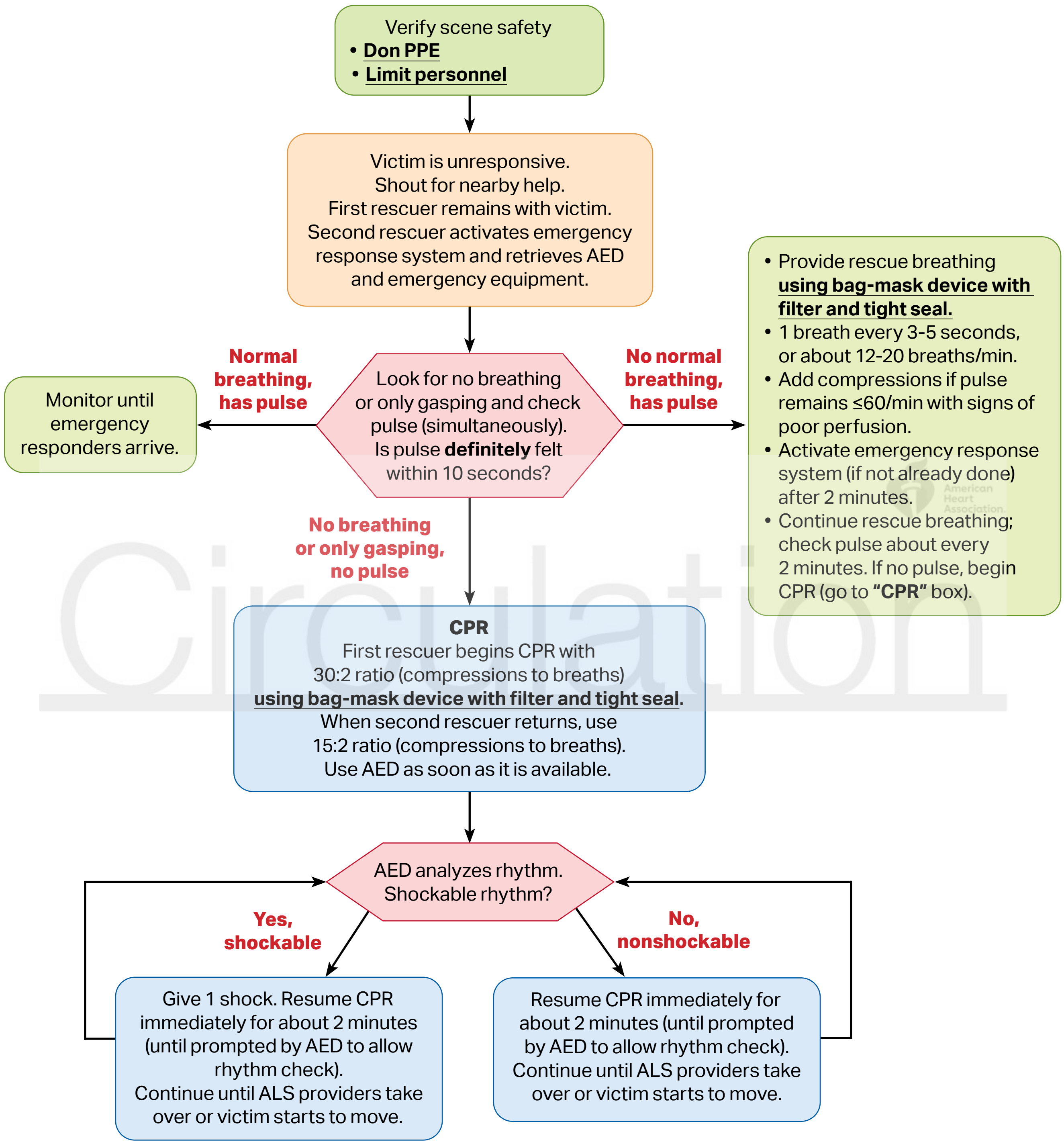
- Pulse and blood pressure
- Abrupt sustained increase in P_{ETCO_2} (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

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

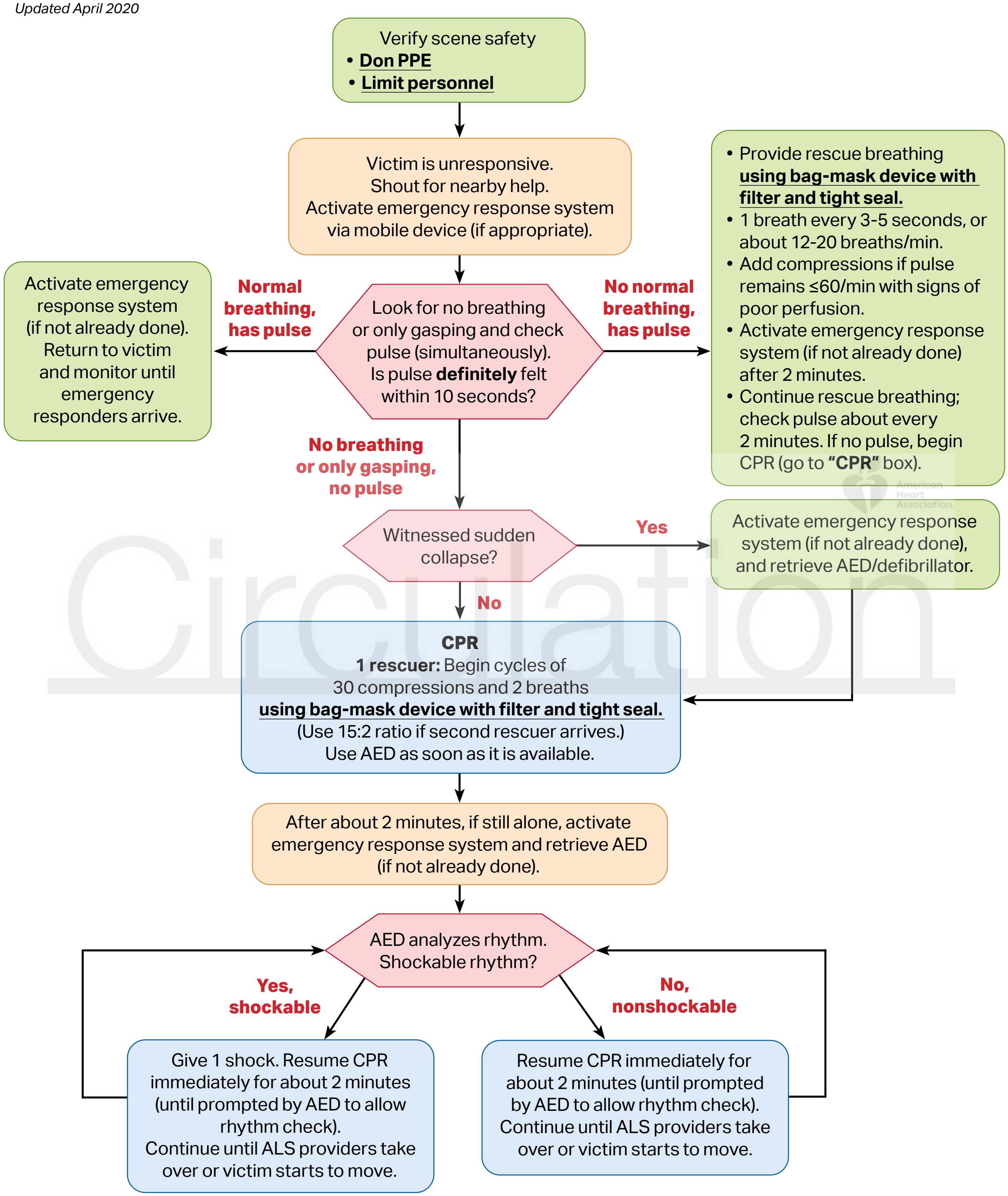
BLS Healthcare Provider
Pediatric Cardiac Arrest Algorithm for 2 or More Rescuers for Suspected or Confirmed COVID-19 Patients

Updated April 2020



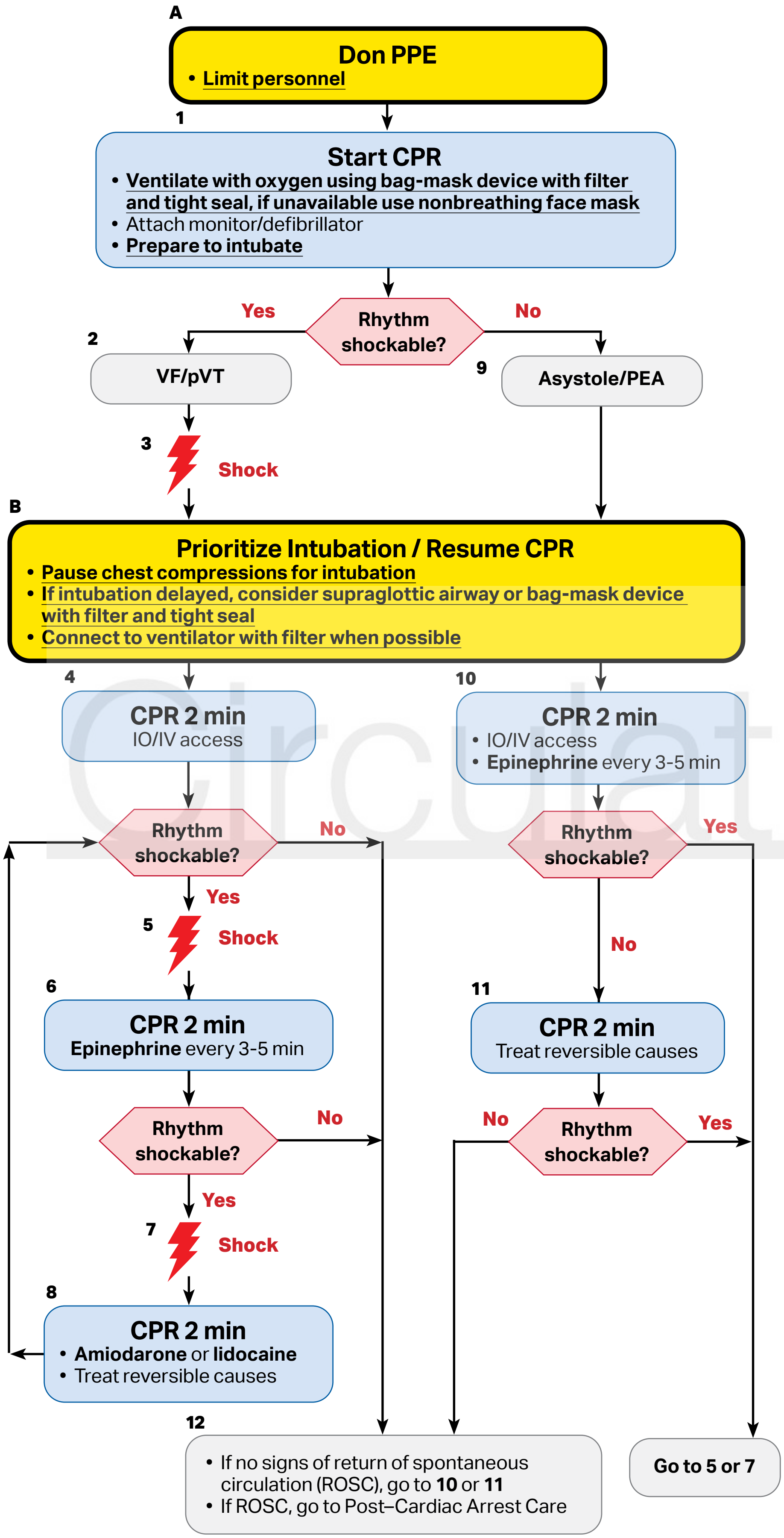
BLS Healthcare Provider
Pediatric Cardiac Arrest Algorithm for the Single Rescuer for Suspected or Confirmed COVID-19 Patients

Updated April 2020



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

Updated April 2020



CPR Quality

- Push hard (≥⅓ 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.
  or
  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).

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