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Interim Singapore guidelines for basic and advanced life support for paediatric patients with suspected or confirmed COVID-19

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ABSTRACT

The COVID-19 pandemic has resulted in significant challenges for the resuscitation of paediatric patients, especially for infants and children who are suspected or confirmed to be infected. Thus, the paediatric subcommittee of the Singapore Resuscitation and First Aid Council developed interim modifications to the current Singapore paediatric guidelines using extrapolated data from the available literature, local multidisciplinary expert consensus and institutional best practices. It is hoped that this it will provide a framework during the pandemic for improved outcomes in paediatric cardiac arrest patients in the local context, while taking into consideration the safety of all community first responders, medical frontline providers and healthcare workers.

Keywords: cardiac arrest, cardiopulmonary resuscitation, COVID-19, novel coronavirus, paediatric

INTRODUCTION

Internationally, the COVID-19 pandemic has changed the practice and landscape of community and hospital resuscitation.^(1,2) However, the current paediatric resuscitation guidelines do not directly address these challenges.

This paper hopes to provide interim guidance and recommendations for paediatric patients who are suspected or confirmed to have SARS-CoV-2 (COVID-19) in the local context. Due to variations in resource availability among various groups, from community responders to highly specialised hospitals, these interim guidelines serve to provide a general overview of the expected minimum standards for the care of critically ill paediatric patients.

We reviewed the local basic and advanced paediatric resuscitation guidelines in the context of the COVID-19 pandemic. As in our current local guidelines, ‘paediatrics resuscitation’ in our recommendations refers to the resuscitation of both infants and children but excludes newborn resuscitation. As data and the science of paediatric resuscitation for suspected or confirmed paediatric COVID-19 patients are still evolving, we took into consideration the available literature and multidisciplinary expert consensus on the subject matter.

OUT-OF-HOSPITAL PAEDIATRIC RESUSCITATION

Most paediatric cardiac arrests are secondary to respiratory causes. Ventilation as part of cardiopulmonary resuscitation (CPR) for infants and children is still critical for improved outcomes.⁽¹⁻³⁾ While paediatric patients with COVID-19 tend to have less severe disease than the adults, severe cases have been reported.⁽⁴⁾ Infected paediatric patients may also put community first responders and emergency medical service providers at risk of being infected. Paediatric basic life support remains unchanged from the local 2016 guidelines (Fig. 1 & Table D).^(5,6)

The potential risks of exposure to COVID-19 by community first responders performing conventional CPR should be weighed against the potential benefit for the infant or child in cardiac arrest. The decision to perform ventilation as part of community CPR for infants and children who are suspected or confirmed to be infected with COVID-19 should be a personal choice. With community social distancing, most paediatric patients are more likely to be with people who are already close contacts (e.g. family members, schoolteachers), and hence the willingness to initiate ventilation would conceivably be greater.⁽⁷⁾ If the community first responders are unable or unwilling to perform ventilations, they are encouraged to at least provide effective chest compressions till the arrival of emergency medical services (EMS) personnel.

Singapore has a dispatcher-assisted first-responder CPR programme that provides real-time CPR instructions and coaching to both trained and untrained community first responders.⁽⁶⁾ It has been anecdotally observed that critically ill paediatric patients have been brought to emergency departments in Singapore by private transport. Thus, it is recommended to align the initial steps of calling for help and 995 (i.e. EMS) in the adult and the paediatric community CPR guidelines (Fig. 1). This would allow CPR instructions and coaching to be given to community first responders, earlier delivery of more advanced care by EMS providers and timely transportation to the nearest hospital, as part of the chain of survival in cardiac arrest.⁽⁴⁻⁷⁾

OUT-OF-HOSPITAL PAEDIATRIC BASIC LIFE SUPPORT

Community first responders who are willing, trained and able to do so should provide rescue breaths in addition to chest compressions, especially if the first responders are those who routinely care for the child. The risk of the rescuer newly acquiring COVID-19 through

provision of rescue breaths is greatly outweighed by the chance of an improved outcome for children in asphyxial arrest who receive ventilations.

It is important that community rescuers, who are likely close contacts of paediatric cardiac arrest victims, are able, skilled and willing to initiate time-critical and life-saving resuscitation when every minute counts, in as a protected a manner as possible for the rescuers. This includes provision of ventilation during life support for paediatric cardiac arrest victims and self-care.

Self-care and protection of community rescuers and pre-hospital healthcare providers

Community rescuers and pre-hospital healthcare providers should take necessary and appropriate personal safety precautions when rendering aid to others (Fig. 1). When appropriate and available, they should use personal protective equipment (PPE) such as mask, goggles, gloves and/or gown. Community first responders should wash hands thoroughly with soap and water or use hand sanitisers to clean their hands as soon as possible after the casualty has been handed over to EMS providers.⁽⁸⁾ Those who feel unwell after the incident must consult a medical practitioner immediately for further assessment. The Ministry of Health will coordinate with the appropriate healthcare agencies and emergency ambulance services to carry out the necessary contact tracing should any patients, including cardiac arrest victims, be COVID-19 positive.

IN-HOSPITAL PAEDIATRIC RESUSCITATION

In-hospital resuscitation paediatric workflows should be designed according to the institution's setup and manpower availability. The following are considerations and guidance for CPR in a suspected or positive COVID-19 patient within the in-hospital setting.

A general guiding principle is that for critically ill children who require resuscitation, until their COVID-19 status is made known, healthcare responders should treat them as a suspected case and don appropriate PPE. The main tenets of in-hospital resuscitation in COVID-19 patients are: (a) early identification of deteriorating patients; (b) high suspicion for COVID-19 in deteriorating patients; (c) reducing healthcare worker exposure to COVID-19; and (d) mitigating the infectious risk of COVID-19 via modifications to current resuscitation guidelines.

Early identification of deteriorating paediatric patients

Institutions must be familiar with the local case definitions for suspected cases released by the Ministry of Health⁽⁹⁾ and develop in-house screening protocols to identify potential patients with COVID-19.

In emergency departments, risk-stratification and appropriate isolation of paediatric patients for COVID-19 should be initiated at presentation.⁽¹⁰⁾ Front-line healthcare workers should have the appropriate personal protection. Patients in isolation should have appropriate monitoring and resuscitation equipment readily available.

In hospital wards, all inpatients who are suspected or confirmed COVID-19 cases should be monitored adequately to identify deterioration early. Use of early warning scores⁽¹¹⁾ or criteria for escalation of care in ward patients should be employed to facilitate early and rapid response. Deteriorating patients should be taken to the high dependency or intensive care unit and placed in a negative pressure room. Early intubation of patients requiring increasing respiratory support is advised. This allows for better organisation of manpower and equipment in a semi-elective setting.

High suspicion for COVID-19 in deteriorating patients

Paediatric patients can have atypical presentations of COVID-19. They have a milder spectrum of disease.⁽³⁾ Main presenting features in children are cough and fever, similar to adults. However, a report from the United States Centers for Disease Control and Prevention showed that only 73% of paediatric cases had classical symptoms of fever, cough or breathlessness, as compared to 93% in the adult population.⁽¹⁰⁾ 10%–24% of children have also been reported to have diarrhoea and/or vomiting, as sole presenting features in some.⁽¹²⁻¹⁵⁾

A newly emerging subset of severe disease has been identified within the paediatric population, paediatric inflammatory multisystem syndrome temporally associated with COVID-19 (PIMS-TS), which has features of Kawasaki disease and toxic shock syndrome.⁽¹⁶⁻²⁰⁾ It is currently thought that previous exposure to COVID-19 induces a hyper-inflammatory response in children, resulting in a multi-system inflammatory disease, although the exact mechanism is unclear. These cases are rare and present with an acute illness, mostly with gastrointestinal symptoms and a prolonged fever, which subsequently progresses to shock with cardiac involvement.⁽¹⁸⁾

A high degree of suspicion for COVID-19 should therefore be maintained for patients who are unwell on a ward, and appropriate risk assessments for COVID-19 should be undertaken. COVID-19 suspect cases should have appropriate swabs done and deteriorating suspect cases should be placed within negative pressure rooms where possible, in anticipation of the need for aerosol-generating procedures.⁽²¹⁾

Reduce healthcare worker exposure to COVID-19

Appropriate donning of PPE by the resuscitation team is mandatory. Minimum protective equipment that should be worn include eye protection (goggles or face shield), N95 mask, fluid-resistant gown and gloves.⁽¹⁹⁾ Personnel expected to attend to COVID-19 suspected or

positive patients should be trained in the donning and doffing of PPE and a minimum standard of competency should be adhered to. These personnel should also be appropriately mask-fitted for the N95 respirator. The addition of a powered air-purifying respirator (PAPR), if available, during resuscitation is also recommended. Healthcare workers who are deployed should be trained in its use and should be competent with donning and doffing to avoid self-contamination.^(22,23)

Resuscitation teams entering the patient's room should include only the essential members required to perform effective CPR.^(1,2) The roles and responsibilities of team members should be clearly identified prior to entry. This reduces the number of team members who are potentially exposed to COVID-19 during the resuscitation. Additional team members in full PPE can be stationed outside the patient's room to coordinate the movement of additional equipment, personnel or medications. Communication systems to enable staff in the room to pass on messages without unnecessary opening of doors should be considered, such as whiteboards and an intercom.

All team members and, if manpower allows, dedicated staff should look out for any PPE breaches in the team and call for replacement of staff if needed. Follow-up protocols for staff with potential exposure and post-exposure management should be in line with the institution's and national infectious disease guidelines. Resuscitation team training should be conducted so that healthcare workers are familiar with the modifications to their local institution's resuscitation workflows.⁽²⁴⁾

Mitigating infectious risk of COVID-19 via modifications to resuscitation guidelines

All personnel present within the room should be in full PPE, as described. Room doors should be closed on entering to reduce exposure to the people outside the room. Subsequent door

opening should be minimised for similar reasons. The following recommendations detail the modifications to the resuscitation process.

Airway and aerosol-generating procedures

Bag-valve-mask ventilation

Bag-valve-mask ventilation (BVM) should be minimised as far as possible to reduce aerosol generation. Where BVM ventilation is needed, a high-efficiency particulate air (HEPA) Filter should be used between the bag and the mask.^(1,2) A tight mask seal and the use of small tidal volumes during BVM allow for reduced aerosolisation of secretions. The use of a two-hand technique for good mask seal may be required to achieve this. Where available, disposable BVM devices may be used.

Intubation

Early intubation is advised to secure the airway and reduce the risk of aerosolisation risk. This should be performed by the most experienced provider present and chest compressions should be paused just prior to intubation to increase chances of success.^(1,2) Resuscitation team members who are not managing the airway should step away from the head end of the patient during the intubation process.

Cuffed endotracheal tubes (ETTs) are preferred to prevent aerosolisation,⁽²⁵⁾ except in infants < 3 kg. Video laryngoscopes with disposable blades, where available, are preferred as they allow for increased physical distance between the airway procedurist and the patient's airway.⁽²⁶⁾ Rapid sequence induction should be employed to ensure adequate muscle relaxation to minimise the cough and gag reflex. Ventilation via the advanced airway should only be started after the cuff of the ETT is inflated. There may be difficulty with auscultation for ETT placement with PAPR.⁽²³⁾ Capnography or capnometry should be used to confirm the

placement of the ETT. Subsequent chest imaging is required to ensure appropriate ETT position. In cases where intubation is not possible or unsuccessful, a supraglottic device may be used by trained personnel.

Ventilator

The ventilator should be set up with an age-appropriate heat and moisture-exchange hydrophobic submicron viral/bacterial filter (HMEF) between the ETT and the ventilator circuit tubing, with separate HEPA filters attached to the inspiratory and expiratory ports of the ventilator to reduce viral transmission.⁽²⁷⁾ For neonates and infants who are unable to tolerate the use of a HMEF, a heated humidification system may be used instead,⁽²⁸⁾ although the risk of virus particle aerosolisation may be higher.⁽²⁹⁾ Once successful intubation has been performed, the patient should be connected to a ventilator with end-tidal carbon dioxide monitoring and in-line suctioning equipment. The maintenance of a closed circuit and minimising disconnection are very important to prevent aerosolisation of secretions. In-line suctioning is therefore preferred if clearance of secretions is required. A summary of the modified algorithm for paediatric pulseless arrest during the COVID-19 pandemic is shown in Fig. 2.

Non-invasive ventilation

The use of non-invasive ventilation in patients with suspected or known COVID-19 is discouraged due to the risk of aerosolisation.⁽³⁰⁾ It may be considered on a case-by-case basis; these patients must be nursed in a negative pressure room, and all staff should be in appropriate PPE/PAPR.

- **Circulation:** It is very important to assess the prevailing rhythm early and perform prompt defibrillation when indicated. This may reduce the need for further resuscitation and unnecessary healthcare worker exposure.
- **Equipment:** A designated resuscitation cart for COVID-19 patients or individual equipment bundles may be prepared and used during the resuscitation process. Equipment used in the resuscitation process will require appropriate disinfection as per local institutions' guidelines for COVID-19.
- **Transfer:** It may be necessary to transfer a patient after resuscitation. Additional personnel should be activated to clear the way of bystanders during the transfer process. All personnel transferring the patient should be in full PPE, which should be changed after the resuscitation where possible. Intubated patients can be given a dose of muscle relaxant before transfer to reduce the risk of disconnection and coughing or gagging on the ETT. Non-intubated patients should have a surgical mask placed over their oxygen delivery device. A closed-circuit ventilator with an appropriate HEPA filter should be used for transfer if available. If this is not possible, manual bagging with an ETT with an attached HEPA filter is advised.
- **Parental presence:** Adult caregivers may be roomed together with paediatric patients. Since the adult is also a suspected or confirmed case, it would be prudent to either place the caregiver in another room or manage their presence. In the event of the paediatric patient requiring resuscitation, depending on resource and manpower availability, the adult caregiver should be quickly moved to the nearest available isolation room. If there are no available isolation rooms to house the caregiver or parental presence during resuscitation is desired, the adult caregiver should be moved to one side of room away from the resuscitation area and an additional team member assigned to provide explanation and support to the adult caregiver during resuscitation. The presence of an assigned team

member is even more important with COVID-19, as the resuscitation may be more challenging in full PPE.

CONCLUSION

These interim recommendations for paediatric resuscitation during the COVID-19 pandemic were extrapolated from the available literature, local expert consensus and recommended institutional practice. It is hoped that they will provide a framework during this challenging period for improved outcomes in paediatric cardiac arrest patients in the local context, while taking into consideration the safety of all community first responders, medical frontline providers and healthcare workers.

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Table I. Summary of modified paediatric basic life support for COVID-19 (adapted from Singapore paediatric resuscitation and basic cardiac life support guidelines 2016).^(5,6)

CPR sequence for paediatric out-of-hospital cardiac arrests	Older children and adolescents	Child (1–8 yr)	Infant (< 1 yr, excluding newborns)
<ul style="list-style-type: none"> Establish unresponsiveness immediately Call 995, get AED if readily available Self care and appropriate protection 	Dispatch assistance for CPR will be available on calling 995		
Open airway (optional for laypeople)	Head tilt, chin lift or jaw thrust (healthcare providers, if trauma suspected)		
Recognition of cardiac arrest	<ul style="list-style-type: none"> Check for breathing (No breathing, gasping or agonal breathing) Pulse check only by trained healthcare workers (≤ 10 s) – adult/child: carotid; infant: brachial 		
Compression landmarks	Lower half of sternum		1 fingerbreadth below intermammary line
Compression method	Heel of 1 hand with other hand on top	Heel of 1 hand, with or without other hand on top	2 thumbs encircling hands or ring and middle fingers
Compression depth (push hard, push fast, full recoil)	Approximately 4–6 cm	At least 1/3 depth of chest (4–5 cm)	At least 1/3 depth of chest (3–4 cm)
Compression rate	100–120/min (push hard, push fast, full recoil)		
Compression-ventilation ratio	<ul style="list-style-type: none"> Laypeople: 30:2 (1 or 2 rescuers) Healthcare providers: 30:2 (1 rescuer), 15:2 (≥ 2 rescuers) Unable/unwilling to perform ventilations: continuous high-quality chest compressions 		
Ventilation	2 breaths at 1 s per breath (2 breaths should not take more than 6 s; chest rise seen)		
	Continuous chest compression (high quality) if unable/unwilling to ventilate		
Apnoea with pulse/signs of circulation: <ul style="list-style-type: none"> Only for trained healthcare workers If available, use bag-valve-mask with viral filters If unavailable, rescue breathing if willing and able 	1 ventilation/breath per 5 s (12 ventilations/min)	1 ventilation/breath per 3 s (20 ventilations/min)	
AED	2 min of CPR, shock with standard AEDs if indicated	2 minutes of CPR, shock with paediatric pads if indicated.	Manual defibrillators preferred but if unavailable, use child paediatric pads

Foreign body airway obstruction: conscious	Abdominal thrust	5 back blow, 5 chest thrust
Foreign body airway obstruction: unconscious	CPR with ventilations, but to look for foreign body before ventilations. Continuous chest compression (high-quality) if unable/unwilling to ventilate	

AED: automated external defibrillator; CPR: cardiopulmonary resuscitation

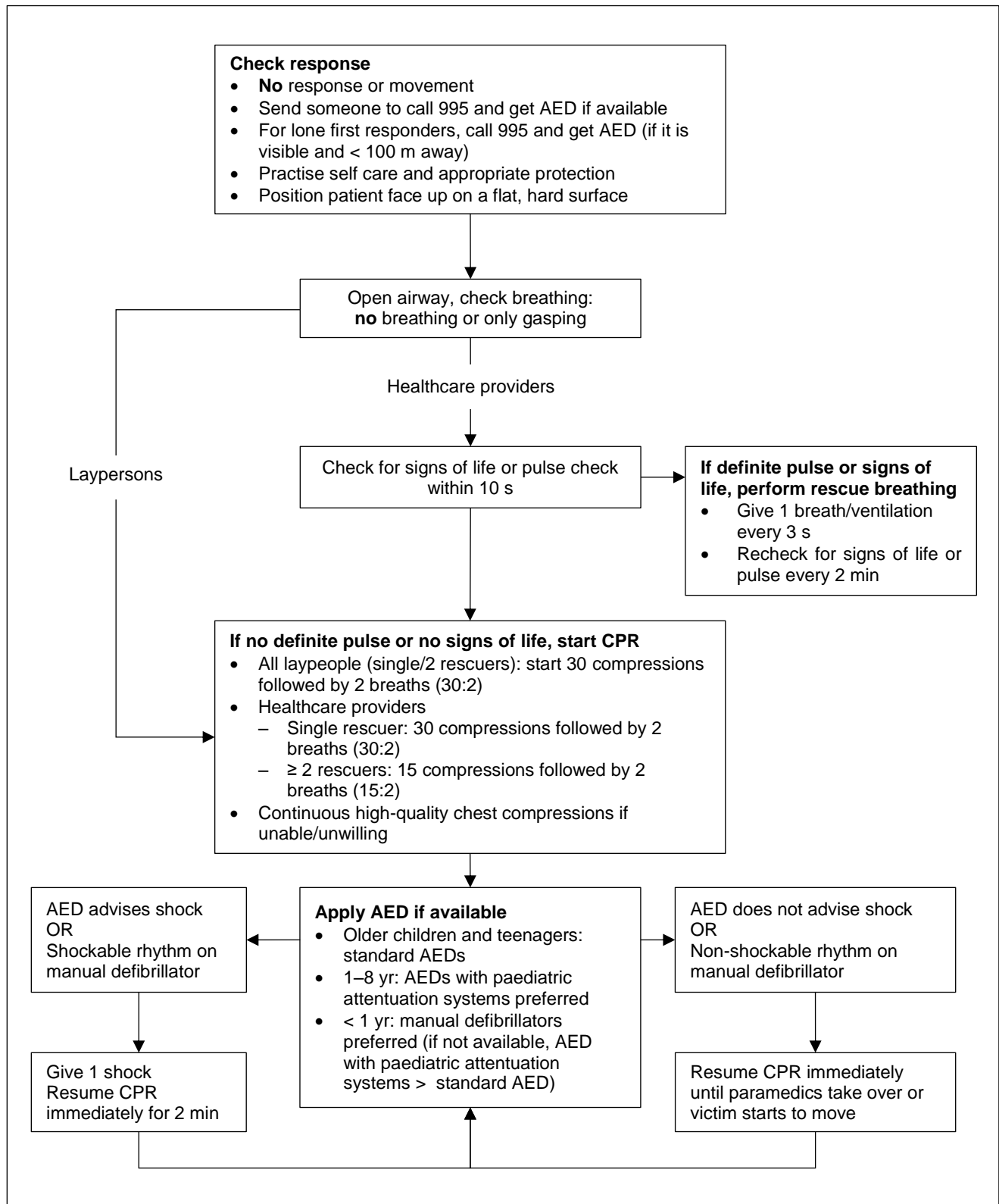


Fig. 1 Flowchart shows modified algorithm for paediatric basic life support during the COVID-19 pandemic (adapted from Singapore Paediatric Resuscitation Guidelines 2016).⁽⁵⁾ AED: automated external defibrillator; CPR: cardiopulmonary resuscitation

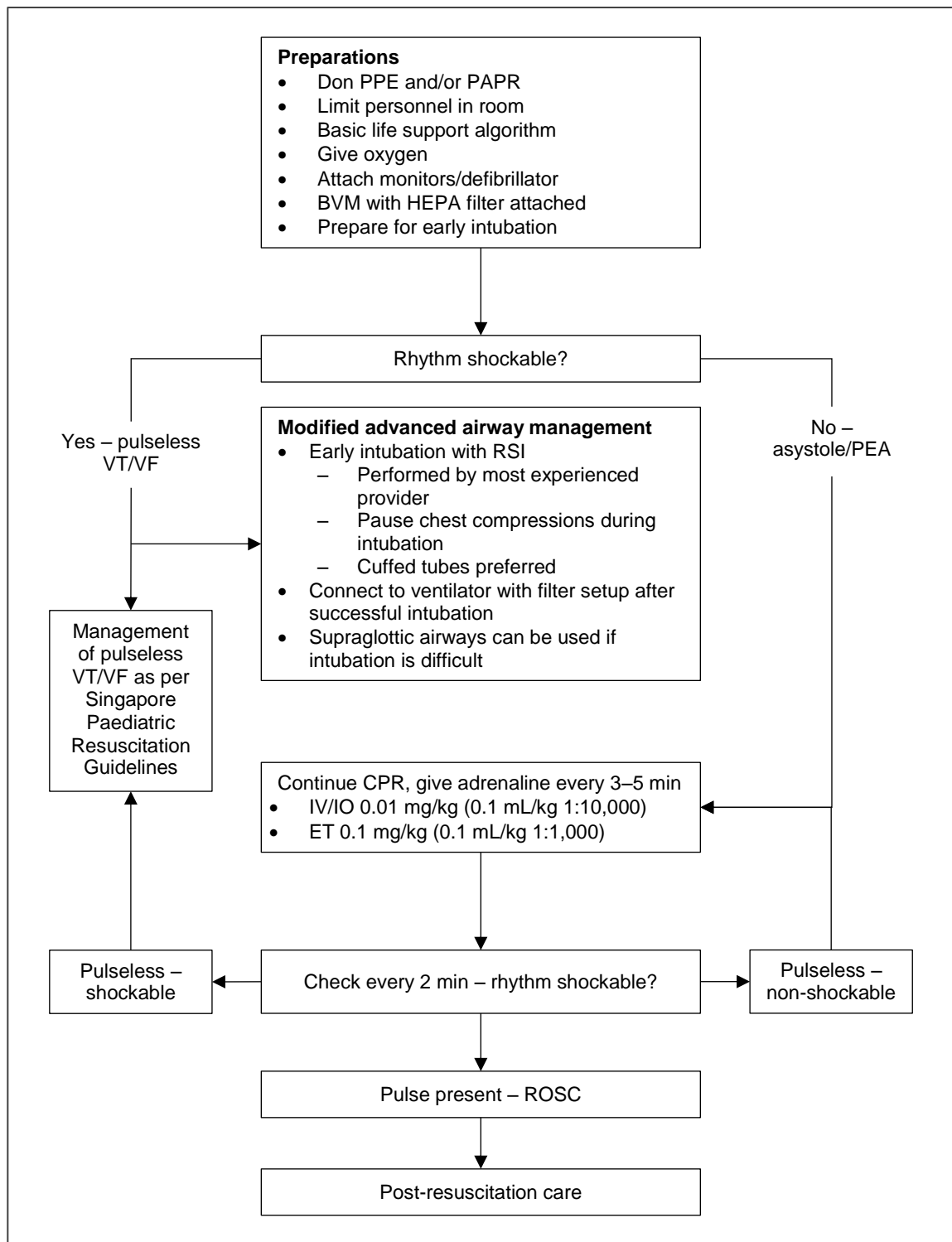


Fig. 2 Flowchart shows modified algorithm for paediatric pulseless arrest during the COVID-19 pandemic (adapted from Singapore Paediatric Resuscitation Guidelines 2016).⁽⁵⁾ BVM: bag-valve-mask; ET: endotracheal; HEPA: high-efficiency particulate air; IV/IO: intravenous/intraosseous; PAPR: powered air-purifying respirators; PEA: pulseless electrical activity; PPE: personal protection equipment; ROSC: return of spontaneous circulation; VT/VF: ventricular tachycardia/ventricular fibrillation