The Philippine Pediatric Society
in cooperation with the
Society of Pediatric Critical Care Medicine Philippines, Inc.

MANUAL on
PEDIATRIC
RESUSCITATION

Manual on Pediatric Resuscitation
Philippine Pediatric Society Inc
Society of Pediatric Critical Care Medicine Philippines Inc.

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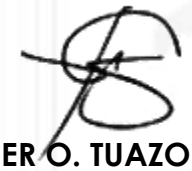
MESSAGE

Life-threatening emergencies do not allow much time for reflection and discussion but demand critical thinking, a sharp focus, and immediate action. As such, various protocols have been designed, based on research and experience, and improved over time to enable healthcare providers to respond to an emergency in a speedy manner. Practice guidelines, drills, and simulations, which include team roles, are important parts of these protocols. Practitioners and trainees have, for a long time, utilized such courses and protocols, albeit designed for a western audience.

The Philippine Pediatric Society has long wanted to create a learning resource that is relevant to local conditions and practices. After a decade of critical discussions, the Society has embarked on creating a manual that focuses on pediatric resuscitation. The manual is intended not only to be faithful to local conditions but also to empower the training programs in Pediatrics in the country for which this was designed.

The Philippine Pediatric Society would like to express our sincere gratitude to the officers and members of the Society of Pediatric Critical Care Medicine Philippines led by its President, Dr. Ramon V. Najarro, who spearheaded the initiative for this landmark project. The Manual is now available after years of hard work, a fruition of their diligent efforts and deep commitment.

I am confident this Manual will be an important tool in the training of our current and future Pediatricians and will result in the timely and better care of our children.



ALEXANDER O. TUAZON, MD, MDE
President, 2016 -2018
Philippine Pediatric Society, Inc.

MESSAGE

Pediatric emergencies happen when we least expect them. In some strange way, they can catch us unprepared and push us off our feet in our attempt to provide immediate measures to reverse an unfolding situation.

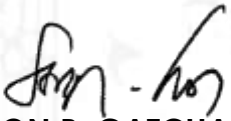
Pediatric residency training in the Philippines has been designed to produce "basic pediatricians" capable of providing standards of care in a variety of pediatric conditions, emergencies included. It is on this premise that the Philippine Pediatric Society Inc. supports all endeavors that will provide competent readiness to every pediatric resident-trainee in our country.

The cornerstone of pediatric emergency medicine is "definite and prompt recognition" of an unfolding critical scenario. It also requires a high degree of competence to make the necessary quick and correct decisions. It must elicit a heightened, effective, and adequate response to produce a reversal of a swiftly deteriorating situation.

With these guiding principles in mind, the PPS launches this unique handbook to address the need to provide high quality education and training to all pediatric healthcare practitioners in all levels. This attempt to reinforce the importance of critical thinking and decisive clinical care encompasses areas that include "clinical acumen, anticipatory and predictive thinking, precise and accurate identification of disease or disorder, correct and appropriate intervention, and preventive measures that promote sustained clinical stability."

As we blaze trails for innovative teaching-learning-training endeavors for the future generation of pediatricians, we envision this publication as a humble contribution to that archive of purposeful and useful guideposts in child healthcare.

May this addition to our knowledge armamentarium find its genuine place as a reference material and guide to better pediatric emergency care medicine in the Philippines.



SALVACION R. GATCHALIAN, MD
President, 2018 - 2020
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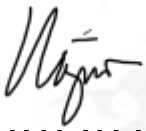
FOREWORD

The art and science of Pediatric Resuscitation has evolved progressively over the past decade. With advances in resuscitation technology and with the influx of new evidence-based data, attempts have been made to integrate and standardize various internationally generated guidelines. Incorporating relevant recommendations from 2010 to the present, the International Liaison Committee on Resuscitation (ILCOR) Pediatric Task Force has come up with the 2018 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations (CoSTR).

The World Health Organization (WHO) has taken cognizance of the nuances and limitations in the management of critically-ill children in countries with scarce or limited resources. In 2016, the Philippine Pediatric Society (PPS) Board of Trustees tasked the Society of Pediatric Critical Care Medicine Philippines (SPCCMP) to spearhead the formulation of the PPS Cardiopulmonary Resuscitation (PPS-CPR) guidelines in line with the current quality CPR recommendations and attuned to our existing national health situation. In 2017, the SPCCMP Task Force came out with its initial manuscript. This was presented to the SPCCMP board, then to the different PPS stakeholders before its final approval by the PPS Board of Trustees.

The inclusion of a chapter on special considerations in resuscitation during a pandemic like COVID 19 was added post-haste to address the current health crisis.

It is our fervent hope that this initial publication of the PPS-CPR Manual may prove invaluable in guiding our health workers in pediatric clinical settings and serve as stimulus for further studies and developments in the field of pediatric CPR.



RAMON V. NAJARRO, MD
President, 2016 - 2018
Society of Pediatric Critical Care Medicine Philippines

FOREWORD

It is with great pleasure to announce that the Philippine Pediatric Society has completed the CPR manual in collaboration with the Society of Pediatric Critical Care Medicine Philippines.

This manual is designed to guide the healthcare providers with both the basic and advanced life support in improving the outcomes and quality of care for the seriously ill children.

EVELYN L. SIASU, MD
President, 2018 - 2020
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ABBREVIATIONS

AED	Automated External Defibrillator
BMV	Bag Mask Ventilation
BP	Blood Pressure
CO_2	Carbon Dioxide
CPR	Cardiopulmonary Resuscitation
ECG	Electrocardiogram
$ETCO_2$	End-Tidal Carbon Dioxide
FBAO	Foreign Body Airway Obstruction
FiO_2	Fraction of Inspired Oxygen
IO	Intraosseous
IV	Intravenous
LA	Left Arm
LL	Left Limb
LMA	Laryngeal Mask Airway
O_2	Oxygen
PEA	Pulseless Electrical Activity
PEEP	Positive End Expiratory Pressure
QRS	QRS complex of the ECG
RA	Right Arm
ROSC	Return of Spontaneous Circulation
SADs	Supraglottic Airway Devices
SBP	Systolic Blood Pressure
SpO_2	Peripheral Pulse Oxygen Saturation
ST	Sinus Tachycardia
SVT	Supraventricular Tachycardia
VFib	Ventricular Fibrillation
VTach	Ventricular Tachycardia


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INTRODUCTION

Pediatric emergencies are commonplace in different countries today. What starts as a simple illness could easily become an emergency, putting the pediatric patient at high risk for morbidity and mortality. Early recognition of clinical deterioration and prompt and appropriate management of life-threatening events through skillful application of basic and advanced pediatric life support decreases this risk and improves patient outcomes.

Cardiorespiratory arrest in children is usually not a sudden event. Cardiac causes, such as ventricular fibrillation or pulseless ventricular tachycardia, are uncommon scenarios in children. The initial presentation is commonly respiratory distress or shock, frequently caused by tissue hypoxia as a result of respiratory failure. Depending on the underlying condition, the body responds through a series of compensatory mechanisms to maintain hemodynamic stability. It adapts to the insult or injury by modifying vital cardiopulmonary parameters until compensatory mechanisms fail, leading to a pathway of either cardiopulmonary failure or cardiopulmonary arrest.

Pediatric resuscitation efforts have set goals of identifying problems that need immediate identification, attention and intervention to protect homeostasis through the promotion of blood circulation and preservation of adequate tissue perfusion. Expertise and absolute confidence in dealing with life-threatening situations are critical to patient survival and are gained through knowledge, hands-on training, and real-world experience.

In the Philippines where resources are limited, it is important to develop guidelines that are based on local conditions. The purpose of this manual to guide pediatricians and fellows/ residents-in-training to recognize early signs of clinical deterioration (respiratory distress, respiratory failure and shock) and provide timely and appropriate intervention to prevent cardiopulmonary failure and cardiac arrest.

This manual will be used under the auspices of the Philippine Pediatric Society, Inc. and is intended for use by doctors caring for Filipino children.


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CHAPTER 1. PEDIATRIC BASIC LIFE SUPPORT

Objectives:

At the end of this chapter, the students should be able to:

1. Gain knowledge and skills in pediatric basic life support.
2. Know the importance of delivering high-quality Cardiopulmonary Resuscitation (CPR) and its impact on survival.
3. Perform high-quality CPR for an infant and child.
4. Demonstrate the appropriate use of an automated external defibrillator during CPR.

Introduction:

Pediatric basic life support starts with the identification of important parameters in resuscitation such as airway, breathing, and circulation. Most pediatric cardiac arrests are due to respiratory problems, shock, or both rather than a primary cardiac event. The provision of effective CPR, leading to better outcomes, entails a combination of chest compressions and ventilations.

Steps in Pediatric Basic Life Support:

In pediatric basic life support, the sequence of actions are as follows:

A. Check for scene safety.

The surroundings should be safe for both the rescuer and the child prior to the initiation of resuscitation. If the area is deemed unsafe, the child must be transferred to a safer area, mindful of the possible risks of deterioration and of adding more injuries to the child.

B. Check for responsiveness.

Firmly tap the child's shoulders with your hands and shout in both ears: "Are you alright?" If the victim is an infant, flick the sole of the foot and/or rub the back.

It is important to check for responsiveness as management and resuscitation protocols differ for a child who is responsive and a child who is not.

1. **IF THE CHILD IS RESPONSIVE** (i.e., answers, moves, or cries):
    a. Make sure that the rescuer and the child are in a safe environment
    b. Keep the child in the position you found him in
    c. Call for help.
    d. While waiting for the code team or the medical emergency team to arrive, assess the child regularly, ensuring that the child is breathing and has a pulse.

2. **IF THE CHILD IS UNRESPONSIVE:**
    a. Call or shout for help.
    b. Turn the child carefully on his back.
    c. Check for pulse and breathing simultaneously.

C. Check for pulse and breathing simultaneously.

1. **HOW TO CHECK FOR BREATHING**
    Look at the chest, watching for chest expansion or chest rise.

2. **HOW TO CHECK FOR PULSE**
    Using 2 fingers, palpate the brachial pulse of the infant or the carotid pulse of the child (Fig 1)

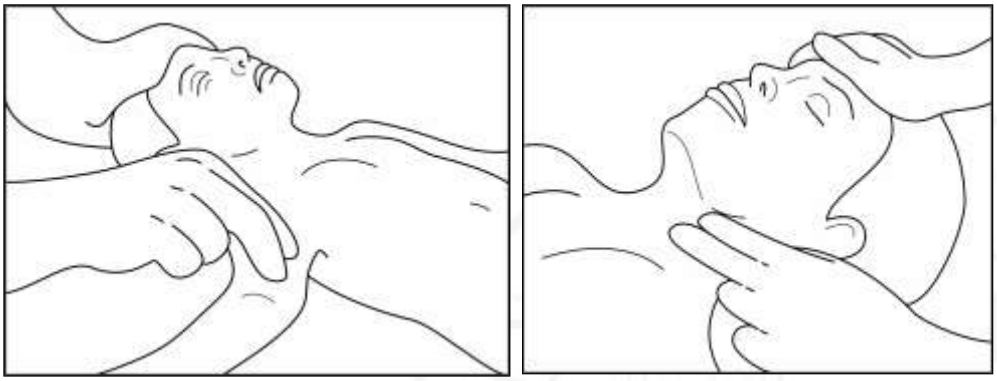


Figure 1. *Brachial pulse in an infant (left); Carotid pulse in children. (right)*

*****CHECK PULSE AND BREATHING SIMULTANEOUSLY FOR 5 - 10 SECONDS**

3. **IF THE CHILD HAS A PULSE WITH NORMAL BREATHING**
    a. Put the child in the recovery position.
    b. Consider cervical spine injury if there is history of trauma.
    c. Call for help.
    d. Regularly check or monitor the child's breathing and pulse.

Recovery Position:

A patient who is unconscious but with a clear airway and is breathing normally, should be positioned in the recovery position (Fig 2) to prevent airway obstruction and to reduce aspiration of saliva, naso-oral secretions, and vomitus.

- Put the patient in the lateral position, to allow free drainage of fluids.
- Make sure that the position is stable and will not put the patient in further danger.
- For an infant, place a shoulder pad or a rolled-up blanket along his back to prevent discomfort and to maintain the lateral position.
- Prevent any pressure on the patient's chest that will impair his breathing.
- Ensure that the patient can easily and safely be turned to the side and back to the recovery position.
- Be mindful of any possible cervical spine fracture and do in-line cervical stabilization maneuvers.
- Regularly turn the patient on both sides to prevent pressure points.
- Adult recovery position may also be suitable for children.

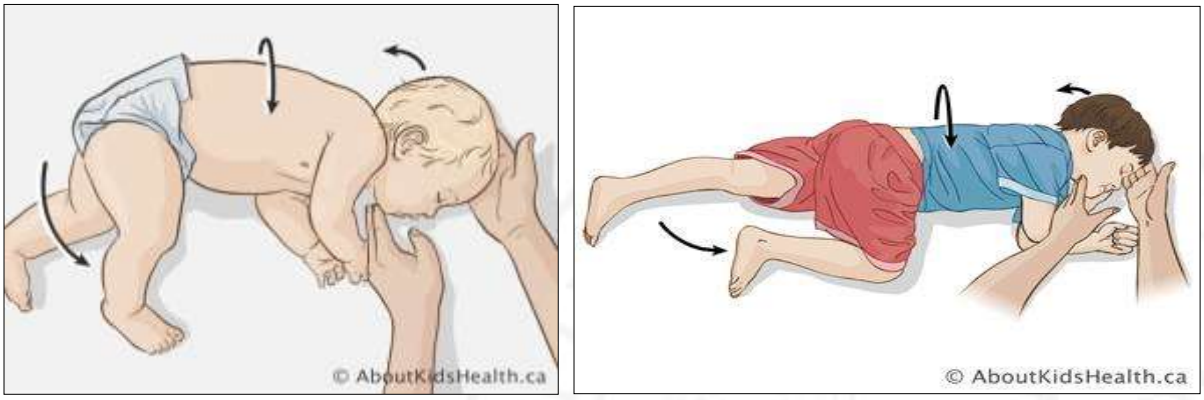


Figure 2. *Recovery Positions: Infant (left) and Child (right)*

4. IF THE CHILD HAS A PULSE WITH ABNORMAL BREATHING or NOT BREATHING AT ALL

a. Open the airway. Remove the obstruction, if visible; do not attempt a blind finger sweep.
b. Do ventilation/ rescue breathing

1) Child

a) Open the airway by doing the head-tilt chin-lift maneuver or jaw thrust (Fig 3) for victims with history of trauma.
b) Pinch the nose using the index finger and the thumb of one hand, resting the heel of that hand on the child's forehead.
c) Allow the child's mouth to open while maintaining chin-lift with the other hand.
d) Take a normal breath and place your mouth on the barrier device. Use a bag mask device if available. Ensure a tight seal.
e) Blow steadily for about 1 second and watch the chest rise.
f) Take another breath and repeat this sequence. Give 1 breath every 2-3 seconds or 20-30 breaths per minute (bpm).

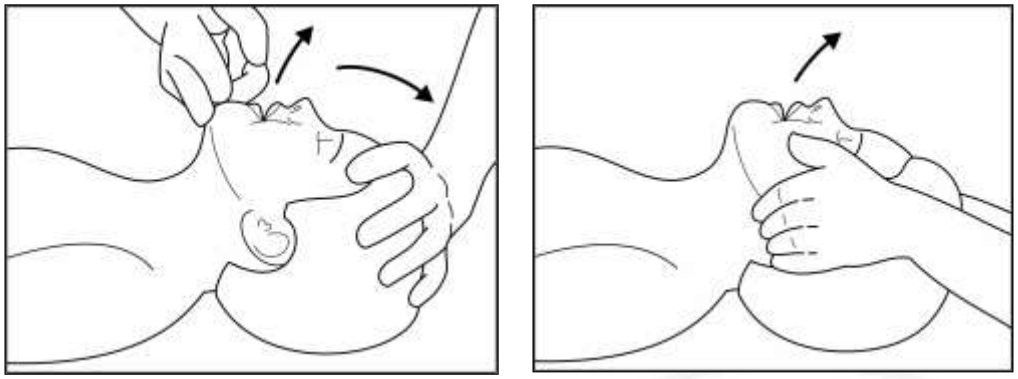


Figure 3. *Head-tilt-chin-lift maneuver (left) Jaw thrust maneuver (right)*

2) Infant

a) Put patient on supine. Place a shoulder roll to maintain sniffing position. Open the airway. (Fig 4)
b) Take a normal breath and place your mouth on the barrier device. Use a bag mask device if available. Ensure a tight seal.

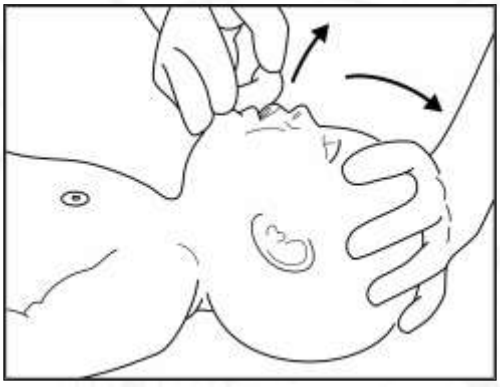


Figure 4. *Opening the Infant's Airway*

c) You may not be able to cover both the mouth and nose of older infants with the device. In this instance, seal the

infant's nose and blow through the mouth. Use a bag mask device, if available. Ensure a tight seal.

d) Blow steadily for about 1 second and watch the chest rise.
e) Take another breath and repeat this sequence. Give 1 breath every 2-3 seconds or 20-30 bpm.

3) Adolescent

a) Open the airway by doing the head-tilt chin-lift maneuver or Jaw thrust (Fig 3) for victims with history of trauma.
b) Pinch the nose using the index finger and the thumb of one hand, resting the heel of that hand on the victim's forehead.
c) Allow the adolescent's mouth to open while maintaining chin-lift with the other hand.
d) Take a normal breath and cover the adolescent's mouth with your mouth, preferably with a barrier device. Use a bag mask device if available. Ensure a tight seal.
e) Blow steadily for about 1 second and watch the chest rise.
f) Take another breath and repeat this sequence. Give 1 breath every 5-6 seconds or 10-12 breaths per minute.

5. IF THE CHILD HAS NO PULSE AND NO BREATHING

a. Activate Emergency Medical Services (EMS)/Code Team and ask for an Automated External Defibrillator (AED).
b. Perform high-quality CPR starting with chest compressions while waiting for help to arrive. Start CPR beginning with chest compressions and combine rescue breathing at a ratio of 30 compressions to 2 ventilations or breaths.

1) Child

a) The site of chest compressions is the lower half of the sternum. Ensure that the child is lying flat on a firm surface.
b) Place the heel of one hand on the lower half of the sternum. Place the heel of the other hand on top of the first hand and interlace the fingers of both hands. (Fig 5)

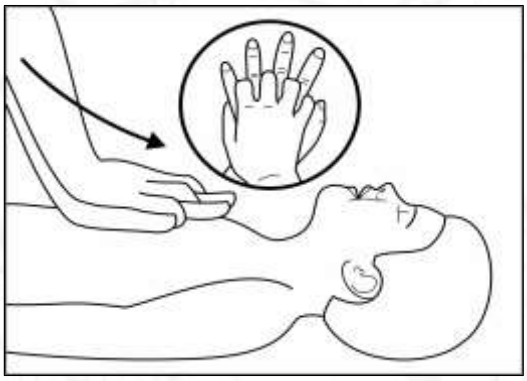


Figure 5. *Hand Position in Chest Compressions*

c) Straighten both your elbows and lock them into position, with your shoulders directly over the child's chest.
d) Compress at a depth of at least one third of the anterior-posterior diameter of the chest or about 5 cm.
e) Allow adequate time for the chest to completely recoil after each compression.
f) Compress the chest at a rate of 100–120 per minute.
g) After 30 compressions, give 2 effective breaths while watching for chest rise.
h) Limit interruptions to less than 10 seconds.
i) For a single rescuer, do chest compressions and ventilations at a ratio of 30:2. Check pulse and breathing every after 5 cycles or 2 minutes.
j) For two or more rescuers, do chest compressions and ventilations at a ratio of 15:2. Check pulse and breathing every after 10 cycles or 2 minutes.

2) Infant

a) The site of chest compression is the lower half of the sternum just below the nipple line.
b) Ensure that the infant is lying flat on a firm surface.
c) Apply compression techniques.

Compression technique:

If you are a single rescuer, compress the infant's sternum using the tips of two fingers of one hand (Fig 6). When there are two or more rescuers, compress the infant's sternum using the two-thumb encircling technique. Place both thumbs flat side-by-side on the lower half of the infant's sternum with the tip pointing towards the infant's head and spread both hands with the fingers together to encircle the lower part of the rib cage, supporting the infant's chest (Fig 7).

i. Compress the sternal area of the infant by at least one-third the anterior-posterior diameter of the chest or at a depth of about 4 cm.
ii. Do the compressions at a rate of 100–120 per minute.
iii. Allow adequate time for the chest to completely recoil after each compression.

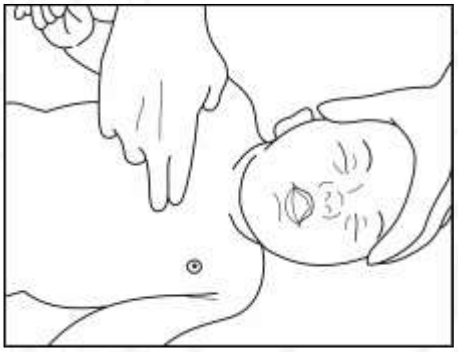


Figure 6. *Single rescuer infant chest compressions using 2-finger technique*

iv. After 30 compressions, give 2 effective breaths while watching for chest rise.
v. Limit interruptions to less than 10 seconds.
vi. For a single rescuer, do chest compressions and ventilations at a ratio of 30:2. Check pulse and breathing every after 5 cycles or 2 minutes.
vii. For two or more rescuers, do chest compressions and ventilations at a ratio of 15:2. Check pulse and breathing every after 10 cycles or 2 minutes.

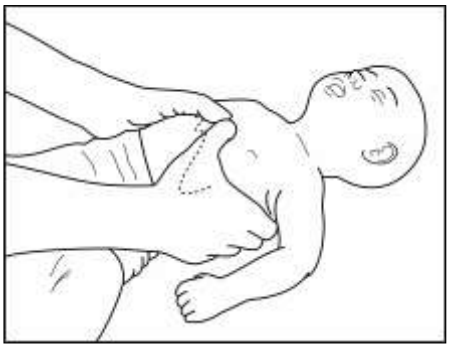


Figure 7. *Multiple rescuer infant chest compression using the encircling techniques*

3) Adolescent

a) The site of chest compressions is the lower half of the sternum. Ensure that the adolescent is lying flat on a firm surface.
b) Place the heel of one hand on the lower half of the sternum. Place the heel of the other hand on top of the first hand and interlace the fingers of both hands.
c) Straighten both your elbows and lock them into position, with your shoulders directly over the child's chest.
d) Compress at a depth of at least one third of the anterior-posterior diameter of the chest or about 5 cm.
e) Allow adequate time for the chest to completely recoil after each compression.
f) Compress the chest at a rate of 100–120 per minute.
g) After 30 compressions, give 2 effective breaths while watching for chest rise.
h) Limit interruptions to less than 10 seconds.
i) Do chest compressions and ventilations at a ratio of 30:2. Check pulse and breathing every after 5 cycles or 2 minutes.

PEDIATRIC BASIC LIFE SUPPORT ALGORITHM

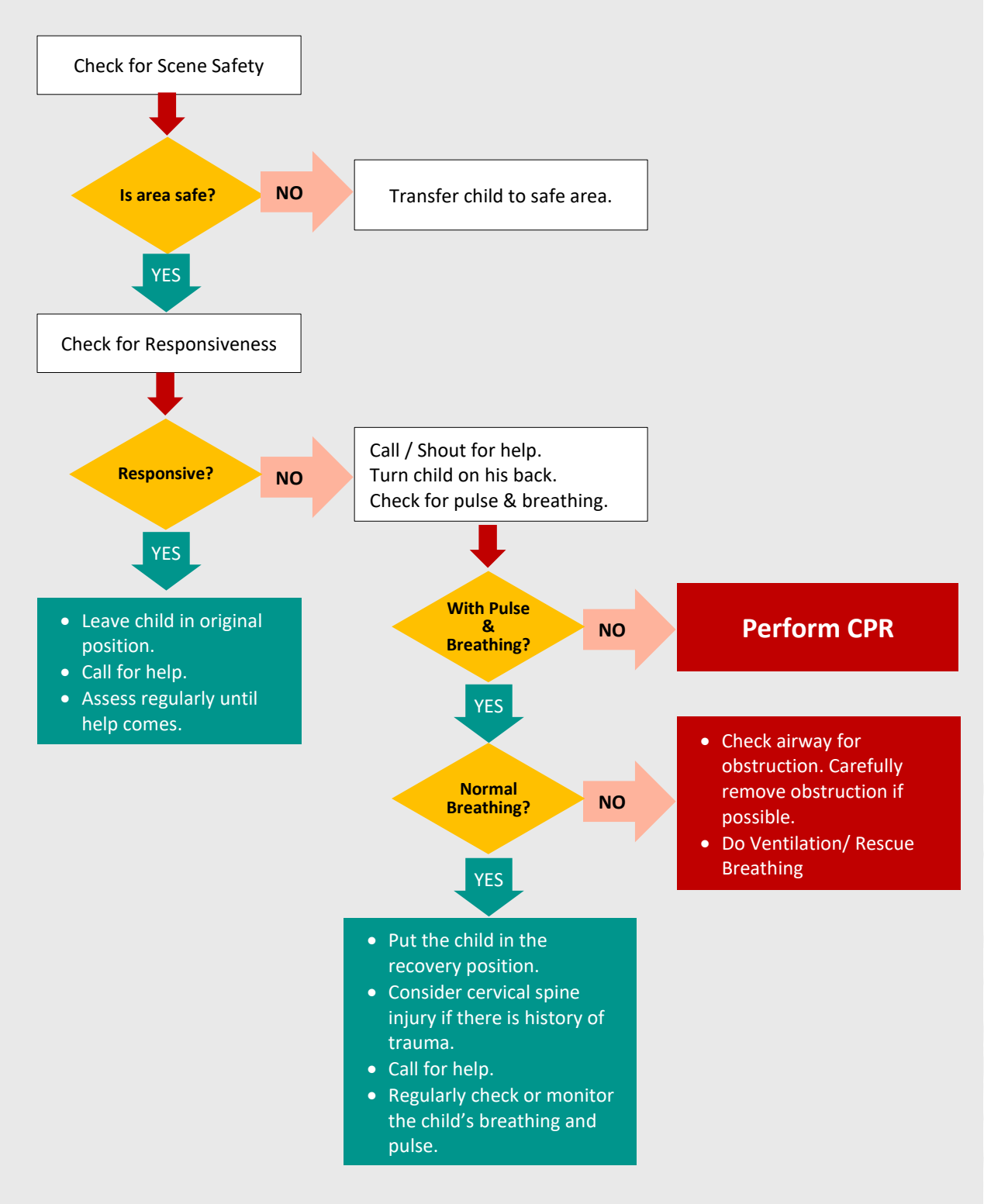


Figure 8. *Pediatric Basic Life Support Algorithm*

Use of the Automated External Defibrillator (AED)

An automated external defibrillator (AED) (Fig 9) is a portable electronic device that can automatically analyze, diagnose, and treat life-threatening cardiac arrhythmias, such as ventricular fibrillation (VFib) and ventricular tachycardia (VTach) which can lead to sudden cardiac arrest. An AED must be available and accessible at all times.

As soon as the EMS or Code Team arrives with an AED, he or she will place the AED at the head part of the victim. The first rescuer will then prompt the second rescuer to switch roles. The second rescuer will take over chest compressions and the first rescuer will now operate the AED as follows.

1. Turn the AED on and follow the voice prompts.
2. Place the pads on the patient's bare chest, following the placement instructions found on the pads (one pad on the right upper portion of the chest and the other pad below the left nipple). Avoid overlapping.
3. Plug the connector next to the flashing light.
4. Wait for the AED to prompt the rescuers to stay clear of the patient while it analyzes the rhythm.
5. If the AED advises shock, the first rescuer instructs the compressor to continue chest compressions while the AED is charging.
6. If the AED advises to deliver shock, let everyone stay clear of the patient and press the shock button.
7. After a shock is delivered, resume high quality CPR starting with chest compressions.



Figure 9. *Automated External Defibrillator (AED)*

The AED usually has two sets of pads: adult pads and pediatric pads (Fig 10). Pediatric attenuated pads are used in children 1-8 years of age, while adult pads are used in adults and in children more than 8 years of age.



Figure 10. *Adult (left) and pediatric (right) AED pads*

Use adult pads in instances when there is no available pediatric pad for children 8 years old and below. Place one pad on the child's chest and the other pad at the back. Follow the steps in operating the AED. In cases that the age of the child or the victim is unknown, use adult pads as well.

Note: If the arrest is unwitnessed, perform CPR approximately 2 minutes (5 cycles for a single rescuer, and 10 cycles for two or more rescuers) before an AED is used.

CHAPTER 2. FOREIGN BODY AIRWAY OBSTRUCTION (FBAO)

Objectives:

At the end of this chapter, the students should be able to:

1. Know the different signs of foreign body airway obstruction (FBAO) and techniques in expelling a foreign body.
2. Demonstrate the maneuvers for expelling aspirated foreign body.

Introduction:

A foreign body obstructing the airway is a common emergency in infants and children. This causes difficulty in the passage of air in and out of the patient's lungs. Different techniques are employed to help expel these foreign bodies from the airway.

Signs of FBAO:

Foreign body airway obstruction is heralded by the sudden onset of coughing, especially if there is recent history of playing or eating small objects. The type of obstruction is related to the type of cough presented.

1. Effective cough (Mild airway obstruction)
    a. With verbal output or crying
    b. Loud cough
    c. Inspiratory stridor
    d. Able to breathe before coughing
    e. Fully responsive

2. Ineffective cough (Severe airway obstruction)
    a. No verbal output
    b. Unable to breathe
    c. Cyanosis
    d. Decreasing level of consciousness

Techniques in expelling a foreign body obstructing the airway:

There are different techniques employed in expelling a foreign body out of the airway, such as back blows, chest thrusts, and abdominal thrusts. These techniques increase the intra-thoracic pressure which helps remove the foreign body from the airway.

Chest thrusts are used in infants while abdominal thrusts are for children and adolescents. The abdominal thrust is not recommended for infants due to possible harm and traumatic injury.

A. Back Blows in infants

1. Sit or kneel down to easily support the infant safely across your lap.
2. Place the infant in a head downward prone position to enable gravity to facilitate the removal of the foreign body.
3. Support the infant's head with one hand. (Fig 11).
4. Do not compress the soft tissues under the infant's jaw as this can worsen the airway obstruction.
5. Deliver up to 5 sharp back blows with the heel of one hand on the back area between the shoulder blades. Aim to relieve the obstruction with each back blow.



Figure 11. *Back blows in infants*

B. Chest thrusts in infants:

1. Turn the infant on its back while firmly supporting the head with your hand, making sure the head is lower than the body.
2. Locate the area for chest thrusts.
3. Give five chest thrusts similar to chest compressions (Fig 12).



Figure 12. *Chest thrust in infants*

C. Abdominal thrusts in children over 1 year:

1. Stand or kneel behind the child then place your arms under the child's arms, encircling his torso.
2. Clench your fist and place it between the umbilicus and the xiphisternal area, then grasp your hand with the other hand and pull sharply inwards and upwards. (Fig 13)
3. Repeat up to five times ensuring pressure is not applied to the xiphoid process.



Figure 13. *Abdominal thrust in children*

Steps in FBAO Management in Pediatric Patients:

1. Assess scene safety.
2. Assess the severity.

For conscious patients with partial obstruction:

Encourage the patient to cough as you continue to monitor the patient's condition while he attempts to expel the obstruction; watch out in case the patient's condition deteriorates.

For conscious patients with total obstruction:

1. Give 5 back blows and 5 thrusts (Chest thrusts for infants and abdominal thrusts for children more than 1 year of age).
2. After doing chest or abdominal thrusts, it is important to reassess the patient.
3. If the foreign object is not yet expelled and the patient remains conscious, continue the sequence of back blows and thrusts. Call for help and do not leave the child at this point.
4. If the object is expelled successfully, assess the child's condition. There is a possibility that part of the foreign object is still present in the respiratory tract and that may cause complications. If in doubt, get medical assistance.

For unconscious patients:

1. Position the patient on a firm, flat surface, then call for help.
2. Immediately check for pulse and breathing simultaneously for about 5 – 10 seconds.
3. If there is no pulse nor breathing, perform high quality CPR but with one difference, each time you give a breath, look for any obstructing object.
4. If an obstructing object is seen, try to remove it with one finger but do not attempt a blind finger sweep which may push the object down into the lower airway.
5. Continue high quality CPR. Do this until advanced life support arrives. Once ROSC is achieved, transfer the patient to a higher care unit.

CHAPTER 3. PEDIATRIC ADVANCED LIFE SUPPORT

Objectives:

At the end of this chapter, the students should be able to:

1. Recognize a patient needing immediate intervention using the Initial Impression, Primary, Secondary, and Tertiary Assessment
2. Formulate a plan of management based on the patient's physiologic status and diagnosis.

Introduction:

Children have efficient compensatory mechanisms that are activated during critical illness or injury. When compensatory mechanisms fail, the child may deteriorate and suffer from irreversible physiologic imbalances, which can be fatal.

Early recognition of the critically-ill or injured child is the cornerstone in the prevention of cardiopulmonary arrest.

Systematic Approach

The systematic approach in the care of a sick or injured child is a continuous process of assessment, classification and management. This process will continue until the patient is stable enough to be transferred to an intensive care unit. In the event that the patient deteriorates, life-saving measures or interventions must be done.

Evaluate, Identify, and Intervene Sequence

Use the evaluate, identify, and intervene sequence when caring for a sick or injured child. From the information gathered during evaluation, identify the child's problem by type and severity, then intervene appropriately based on the physiologic status and diagnosis.

A. INITIAL IMPRESSION

This visual and auditory tool is used as you approach the patient in the first few seconds of encounter.

1. Parameters:
   a. **Appearance** or the level of consciousness
   b. **Breathing**: rate, effort, and abnormal sounds
   c. **Color**: pink, pale, mottled, or cyanotic

2. Identify and manage the physiologic condition of the patient as:
   a. Respiratory Distress
   b. Respiratory Failure
   c. Life threatening condition with or without signs of life.

3. Reassess the patient's condition using the primary assessment.

B. PRIMARY ASSESSMENT

This is a more detailed tool for assessing and evaluating the patient:

1. Parameters:
   a. AIRWAY
      1) **CLEAR:** The victim is breathing comfortably. No intervention needed.
      2) **MAINTAINABLE:** The victim needs non-invasive interventions such as proper positioning, suctioning or airway adjuncts.
      3) **UNMAINTAINABLE:** The airway cannot be maintained despite proper positioning, suctioning or airway adjuncts. An advanced airway is necessary.

   b. BREATHING
      1) Respiratory rate
      2) Effort of breathing
      3) Air entry or breath sounds.
      4) Oxygen saturation

   c. CIRCULATION
      1) Heart rate
      2) Blood pressure
      3) Central and Peripheral pulse
      4) Capillary refill time
      5) Urine Output

d. **DISABILITY:** Check the level of consciousness, pupils, and blood sugar.

e. **EXPOSURE:** Check the presence of fever, rashes and bruises.

2. Given the information from the identified parameters, classify the patient's condition using Table 1.

Table 1. *Classification of Patient's Condition based on Primary Assessment*

A. Respiratory distress **B. Respiratory failure**	Upper airway obstruction
	Lower airway obstruction
	Lung tissue disease
	Disordered control of breathing
C. Compensated shock **D. Hypotensive shock**	Hypovolemic shock
	Obstructive shock
	Distributive septic shock
	Cardiogenic shock

C. SECONDARY ASSESSMENT

This tool focuses on the resuscitation-oriented history and pertinent physical examination of the patient.

1. Parameters (utilizing the mnemonic, S-A-M-P-L-E):
   S – Signs and Symptoms
   A – Allergy
   M – Medications
   P – Past Medical History
   L – Last Meal
   E – Events leading to current condition

2. After the secondary assessment, a diagnosis is made, and specific intervention is given to the patient.

D. TERTIARY ASSESSMENT:

This includes the laboratory, radiologic and other diagnostic examinations.

High-Functioning Team Roles and Dynamics

Healthcare providers must have an effective teamwork to increase the chances of a positive, long-term outcome. Medical expertise, mastery of resuscitation skills, effective communication and team dynamics lead to a constructive high-functioning team.

The timing, quality, coordination, and administration of interventions are essential for a successful resuscitation attempt.

Elements of Effective Team Dynamics in a High-Functioning Team

1. Clear Roles and Responsibilities

Each member is assigned a distinct role and responsibility to effect a successful resuscitation.

Table 2. Team Roles for Resuscitation

TEAM MEMBER	ROLE
Team Leader	Keeps the team organized, assigns roles, trains members, and facilitates all actions during the code.
Compressor	Responsible for effective chest compressions
Airway Manager	Manages all aspects concerning the patient's airway.
AED/Monitor/ Defibrillator	Operates the AED and shares chest compression duties.
IV/IO Medications Provider	In charge of vascular access, administration of medications and provides feedback.
Time Recorder	Records frequency and duration of CPR, interventions, medications, and treatments.

2. Knowing One's Limitations

Each member must acknowledge their limitations and the extent of their capabilities. Asking for help and calling for assistance early is essential.

3. Constructive Interventions

Each member should know when and how to intervene in a tactful manner if an inappropriate action is about to occur.

4. **Knowledge Sharing**

   Team members should share new information, ideas, and suggestions to avoid fixation errors.

5. **Summarizing and Reevaluating**

   Members must learn to summarize and reevaluate a patient's assessment, the findings and interventions performed. They should remain open to differential diagnoses and changes in treatment.

6. **Closed-Loop Communication**

   Team members should maintain a closed-loop communication to ensure correct transmission of messages regarding allocation and completion of tasks.

7. **Clear Messages**

   Distinct, calm and concise communication among team members should be used to avoid errors.

8. **Mutual Respect**

   Respectful behavior of the team members must be maintained to promote a supportive working environment.


PHILIPPINE PEDIATRIC SOCIETY
1947

CHAPTER 4. CRITICAL CONDITIONS NEEDING RESUSCITATION

A. RESPIRATORY DISTRESS/FAILURE

Objectives:

At the end of this section, the students should be able to:

1. Recognize respiratory distress and failure.
2. Identify the types of respiratory problems in children.
3. Perform rapid initial evaluation and stabilization of children with respiratory distress and failure.

Introduction:

For the pediatric age group, respiratory insufficiency or compromise leading to respiratory arrest commonly precedes cardiac arrest. Prompt recognition and effective airway support are an essential component in preventing cardiopulmonary arrest.

Respiratory Distress:

A clinical state where there is an abnormal respiratory pattern characterized by the following signs and symptoms:

1. Tachypnea
2. Increased respiratory effort
    a. Use of accessory muscles: chest indrawing/retractions (intercostal, subcostal, suprasternal)
    b. Nasal flaring
3. Restlessness and agitation
4. Pallor
5. Tachycardia
6. Abnormal audible breath sounds (stridor, wheezing)

Without prompt and appropriate intervention, respiratory distress can rapidly progress to respiratory failure.

Respiratory Failure

A clinical state wherein oxygenation and/or ventilation are insufficient to meet the body's metabolic demands.

Signs and symptoms of respiratory failure are the following:

a. Grunting or head bobbing
b. Bradypnea or apnea
c. Decreased sensorium
d. Cyanosis
e. Tachycardia or bradycardia
f. Hypoxemia (<90% SaO_2) despite administration of 100% oxygen
g. Hypercarbia

Without prompt and appropriate intervention, respiratory failure can lead to cardiopulmonary arrest.

Types of Respiratory Problems in Children

The following table presents the description, signs and symptoms, and examples of the types of respiratory problems found in children.

Table 3. *Types of Respiratory Problems in Children*

	Upper Airway Obstruction	Lower Airway Obstruction	Lung Tissue Disease	Disordered Control of Breathing
Description	Obstruction of the upper airway from the nasal cavity to the larynx	Obstruction of the lower airway at the level of trachea, bronchi and bronchioles	Scarring or inflammation of lung tissue impairing gas exchange	Malfunction of breathing control mechanisms
Signs and Symptoms **A. Sensorium**	Anxious or Irritable (mild), Lethargic or Unresponsive (severe)	Anxious or Irritable (mild), Lethargic or Unresponsive (severe)	Anxious or Irritable (mild), Lethargic or Unresponsive (severe) retraction	Anxious or Irritable (mild), Lethargic or Unresponsive (severe)
B. Color	Pale/Mottled/ Cyanotic	Pale/Mottled/ Cyanotic	Pale/Mottled/ Cyanotic	Pale/Mottled/ Cyanotic
C. Respiration Rate	Increased	Increased	Increased	Variable
Effort	Increased	Increased	Increased	Variable
Air entry	Decreased	Decreased	Decreased	Variable
Breath sounds	Stridor	Wheezing	Crackles and Grunting	Normal
Examples	Epiglottitis, croup, foreign body, anaphylaxis	Asthma, bronchiolitis	Pneumonia	Seizure, CNS infection, Poisoning/ Drug overdose

Regardless of the etiology of respiratory distress, it cannot be overemphasized that immediate recognition, stabilization of airway, and timely intervention are key to preventing the progression of an impending respiratory failure to respiratory arrest. Thus, it is important to recognize the causes of respiratory distress that need immediate attention and intervention.

Rapid Initial Evaluation and Stabilization

Initial assessment and evaluation of acutely ill or injured children focuses on ***appearance, breathing,*** and ***color***. This enables the healthcare provider to quickly identify conditions that require immediate intervention. Initial assessment should take less than one minute, allowing the patient to maintain a position of comfort that best supports the airway.

The common features specific to children with respiratory distress are:

Appearance: Irritability, restlessness, agitation, and combativeness are early manifestations of hypoxia. Somnolence and lethargy are signs indicative of severe hypoxia, hypercarbia, and/or respiratory fatigue.

Breathing: Tachypnea is usually the initial sign of respiratory difficulty/distress. Other indicators include abnormal breath sounds like stridor and wheezing, increased use of accessory muscles, and patients maintaining a position of comfort to maximize airway opening (e.g., "sniffing" position for upper airway obstruction and "tripod" position for lower airway obstruction).

Color: Cyanosis, mottling and pallor are varying findings indicative of either hypoxemia and/or shock.

After rapid initial assessment, management should focus on the following:

Airway:

- Provide 100% fraction of inspired oxygen (FiO_2).
- Allow the patient to assume a position of comfort or perform maneuvers to open the airway— jaw thrust (suspected trauma) or head-tilt chin-lift (without trauma).
- Clear the airway by suctioning the oropharynx not more than 10 seconds.
- Insertion of artificial airway (Nasopharyngeal or Oropharyngeal airway) if indicated.

Breathing:

- Assist ventilation by manually providing 100% oxygen through a non-rebreather mask or other high-concentration devices; or positive pressure ventilation by a bag-valve mask or flow-inflating device.
- Monitor oxygenation by pulse oximetry (SpO_2).
- Monitor ventilation by end-tidal carbon dioxide ($ETCO_2$).
- Administer medications as needed to treat underlying cause (e.g., inhaled salbutamol for asthma/status asthmaticus or inhaled racemic epinephrine for croup)

Circulation:

- Monitor heart rate and rhythm
- Establish vascular access for fluid resuscitation and medications if needed.

Management of Respiratory Distress/Failure

1. Use of Oxygen Supplementation

Oxygen supplementation is given to a child in respiratory distress and/or shock. In a critically-ill or injured patient, high-flow oxygen is used.

Table 4. *Amount of Oxygen Flow Delivered by Device*

Device		Amount of Oxygen Delivered
Low Flow Devices	Simple nasal cannula	0.25 – 4 Liters per minute
	Simple face mask	6 - 10 Liters per minute
High Flow Devices	Non-rebreathing face mask	11 - 15 Liters per minute
	High flow nasal cannula	6 – 60 Liters per minute

2. Airway Management

Open the airway by using the head-tilt chin-lift maneuver or jaw thrust. The healthcare provider must optimize ventilation, ensure adequate oxygenation, and always start with 100% FiO_2. Respiratory monitoring must be done by attaching a pulse oximeter. Adequate ventilation and oxygenation may be achieved through the use of bag-mask ventilation (BMV), laryngeal mask airway (LMA) or other supraglottic airway, invasive ventilation, and/or surgical airway. It is recommended to monitor end tidal carbon dioxide levels in an intubated patient if available.

3. Rescue breathing

It is the act of providing breaths to a patient with detectable cardiac activity (positive pulse) but with apnea or absence of breathing. The rate of breaths given depends on the patient. Table 5 shows how many breaths are given per minute.

***Table 5**. Rate of rescue breaths*

Patient	Rate of breaths given
Infant or child	1 breath every 2 to 3 seconds (20 - 30 breaths per minute)
Adolescent	1 breath every 5 to 6 seconds (10 -12 breaths per minute)

Each breath should result in visible chest rise and fall. Check the pulse every 2 minutes. If the patient becomes pulseless, begin CPR.

4. Oral and Nasopharyngeal Airways

An oropharyngeal airway (OPA) (Fig 14) and nasopharyngeal airway (NPA) (Fig 15) can help open and maintain the airway of a child. OPA is used to help open the airway of an unconscious child with no gag reflex. An appropriate OPA size is measured from the corner of the mouth to the angle of the mandible. NPA is used in a conscious or semi-conscious child with an effective gag reflex. However, it should not be used in patients with basal skull fracture or coagulation defects. An appropriate NPA size is measured from the tragus of the ear to the tip of the nose.



***Figure 14.** Oropharyngeal Airway*

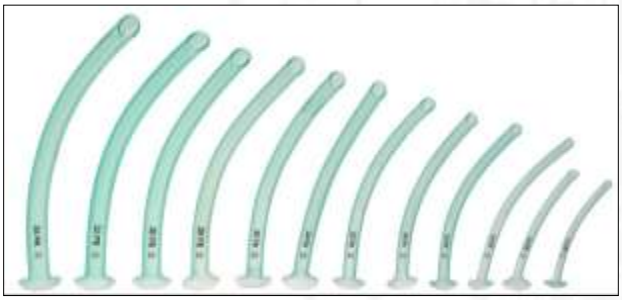


***Figure 15.** Nasopharyngeal Airway*

5. Supraglottic Airway Devices

Supraglottic airway devices (SADs) (Fig 16) can be used in achieving airway control and ventilation. SADs are helpful in airway obstructions caused by supraglottic airway abnormalities, or if bag-mask ventilation is difficult or not possible.

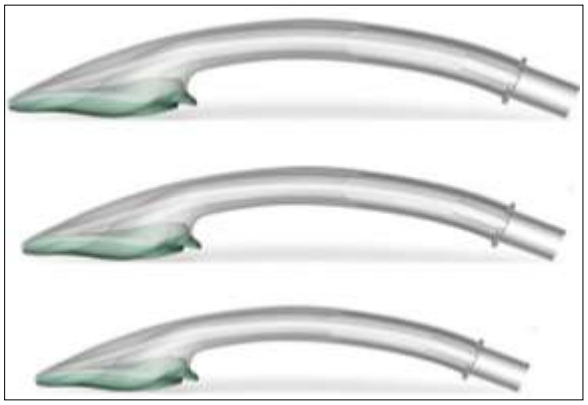


Figure 16. *Supraglottic Airway Device*

SADs are used in patients who are very difficult to intubate especially in emergency situations. It is an alternative to endotracheal intubation and is used for those who will not require prolonged intubation. It is used by skilled and experienced physicians.

6. Endotracheal Intubation

Endotracheal intubation (Fig 17) is the most secure and effective way of establishing and maintaining the airway. It also prevents gastric distension, protects the lungs from aspiration, enables adequate control of the airway pressure, and provides positive end expiratory pressure (PEEP).

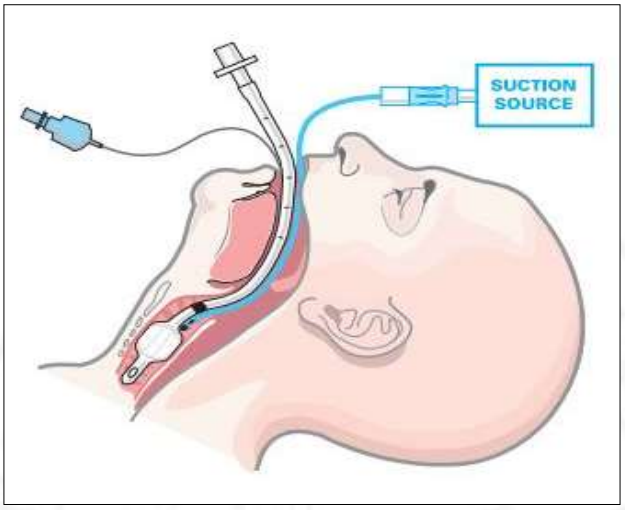


Figure 17. *Endotracheal Intubation*

The oral route is preferred for endotracheal intubation during resuscitation because it is faster, easier, and is related with less complications than nasal intubation. Anesthetics, sedatives, and neuromuscular blocking agents may be used in conscious, agitated patients. Intubation should be performed only by skilled and experienced physicians.

Endotracheal tubes (ETT) are either cuffed or uncuffed (Fig 18) and come in age-appropriate sizes. Uncuffed tracheal tubes are commonly used in children up to 8 years of age. Latest updates recommend using cuffed tubes for all intubations when available. Its diameter can be estimated by using the length-based pediatric resuscitation tapes (e.g., Broselow tape) or computed using the formula based on the age of the patient.



Figure 18. *Cuffed and uncuffed Endotracheal Tubes*

Table 6. *Formula to Determine Endotracheal Tube Diameter/ Size*

Endotracheal Tube	Formula for ETT Diameter / Size
Cuffed Endotracheal Tube:	$\frac{Age\ in\ Years}{4} + 3.5$
Uncuffed Endotracheal Tube:	$\frac{Age\ in\ Years}{4} + 4$

The formula below is used to estimate the initial depth of tube placement.

Endotracheal Tube depth = ETT Size x 3

Confirmation of correct tracheal tube placement must always be done.

Increased risk of death occurs in children with displaced, misplaced, or obstructed ETT. Correct tracheal tube position is assessed by:

- Direct laryngoscopic visualization
- End-tidal CO_2 detection
- Symmetrical chest wall expansion during positive pressure ventilation
- Absence of gastric distension and air entry into the stomach
- Equal air entry on bilateral auscultation of the chest
- Clinical improvement (oxygen saturation, heart rate, color, effort of breathing)

For an intubated patient who suddenly deteriorates, evaluate and assess for:

D - displacement of the tube out of the trachea
O - obstruction of the endotracheal tube
P - presence of pneumothorax
E - equipment or ventilator circuit failure

7. Breathing

Oxygenation

The critically-ill/injured child should be given 100% oxygen concentration during initial resuscitation. If the child has been stabilized and/or there is return of spontaneous circulation (ROSC), titrate the fraction of inspired oxygen (FiO_2) to achieve and maintain a 94–99% oxygen saturation.

Ventilation

Avoid providing excessive ventilation i.e., increase in volume or rate during CPR since it may cause a corresponding increase in the intrathoracic pressure and decrease in the venous return and cardiac output. This may lead to decreased cerebral and coronary perfusion and may result in poor survival. Adequate tidal volume delivery is achieved when there is good chest wall rise. The appropriate ratio of chest compressions to ventilations for age should be used. Once endotracheal tube is in place, positive pressure ventilation should be continued without interrupting the chest compressions of 100 – 120 per minute. If ROSC is achieved, the rescuer must provide normal ventilation based on the child's age. Monitor the end-tidal CO_2 and arterial blood gas to attain a normal arterial carbon dioxide tension ($PaCO_2$) and arterial oxygen levels. Poor outcomes are associated with hypocarbia and hypercarbia following cardiac arrest. Take into consideration the different conditions that may have low oxygen saturations such as congenital heart diseases and pulmonary diseases.

Bag Mask Ventilation (BMV)

Bag mask ventilation (Fig 19) is an effective and safe breathing maneuver for children requiring assisted ventilation for a short period of time prior to intubation. The effectiveness of BMV is seen by observing adequate chest rise and fall, monitoring heart rate, auscultating for breath sounds, and measuring oxygen saturation.



Figure 19. *Bag mask ventilation*

Monitoring of Breathing and Ventilation

Breathing and Ventilation is monitored using the following:

a. **End-tidal CO_2**

Use a colorimetric detector (e.g., litmus paper $ETCO_2$) or a capnometer (e.g., Digital End Tidal CO_2 Monitoring Device) to confirm endotracheal tube placement in a patient weighing more than 2 kg. A correctly placed tube will cause a color change or the presence of a capnographic waveform for more than four ventilated breaths in the presence of a perfusing rhythm. During cardiopulmonary arrest, an $ETCO_2$ of 10 - 20 mmHg may provide information on the effectiveness of chest compressions, tube placement, and early indication of ROSC. Normal $ETCO_2$ value is 35 – 45 mmHg.



Figure 20. *Litmus Paper $ETCO_2$*



Figure 21. *Digital End-tidal CO_2 Monitoring Device*

b. **Peripheral pulse oximetry (SpO_2)**



Figure 22. *Portable Pulse Oximeter*

The child's degree of oxygenation is determined by continuous clinical evaluation with pulse oximetry. This detects the immediate oxygen saturation of patients. However, pulse oximetry can be unreliable in circulatory failure, cardiopulmonary arrest, or poor peripheral perfusion. Pulse oximetry is relatively simple but is a poor guide to tracheal tube displacement and must not be relied upon as the sole parameter.

B. CIRCULATORY FAILURE

VASCULAR ACCESS

Objectives:

At the end of this section, the students should be able to:

1. Identify the common sites for peripheral, central and intraosseous access.
2. Enumerate the advantages, disadvantages and complications of using each type of vascular access.
3. Explain the indications and contraindications of intraosseous access
4. Demonstrate the proper way of inserting an intraosseous access.

Introduction:

An important aspect of pediatric resuscitation is the establishment of a vascular access preferably within minutes after the recognition of shock or cardiac arrest. This is to administer fluids, medications, and blood products to the patient in a timely manner. However, it is very difficult to obtain vascular access in a critically ill child or infant. Therefore, it is important to have knowledge and skills on the different types that can be used. The different vascular access includes peripheral, central, and intraosseous cannulation. It is always best to use the largest and most accessible vein. Usually, a peripheral venous access is inserted if peripheral veins can be readily seen or palpated. However, when presented with a child or infant in cardiopulmonary arrest, shock, or status epilepticus, intraosseous cannulation can be done especially when attempts to place a peripheral line have already failed.

Peripheral Venous Access

The peripheral vein is the most commonly used, easiest, and safest site to insert a vascular access. Preferably a large bore needle should be used.

Common sites for peripheral venous access include the upper and lower extremities, scalp (infants), and the external jugular vein.

1. Upper extremity: the **cephalic, basilic, median cubital vein** of the forearm and the dorsal veins of the hand.
2. Lower extremity: the **great saphenous vein** at the ankle and the veins of the dorsal arch.

3. The **small superficial veins of the scalp** can be used in infants, but caution must be used not to accidentally puncture the temporal artery or its branches.
4. The **external jugular vein** is also a useful site except in children with accompanying airway problems and respiratory failure because inserting at this site would require manipulation of the neck.

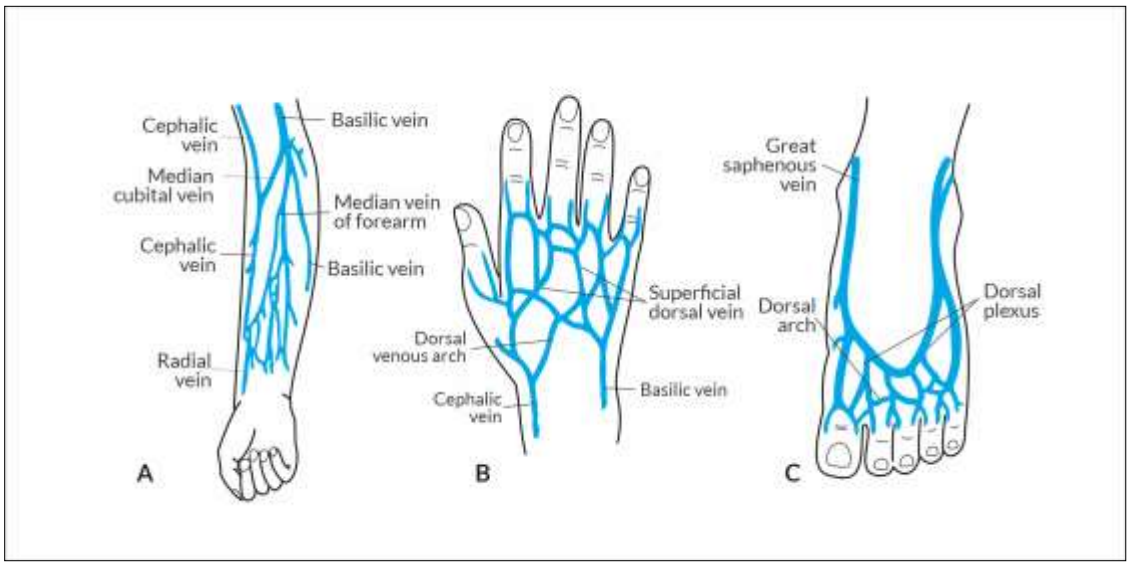


Figure 23. *Peripheral Venous Access Sites*

Complications of peripheral venous access:

- Hematoma
- Infection at underlying site
- Infiltration
- Phlebitis
- Pulmonary thromboembolism

Certain medications should be diluted and given via the largest peripheral vein possible to avoid irritation.

Central Venous Access

Central venous access can be used to administer large volumes of fluids during resuscitation as well as potentially irritating solutions. This access is also used for blood collection and for inserting monitoring devices, which can measure central venous pressure or mixed venous hemoglobin-oxygen saturation. Single, double, or triple lumen polyethylene catheters are used for short term access while *silastic* catheters work best for long term access.

The most frequently used sites for central venous access:

1. **Femoral vein** - relatively easy to locate and access since it is distant from major sites of activity during resuscitation. It also has a lower rate of complication than the other central sites. However, it should not be used in patients with possible trauma or abdominal problems where interruption of the inferior vena cava is entertained.
2. **Subclavian vein**
3. **Internal jugular vein**

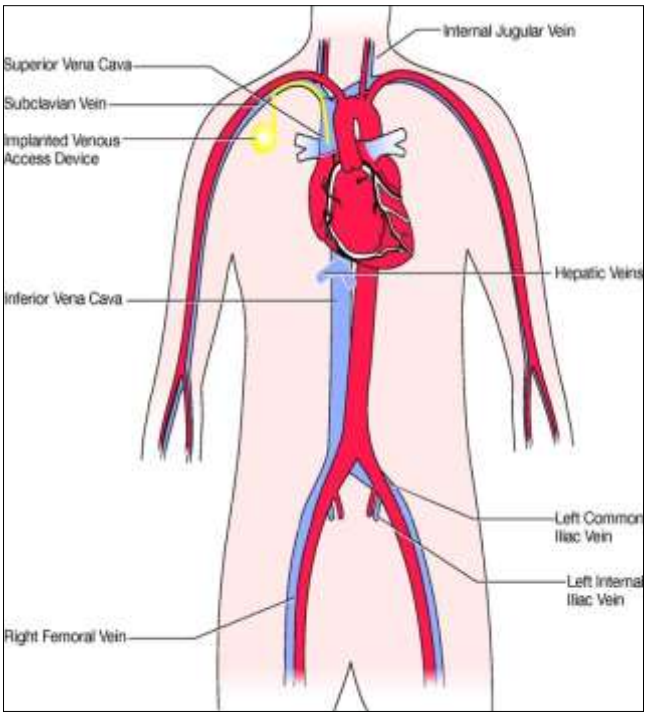


***Figure 24**. Central Venous Access Sites*

Special training is needed for insertion of central lines. Ultrasound guidance can be used for placing the femoral vein or internal jugular venous catheters. Position of catheters can be identified and confirmed using chest or abdominal radiographs.

Complications of central venous cannulation:

- Cellulitis
- Sepsis
- Bleeding
- Thrombosis
- Phlebitis
- Pneumothorax (from subclavian and internal jugular vein catheterization)
- Pulmonary thromboembolism
- Air and catheter fragment embolism

Intraosseous (IO) Access

Intraosseous cannulation is a relatively simple and effective method to establish vascular access during pediatric resuscitation. If a reliable venous access cannot be achieved quickly within 90 seconds or despite two to three attempts, IO cannulation can be done. All medications, blood products and fluids can also be given via IO route.

The most commonly used sites for IO insertion are:

1. Proximal tibia
2. Distal tibia
3. Distal femur
4. Anterior superior iliac spine

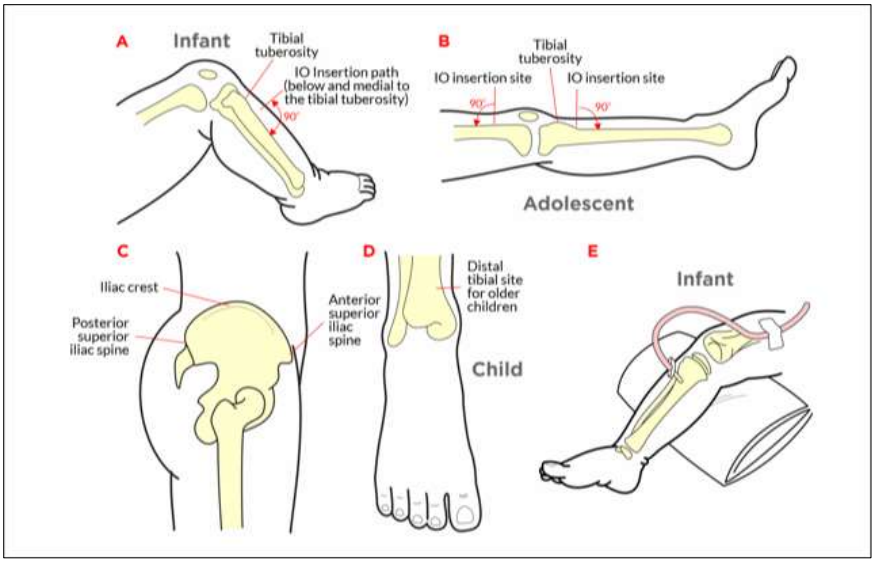


Figure 25. *Intraosseous Access*

Contraindications to IO access:

- Fractures and crush injuries near the access site
- Fragile bones (osteogenesis imperfecta)
- Previous attempts to establish IO access on the same site
- Infection of the overlying tissues

Always use universal precaution when attempting vascular access.

The steps in establishing IO access include:

1. Position the leg with slight external rotation.
2. Stabilize the leg on a firm flat surface; avoid placing your hand behind the leg to avoid self-injury.
3. Feel the tibial tuberosity just below the patella. Slide your finger 1-3 cm below the tibial tuberosity, go medial and you will feel a flat area. This is where you insert the IO needle.
4. Use a large-bore disposable needle at least 18-gauge if a standard IO needle is not available. Insert the needle over the anteromedial surface of the tibia in a 90-degree angle. Do not insert superiorly as you may hit the epiphyseal or growth plate. Insert the needle through the cortical bone using a twisting motion until you feel a give or click. The needle should stand alone if inserted correctly.
5. Remove the stylet if using a standard IO needle. Attach a 3-way stopcock with saline-filled syringe. Infuse a small amount of saline; this should flow easily. Check for swelling at the insertion site or behind the insertion site for possible infiltration.
6. Place tape over the flange to stabilize the needle. Gauze pads on both sides of the needle can be placed for support.

C. FLUID RESUSCITATION FOR CIRCULATORY FAILURE OR SHOCK

Objectives:

At the end of this section, the students should be able to:

1. Recognize signs of shock.
2. Classify shock according to severity and type.
3. Formulate appropriate interventions.

Introduction:

When a child shows signs of circulatory failure caused by shock secondary to any etiology—hypovolemic, distributive, obstructive, and cardiogenic—controlled volume administration is indicated. Shock is classified according to severity. **Compensated Shock** occurs when compensatory mechanisms like tachycardia, increased systemic vascular resistance, increased inotropy, and increased venous tone are able to maintain a systolic blood pressure of at least the 5th percentile for age. **Hypotensive Shock** occurs when compensatory mechanisms fail and systolic blood pressure falls below the 5th percentile for age.

The definition of hypotension in reference to BP for different pediatric age groups is as follows:

Table 7. *Hypotension in Different Pediatric Age Groups*

	Age Group	Systolic Blood Pressure
For term neonates	0 to 28 days of age	SBP <60 mm Hg
For infants	1 month to 12 months	SBP <70 mm Hg
For children	>1 year to 10 years	SBP < (70 mmHg + [Age in years x 2])
	Beyond 10 years	SBP <90 mm Hg

Isotonic crystalloids are recommended as the initial resuscitation fluid of choice for infants and children with any type of shock. If the systemic perfusion is inadequate, a bolus of 10 – 20 ml/kg body weight should be given. During and after each bolus, reassessment of the clinical parameters of shock (sensorium, respiratory rate, color, heart rate, pulse volume, capillary refill time, skin temperature, blood pressure, and urine output) are necessary. This assessment helps the physician to decide if succeeding boluses or other treatments are required. However, for patients who are poorly responding with the boluses, early initiation of inotropic or vasopressor drugs is warranted. The patients with

decreased sensorium or consciousness or worsening respiratory failure will need immediate intubation and mechanical ventilation.

Timely administration of blood products such as fresh whole blood (FWB) or packed red blood cells (pRBC) should be considered to treat hypotension secondary to hemorrhage. Avoid glucose-containing solutions as resuscitation fluid to prevent hyperglycemia. D5-containing solutions may be used in hypoglycemic patients in shock up to a maximum of 20ml/kg. Monitor blood glucose levels closely especially in infants and small children who are very prone to hypoglycemia.

Table 8. *Hemodynamic profiles of the types of shock in children*

Physiologic variable	Preload	Pump function	Afterload	Tissue perfusion	Tissue perfusion
Clinical measurement	Clinical signs* or central venous pressure (if measured)	Cardiac output or index¶	Systemic vascular resistance	Capillary refill time$^{\Delta}$	Mixed venous oxygen saturation$^{\lozenge}$
Hypovolemic	↓	↓	↑	↑	Low
Cardiogenic	↑	↓	↑	↑	Low
Obstructive	↑§	↓	↑	↑	Low
Distributive	↓ or ↔	↑	↓	↓ (initial)	High

* Clinical signs of decreased preload include tachycardia, tachypnea, decreased or absent peripheral pulses; normal or weak central pulses; capillary refill time >2 seconds; skin that is pale, mottled, cold or diaphoretic; dusky or pale extremities, altered mental status, decreased urine output, and flat jugular veins. Clinical signs of increased preload include jugular venous distension, pulmonary edema, and hepatomegaly. These patients are also typically tachycardic and poorly perfused. Refer to topics on evaluation of shock in children.

¶ Cardiac index (cardiac output per body surface area) is typically what is measured during clinical care.

Δ In patients with shock, capillary refill time >2 seconds is associated with low mixed venous oxygen saturation while flash capillary refill suggests increased mixed venous oxygen saturation.

◊ A low mixed oxygen saturation is <70 percent when measured through a triple lumen catheter and <65 percent when measured through a pulmonary artery catheter.

§ In patients with obstructive shock caused by tension pneumothorax, the patient typically displays clinical signs of increased preload. However, because blood return to the heart is obstructed by compression or occlusion of the superior and inferior vena cavae, physiologic preload is decreased.

(Lifted from: Up to Date "Initial Evaluation of Shock", Mark Waltzman, MD Feb 25, 2019)

Types of Shock:

1. **Hypovolemic Shock** – most common type of shock in children due to a decrease intravascular volume from gastrointestinal losses, bleeding, inadequate oral intake and increased metabolic demand (fever, tachypnea)

2. **Cardiogenic Shock** – inability of the heart to pump and contract effectively to produce adequate stroke volume. This may be secondary to cardiac disease (myocarditis, heart failure, cardiomyopathy, arrhythmias)

3. **Obstructive Shock** – results from a physical obstruction of blood flow from the heart going to the systemic circulation. This may occur secondary to tension pneumothorax, cardiac tamponade, thrombosis, and pulmonary embolism. This requires prompt recognition because they require specific management

4. **Distributive Shock** – refers to a condition with decreased systemic vascular resistance resulting from maldistribution of blood flow as seen in sepsis, anaphylaxis and neurologic /spinal cord injury

The classification of shock is based upon the physiologic mechanisms that result in decreased tissue perfusion. This classification has important consequences for management decisions. It is important to note that a child may present with more than one type of shock at a given time.

Treatment for Shock:

1. **Hypovolemic Shock**

   Hemorrhagic: Initially administer crystalloid or colloid 20 mL/kg over 5-20 minutes or over 5-10 minutes if severely hypotensive and repeat as needed. Depending upon the response to fluid therapy, administration of FWB 20mL/kg or pRBC 10mL/kg may be warranted. Stop external bleeding.

   Non-hemorrhagic: Administer crystalloid 20 mL/kg over 5-20 minutes and repeat as needed until clinical parameters of shock are reversed. Consider colloid infusion if crystalloids are not effective.

   Vasoactive medications have no role in the treatment of isolated hypovolemic shock and may worsen tissue hypoxia.

2. **Cardiogenic Shock**

   Bradyarrhythmia or tachyarrhythmia: Follow the appropriate "Poor Perfusion" algorithm based on heart rate (bradycardia or tachycardia).

   Other conditions leading to cardiogenic shock: Administer in smaller boluses of crystalloid 5-10 mL/kg over 10-20 minutes, while frequently monitoring for signs of fluid overload or pulmonary edema like dyspnea or shortness of breath, oxygen desaturations, new onset rales or wheezing, and hepatomegaly. Repeat until clinical parameters of shock are reversed.

Start inotropes such as milrinone, dobutamine and low dose epinephrine. Consider giving diuretics for fluid overload as soon as hemodynamic stability is achieved. Consult a pediatric cardiologist.

3. Obstructive Shock

Pulmonary embolus: Administer crystalloid 5 -10 mL/kg over 5-20 minutes and repeat until clinical parameters of shock are reversed. Watch out for fluid overload. Give anticoagulants or thrombolytics. Consult a subspecialist (Interventional cardiology or hematology).

Cardiac tamponade: Administer crystalloid 20 mL/kg over 5-20 minutes and repeat until clinical parameters of shock are reversed. Refer for pericardiocentesis. Consult a subspecialist.

Ductal dependent congenital heart disease: Administer prostaglandin E. Consult a subspecialist.

Tension Pneumothorax: Administer 100% oxygen via non-rebreather mask. Immediately perform needle decompression on the affected side, 2nd anterior intercostal space midclavicular line just above the third rib while awaiting chest tube thoracostomy. Administer crystalloid 20 mL/kg over 5-20 minutes and repeat until clinical parameters of shock are reversed.

4. Distributive Shock

Septic: Administer crystalloid 20 mL/kg over 5-20 minutes and repeat with boluses of 10-20 ml/kg until clinical parameters of shock are reversed. If patient is poorly responding after 40–60 ml/kg of fluids, consider administration of vasoactive medications such as epinephrine or norepinephrine. Dopamine may be substituted if epinephrine or norepinephrine is not readily available. Consider steroids for adrenal insufficiency if patient fails to improve with fluids and vasoactive agents. Give empiric antibiotics within 1 hour of recognizing septic shock.

Anaphylactic: Give epinephrine 0.01mg/kg IM (maximum of 0.5 mg/ dose) every 5 – 15 minutes or even sooner if clinically indicated. Administer crystalloid 20 mL/kg bolus over 5-20 minutes and repeat until clinical parameters of shock are reversed. Consider epinephrine infusion if without adequate response to fluid administration and IM epinephrine.

Neurogenic: Administer crystalloid 20 mL/kg bolus over 5-20 minutes and repeat until clinical parameters of shock are reversed. Consider a vasopressor if no improvement.

CHAPTER 5. RHYTHM DISORDERS

Objectives:

At the end of this chapter, the students should be able to:

1. Recognize and manage the common rhythm disturbances in children.
2. Demonstrate the proper use of a defibrillator.

Recognition of Cardiac Arrhythmia

Cardiac arrhythmia is defined as a disturbance of the heart rate and/or rhythm. This includes asystole, bradyarrhythmia, Ventricular tachycardia (VTach) with or with no pulse; Ventricular fibrillation (VFib); and Supraventricular tachycardia (SVT), stable and unstable.

The physician attending to the resuscitation should be able to interpret the rhythm using the following electrocardiographic features:

1. Heart rate
2. Rhythm or RR interval: Regular? Irregular?
3. P-waves: Present? Absent?
4. QRS complex: Narrow? Wide?

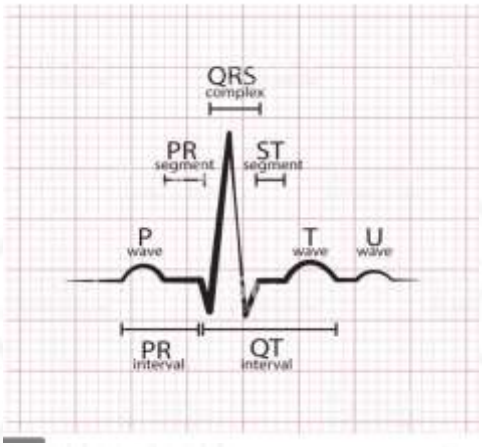


Figure 26. *Parts of an ECG cycle/ rhythm*

Operating the Cardiac Monitor

1. Apply precordial leads on the chest.
    a. Negative (White/RA) lead on the patient's right shoulder.
    b. Ground (Black/LL) on the patient's left shoulder.
    c. Positive (Red/LA) lead on the patient's left lower ribs.
2. Turn on the cardiac monitor and adjust device into manual mode.
3. Display rhythm in standard monitoring lead (Lead II).

Abnormal Cardiac Rhythms

Sinus Tachycardia has a rate that is above normal for age but less than 180 bpm (child) or 220 bpm (infants) that varies with other factors including fever, stress and other activities; RR interval is variable, present P waves and a narrow QRS complex.



Figure 27. *Sinus Tachycardia*

Sinus Bradycardia has a heart rate that is below normal for age, with regular rhythm, present P waves and a narrow QRS complex. For some patients, heart rates lower than normal may be physiologic (i.e., athletes, during sleep). In other patients, sinus bradycardia can be due to hypoxia, hypotension, hypothermia, acidosis, and medications.



Figure 28. *Sinus Bradycardia*

Supraventricular Tachycardia (SVT) has a cardiac rate above 180 bpm (child) or 220 bpm (infants) with regular rhythm (poor beat to beat variability), absent P wave and a narrow QRS complex.



Figure 29. *Supraventricular Tachycardia*

Ventricular Tachycardia (VTach) is a broad complex tachycardia which has a typical saw-toothed appearance with a very high ventricular rate of 100-250 beats per minute; Regular rhythm, no identifiable P wave and QRS complex is wide. The usual causes of Vtach in children include electrolyte imbalances, medications, or myocarditis.

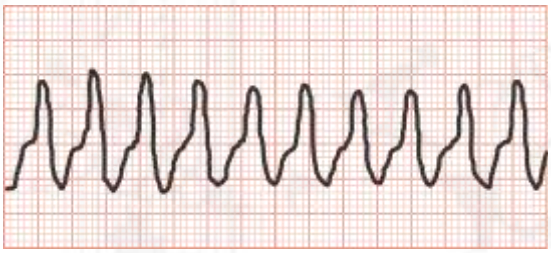


Figure 30. *Ventricular Tachycardia*

Ventricular Fibrillation (VFib) is a fatal heart rhythm characterized by a chaotic waveform. No identifiable P wave and QRS complex.

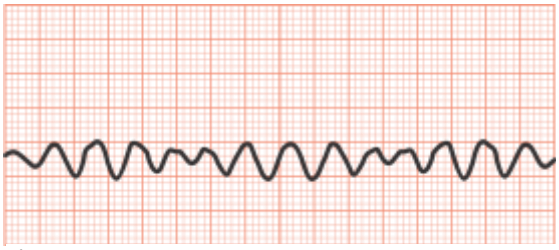


Figure 31. *Ventricular Fibrillation*

Asystole is characterized by no discernable electrical activity.

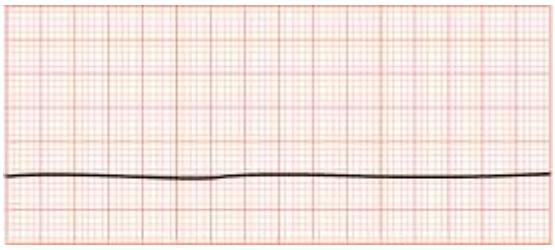


Figure 32. *Asystole*

Non-Shockable Rhythms

Cardiopulmonary arrests in children and adolescents are mostly of respiratory origin. Immediate CPR is required in pediatric age group while waiting for a defibrillator. The most common ECG rhythms in infants, children, and adolescents who are in cardiopulmonary arrest include **asystole** and **pulseless electrical activity (PEA)**.

PEA is characterized by presence of organized electrical activity with absent pulses. It follows hypoxia or myocardial ischemia that can cause impairment of cardiac output, which can be reversible.

Management includes high quality CPR and Epinephrine IV or IO (0.1 ml/kg of 1:10,000 dilution) given every 3 – 5 minutes. In such event, identify and treat any reversible cause of cardiac arrest.

Reversible causes of cardiac arrest (H's and T's) include:

1. Hydrogen ion excess
2. Hypoxia
3. Hypovolemia
4. Hyper/hypokalemia
5. Hypothermia
6. Hyper/Hypoglycemia
7. Thrombosis (coronary or pulmonary)

8. Tension pneumothorax
9. Tamponade (cardiac)
10. Toxins

Bradycardia (heart rate <60 per min) with poor perfusion despite adequate oxygenation and ventilation is managed as asystole.

Sinus Tachycardia is managed by identifying and treating the underlying cause.

Stable Supraventricular Tachycardia is a narrow complex tachycardia wherein the patient has good perfusion. Onset is abrupt without prodrome.

Vagal maneuvers can be initially attempted by doing the following for 10 – 20 seconds:

1. Valsalva maneuver (e.g., blowing through a narrow straw or an inverted barrel of a 10 ml syringe)
2. Cold stimulus to the upper half of the face without covering the nose
3. Forceful and sustained coughing

The use of **Adenosine/Amiodarone** for stable SVT:

If attempts of vagal maneuver fail to convert the rhythm, medication therapy can be given with Adenosine 0.1 mg/kg (max 6 mg), doubling the second dose to 0.2 mg/kg (max 12 mg), if necessary. If arrhythmia persists, a rapid IV push of Amiodarone 5mg/kg over 20-60 minutes may be given.

Shockable Rhythm

The available defibrillators nowadays are either automated or manually operated, which may be capable of delivering either monophasic or biphasic electric current. The manual defibrillators are capable of providing full energy requirements from neonates to older age groups. Automated external defibrillators (AEDs) are pre-set equipment delivering the energy dose required to defibrillate or shock.



Figure 33. *Cardiac Defibrillator*

A. Defibrillation

Defibrillation or unsynchronized shock is indicated for a patient without a pulse and the cardiac rhythm is either Vfib or Vtach. The initial dose is 2 J/kg, with incremental shock doses up to a maximum of 10 J/kg not to exceed the adult dose (200 joules for biphasic and 360 joules for monophasic).

Defibrillation techniques:

1. Attach chest leads.
2. Turn on the defibrillator.
3. Display rhythm in standard monitoring lead (lead II).
4. Select the energy dose.
5. Apply the appropriate paddles on the chest.
6. Charge the defibrillator.
7. Clear the patient and make sure that:
   a. nobody is touching the patient,
   b. oxygen support is removed, and
   c. monitor still shows shockable rhythm.
8. Press the shock button.
9. Resume chest compressions immediately.

Ventricular fibrillation and Pulseless Ventricular tachycardia

1. Follow the steps in operating the defibrillator.
2. Attempt immediate defibrillation at 2 J/kg.
3. Minimize delay between chest compressions and delivery of shock to less than 10 seconds.
4. Resume chest compressions immediately after defibrillation.
5. Check the cardiac rhythm on the monitor after 2 minutes of CPR.
6. Give the second shock (4 J/kg) if the rhythm is still VFib or pulseless VTach.
7. Resume chest compressions immediately after delivering shock and give epinephrine at 0.1 mL/kg using the 1:10,000 dilution.
8. Check the cardiac rhythm on the monitor after 2 minutes of CPR.
9. Give the third shock (6 J/kg) if the rhythm is still VFib or pulseless VTach.
10. Resume chest compressions immediately after delivering shock and give amiodarone at 5mg/kg/dose bolus or Lidocaine at 1mg/kg/dose.
11. Continue incremental shock doses up to a maximum of 10 J/kg not to exceed the adult dose followed by 2 minutes of CPR if the rhythm is still VFib or pulseless VTach.
12. Give epinephrine alternately with amiodarone or lidocaine every 2 minutes.

If with organized rhythm, check for central pulse to confirm return of spontaneous circulation (ROSC).

Assess the hemodynamic status (vital signs, peripheral pulses, capillary refill time) of the child. Treat any reversible causes of cardiac arrest and unsuccessful resuscitation using the H's and T's. Take note that hypoxia and hypovolemia are commonly observed in critically-ill or injured children. Electrolyte disturbances such as hypo/hyperkalemia and toxicity are usual causes of arrhythmia.

If VFib or pulseless VTach recurs, the physician should resume CPR, give amiodarone or lidocaine, and give shock by defibrillating at the energy level that was previously effective.

IMPORTANT: Perform high quality CPR until an AED/defibrillator becomes available.

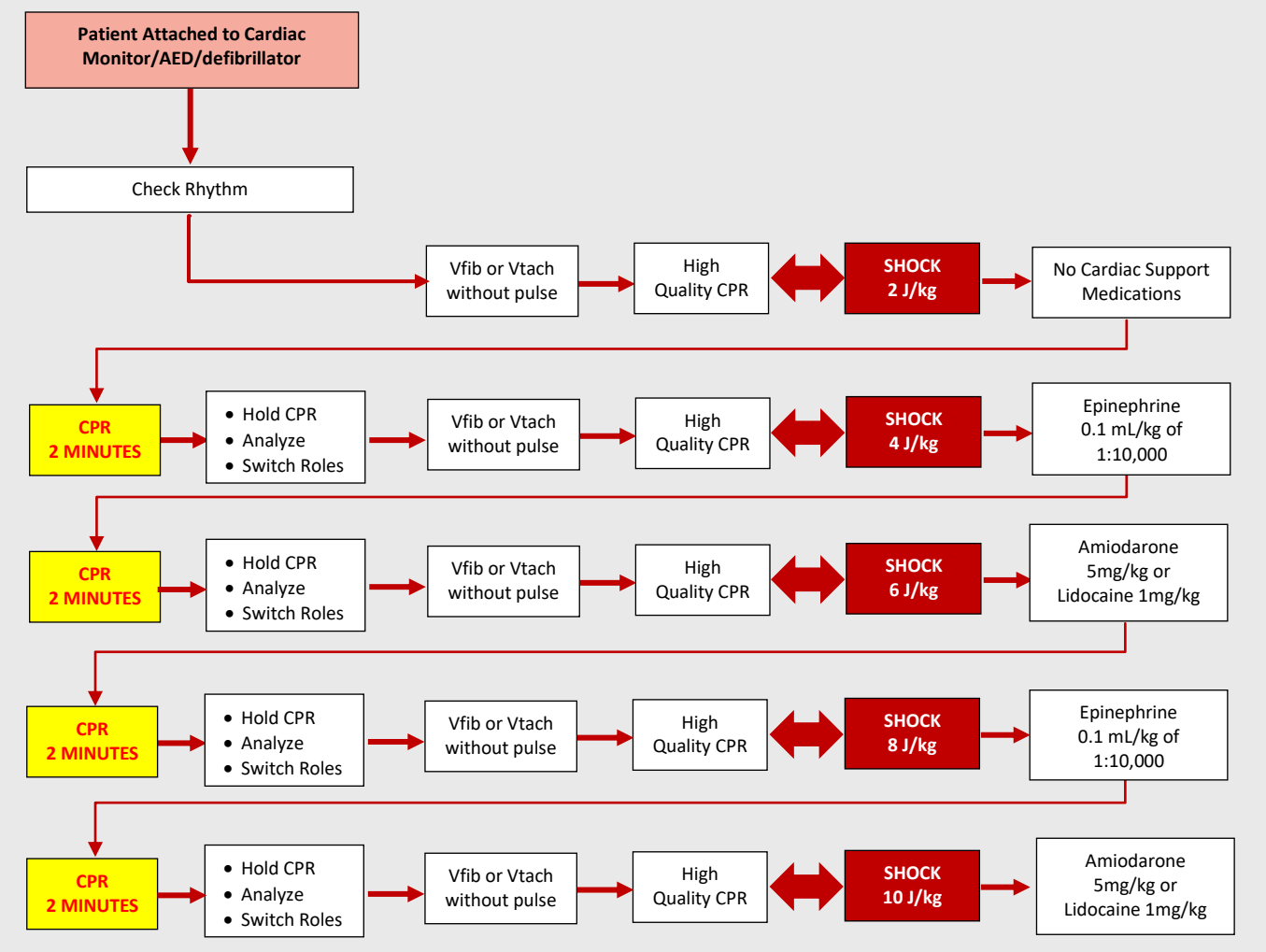


Figure 34. *Algorithm for Vfib or Vtach without pulse*

B. Synchronized Cardioversion

Unstable SVT is a narrow complex tachycardia wherein the patient has poor perfusion. Providers should rapidly convert the rhythm back to sinus rhythm. If the child has an IV access, Adenosine can be given via rapid IV push. Adenosine has a short half-life so a proximal IV is best with the use of a 3-way stop cock. If the child doesn't have an IV access, synchronized cardioversion should be performed.

Ventricular Tachycardia with a pulse is a wide complex tachycardia. If there are no signs of cardiopulmonary compromise, Amiodarone, Lidocaine, and Procainamide may be considered and referral to a specialist is advised. If patient develops hypotension and altered sensorium, synchronized cardioversion should be performed.

Synchronized Cardioversion techniques:

1. Attach chest leads.
2. Turn on the defibrillator.
3. Display rhythm in standard monitoring lead (lead II).
4. Select Sync mode.
5. Select the energy dose (0.5 - 1 J/kg initially then 2 J/kg).
6. Apply the appropriate paddles on the chest.
7. Charge the defibrillator.
8. Clear the patient and make sure that:
   a. nobody is touching the patient.
   b. oxygen support is removed.
   c. monitor still shows shockable rhythm.
9. Press the shock button and keep paddles on the chest for 3-4 seconds to synchronize.

*Consider sedating the patient before synchronized cardioversion

CHAPTER 6. POST-RESUSCITATION CARE

Objectives:

At the end of this chapter, the students should be able to:

1. Discuss Post-Cardiac Arrest Syndrome and the essential supportive care of the respiratory, circulatory, neurologic, and metabolic systems.
2. Present the role of family support, prognostication, brain death, and organ donation among comatose post- arrest patients.

Post-Cardiac Arrest Syndrome

Post-cardiac arrest syndrome resembles sepsis, owing to the endothelial injury and abnormalities in the microcirculation. It may manifest as coma, seizure, ventricular dysfunction, and ischemia/reperfusion injury.

Upon return of spontaneous circulation (ROSC), immediate priority is given to the support of airway, breathing, circulation, and temperature control, diagnosis of treatable causes of cardiac arrest and optimization of recovery in the ICU until discharge.

Control of Oxygenation

Avoid hyperoxemia. Aim for an oxygen saturation of 94-99% especially in the first 24 hours upon ROSC. Studies in animals and humans showed that hyperoxemia is associated with worse outcomes.

Control of Ventilation

The tip of the endotracheal tube must be just above the carina. Verify tube placement with a chest radiograph. Maintain normal range of pCO_2 by adjusting the rate and tidal volume of the ventilator. Insert a nasogastric/orogastric tube to avoid stomach distention especially after manual ventilation.

Circulation

Aim for a normal mean arterial pressure (MAP) (Table 9) for age through judicious use of fluid and inotropic support. Attach patient to a cardiac monitor. Watch out for abnormal rhythm disturbances. Continuously monitor the urine output, capillary refill time, pulse volume, and the heart rate. When conditions allow, insert a jugular line to monitor the central venous pressure (CVP) as well as the central venous oxygen saturation ($ScvO_2$).

Table 9. *Normal MAP and SBP for Age*

ESTIMATED BLOOD PRESSURE BY AGE			
MEASUREMENT	**50th %**	**5th %**	
Systolic BP	90 + (age x 2)	60 (neonate); 70 (1mo – 1 yr); 70 + (age x 2) (for 2-10 yrs); <90 (>10 yrs)	
MAP	55 + (age x 1.5)	40 + (age x 1.5)	
NORMAL VITAL SIGNS BY AGE			
Age	**HR (beats / min)**	**Bp (mm Hg)**	**RR (breaths / min)**
Preemie	120 – 170	55-75/ 35-45 (gestational age approximates normal MAP)	40 – 70
0 – 3 mo	110 – 160	65 – 85 / 45 – 55	30 – 60
3 – 6 mo	100 – 150	70 – 90 / 50 -65	30 – 45
6 – 12 mo	90 – 130	80 – 100 / 55 – 65	25 – 40
1 – 3 yrs	80 – 125	90 – 105 / 55 – 70	20 – 30
3 – 6 yrs	70 – 115	95 – 110 / 60 – 75	20 – 25
6 – 12 yrs	60 – 100	100 – 120 / 60 – 75	14 – 22
>12 yrs	60 – 100	100 – 120 / 70 – 80	12 – 18

Source: The Harriet Lane Handbook, 20th Edition, Branden Engorn et al, Editors, The Johns Hopkins Hospital, 2012.

Cerebral Perfusion

Target MAP for age to maintain adequate cerebral perfusion. Frequently monitor the neuro-vital signs (Glasgow Coma Scale and pupillary reaction). Watch out for seizure and signs of increased intracranial pressure. If possible, continuous EEG monitoring is recommended since non-convulsive seizures may occur in a comatose patient. Prophylactic administration of anti-convulsant is not yet sufficiently studied.

Glucose Control

Wide swings in blood glucose (hypoglycemia to hyperglycemia) are associated with high mortality. Sustained hyperglycemia should be treated with insulin whereas hypoglycemia with glucose solution infusion.

Temperature Control

Manage hyperthermia with anti-pyretics and active cooling strategies like ice packs, wet blankets, and cooling pads. The current practice of the Targeted Temperature Management (TTM) of 32 – 36 degrees centigrade among comatose children with ROSC after in hospital and out of hospital cardiac arrest (IHCA and OHCA, respectively) is based on very low certainty of evidence and thus is not strongly recommended. Knowledge gaps still exist on the duration of TTM and rewarming as well as in the optimal temperature range. Clinicians must be aware of the serious adverse effects of induced hypothermia like bradycardia, insulin insensitivity, electrolyte imbalance, and Disseminated Intravascular Coagulation (DIC). The generally accepted contraindications for TTM are uncontrolled sepsis and pre-existing coagulopathy. Aim for normothermia.

BRAIN DEATH

Prognostication

Use a multi-modal diagnostic tool when prognosticating a comatose patient who had just been resuscitated to avoid giving a falsely pessimistic prediction. The most widely accepted tools are EEG and four vessel cerebral angiography although these are not essential in making a diagnosis of brain death in children.

Algorithm for the Determination of Brain Death in Children

The first exam should be done 24 hours after the arrest or the severe brain injury. Aim for normothermia and euvolemia. There has to be an identifiable irreversible cause of the coma. On neurologic exam, there should be no response to any stimuli (excluding spinal reflexes) and all brain stem reflexes should be absent. Apnea test must be positive.

When all toxic, drug, and other metabolic disorders have been excluded, the patient can be declared brain dead. Otherwise, continue observation and management or perform ancillary testing using EEG or cerebral perfusion studies to reduce inter-examination waiting period.

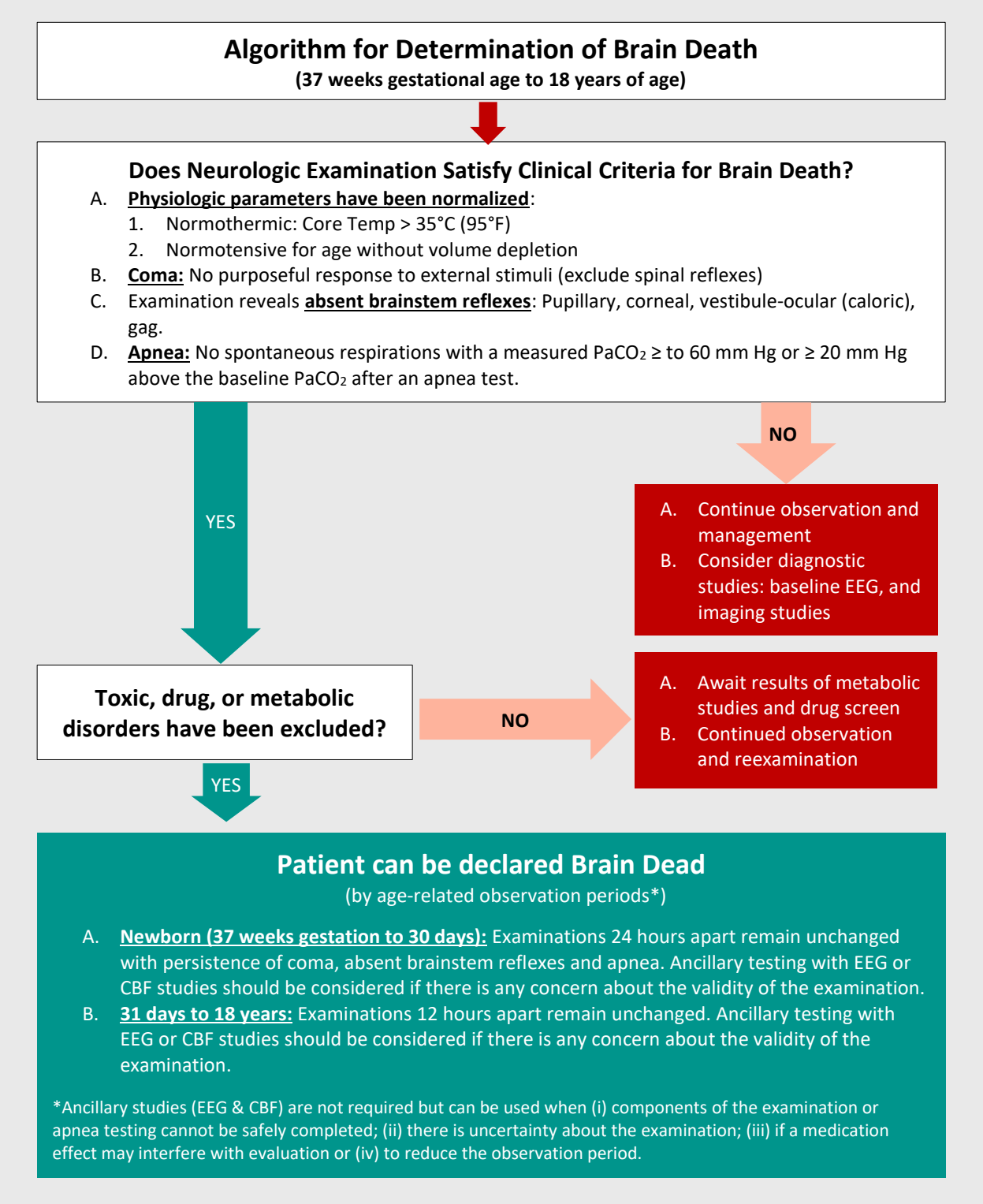


Figure 35. *Algorithm for Determination of Brain Death*
Adapted from: Crit Care Med. 2011; 39(9):2139–2155. Pediatrics. 2011; 128(3):e720-e740. Ann Neurol. 2012;71(4):573–585.

Organ Donation

Patients who progress to brain death may be evaluated for organ donation where such programs exist. In the Philippines, the Organ Donation Act of 1991, as amended by Republic Act No. 7885, allows organ and tissue donations from donors who have been declared brain dead. Human transplantable organs include the kidneys, liver, lungs, heart, intestines, and pancreas, in addition to human tissues such as eye tissues (corneas, sclera, etc.), bones, skin, and blood vessels. Link: website www.doh.gov.ph (*Organ donation from brain-dead persons*).

Family Support

In the light of data suggesting that it may be helpful, offering select family members the opportunity to be present during a resuscitation is reasonable and desirable. Parents and other family members seldom ask if they can be present unless they are encouraged to do so by healthcare providers. Resuscitation team members should be sensitive to the presence of family members during resuscitative efforts, assigning a team member to remain with the family to answer questions, clarify information, and otherwise offer comfort.



CHAPTER 7. CONSIDERATIONS ON RESUSCITATION DURING A PANDEMIC LIKE COVID19

General principles relevant to resuscitation of suspected and confirmed COVID19 patients

A. Ensure scene and personnel safety.

- Put on full Personal Protective Equipment (PPE) as per donning protocol.
    - N95 mask
    - Goggles
    - Face shield
    - Gown
    - Double gloves
    - Hair cap
    - Booties

B. If patient is unresponsive:

- Alert EMT/code team of possible COVID19 infection.

C. During pulse or breathing check:

- Do not listen and feel for breathing anymore.

D. During CPR:

- Avoid giving rescue breaths.
- Avoid bag mask ventilation.
- Minimize aerosolizing procedures.
- If already on mechanical ventilation, continue chest compression with FiO_2 at 100%.
- If not on mechanical ventilation, do hands-only CPR, consider early intubation by most experienced person or team.

E. After resuscitation:

- Remove PPE as per doffing protocol.
- Observe proper waste disposal.
- Disinfect/sterilize equipment and resuscitation area.

Ethical Principles Relevant to Resuscitation During Pandemics

- Allocate resources fairly (UP-Manila COVID-19 Ethics Study Group).
- The principle of net utility gives priority to those with the greatest probability of survival.
- The principle of equity gives equal opportunity for access to scarce resources to patients with similar prognosis on a "first come, first served" basis or "lottery" method.
- Principle of prudence applies to emergency responders. The healthcare worker may refuse to engage in life saving services if his or her safety is compromised. (PMA 2019 Code of Ethics).
- It is recommended that Institutions should have in place an Ethics Committee whose members are available for consult when ethical dilemmas due to the pandemic arise.
- The principle of respect for persons ordains the following (Tan, Guia, et al):
    - Decision not to initiate or to withdraw life-sustaining therapies should be openly discussed with patients and/or their relatives. Informed Consent must be obtained.
    - Palliative care must be given if life-sustaining treatment will not be initiated or is withdrawn.
    - It should be made clear to the patient and his family that if certain measures (like BIPAP ventilation) will increase the risk for the HCW because of aerosolization of the virus, such measure will not be initiated.
    - Open and respectful discussion of Advance Directives may minimize allocation dilemmas.

ANNEX

Pediatric Resuscitation Algorithm

INITIAL IMPRESSION

EVALUATE	IDENTIFY	MANAGE / INTERVENE
A - Appearance **B** - Breathing **C** - Color	Respiratory Distress Respiratory Failure	1. Call for help, activate code/EMS, bring AED/ defibrillator/e-cart 2. Supplemental O_2 • NRM 11-15 LPM • BMV (infants & children) 1 every 2-3 secs • BMV(adolescents) 1 every 5-6 secs • BTV(all ages) 1 every 2-3 secs 3. Hook Monitors • Cardiac Monitor • Pulse Oximeter
	NO SIGNS OF LIFE	Basic Life Support

**At any point that you encounter a life-threatening condition, immediately begin lifesaving interventions and activate code.*

PRIMARY ASSESSMENT

EVALUATE	IDENTIFY		MANAGE / INTERVENE
A - Airway **B** - Breathing RR, O_2sat, WOB, BS **C** - Circulation HR, BP, CP, PP, CRT, UO **D** - Disability AVPU, Pupils, Sugar **E** - Exposure temp, rashes, bruises	Respiratory Distress Respiratory Failure	Upper Airway Obstruction Lower Airway Obstruction Lung Tissue Disease Disordered Control of Breathing	1. Oxygenation • Continue or Shift 2. Monitor • Rate • Rhythm • P wave • QRS Complex 1. Sinus Brady/ Tachy 2. VTach 3. VFib 4. SVT 3. IV/IO • Secure/Check patency if with vascular access already 4. Others
	Shock Compensated Hypotensive	Hypovolemic Shock Obstructive Shock Distributive Septic Shock Cardiogenic Shock	

**At any point that you encounter a life-threatening condition, immediately begin lifesaving interventions and activate code.*

SECONDARY ASSESSMENT

EVALUATE	IDENTIFY	MANAGE / INTERVENE
S - Signs & Symptoms **A** - Allergies **M** - Medications **P** - Past Medical History **L** - Last Meal **E** - Events (Onset) PHYSICAL EXAMINATION (Head to Toe)	**FINAL DIAGNOSIS**	**CASE SPECIFIC INTERVENTION**

**At any point that you encounter a life-threatening condition, immediately begin lifesaving interventions and activate code.*

RETURN OF SPONTANEOUS CIRCULATION (ROSC)

C – Circulation	**B** – Breathing	**C** – Consciousness
• Maintain hemodynamic stability (blood pressure and perfusion)	• Maintain adequate oxygenation, O_2 saturation >94%-99% • End Tidal CO_2 of 35-45mmHg • ABG ($PaCO_2$, PaO_2)	• Treat Fever aggressively • Normothermia (36°C – 37.5°C)

TERTIARY ASSESSMENT

Diagnostics:
A. Laboratory Test
B. Radiologic Imaging

TRANSFER TO ICU

Figure 36. *Pediatric Resuscitation Algorithm*

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SOURCE OF FIGURES

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APPENDIX: Pediatric Resuscitation Medications

PEDIATRIC RESUSCITATION MEDICATIONS

Drug	Classification	Indications	Dose/ Administration	Side Effects	Considerations
Adenosine	Antiarrhythmic	SVT	**1st dose:** 0.1 mg/kg rapid IV push to max of 6 mg. **2nd dose:** 0.2 mg/kg rapid IV push to max of 12 mg	Transient asystole, facial flushing, headache, shortness of breath, dyspnea, nausea, chest pain, and lightheadedness.	Cardiac monitoring during administration; Rapid onset of action, <1minute; rapid flush with 10-20 ml saline following administration using 2-syringe technique.
Albumin, Human 25% (12.5g/ 50mL)	Plasma volume expander	Shock, trauma, burns	0.5-1 g/kg by rapid infusion; (10-20mL/kg of 5% solution)	Rapid infusion may cause fluid overload; hypersensitivity reactions may occur; may cause rapid increase in serum sodium levels.	Monitor for cardiopulmonary function and systemic perfusion; decreases ionized calcium concentration, BP monitoring; Use within 4 hours once opened; Onset is within 15-30 minutes.
Alprostadil	Prostaglandin; vasodilator	Maintain patency of ductus arteriosus (PDA) in congenital heart disease	**Initial:** 0.05-0.1 mcg/kg/ minute **Maintenance:** 0.01-0.4 mcg/kg/ minute infusion	May cause apnea (10%–12%), fever, seizures, flushing, bradycardia, hypotension, diarrhea, gastric outlet obstruction, and reversible cortical proliferation of long bones (with prolonged use). Decreases platelet aggregation.	Monitor SpO_2, RR, BP, ECG, and temperature. May cause tissue loss; should be refrigerated until administered
Amiodarone	Anti-arrhythmic	SVT, VT with pulses, VF, VT without pulse	5 mg/kg over 30 min followed by a continuous infusion starting at 5 micrograms (mcg)/kg/min; infusion may be increased up to a max. dose of 15 mcg/kg/min or 20 mg/kg/24 hr.	May cause worsening of preexisting arrhythmias with bradycardia and AV block. May also cause hypotension, anorexia, nausea, vomiting, dizziness, paresthesia, ataxia, tremor, SIADH, and hypothyroidism or hyperthyroidism.	**Contraindicated** in severe sinus node dysfunction, marked sinus bradycardia, second- and third-degree AV block. **Use with caution** in hepatic impairment.

PEDIATRIC RESUSCITATION MEDICATIONS

Drug	Classification	Indications	Dose/ Administration	Side Effects	Considerations
Atropine	Anti-cholinergic	Symptomatic bradycardia, toxins and overdoses of Organo-phosphates-carbamates; Rapid Sequence Intubation (RSI)	**Bradycardia:** 0.02 mg/kg/dose IV Q5 min × 2–3 doses PRN; **min. dose:** 0.1 mg; **max. single dose:** 0.5 mg in children, 1 mg in adolescents; **max. total dose:** 1 mg children, 2 mg adolescents **Toxins:** ***Child:*** 0.05–0.1 mg/kg Q 5–10 min until bronchial or oral secretions terminate. ***Adult:*** 2–5 mg/dose Q5–10 min until bronchial or oral secretions terminate. **RSI:** ***Child:*** 0.01 mg/kg/dose SC/IV/IM, **max. dose:** 0.4 mg/dose; **min. dose:** 0.1 mg/dose; may repeat Q4–6 hr ***Adult:*** 0.5 mg/dose SC/IV/IM	Doses <0.1 mg have been associated with paradoxical bradycardia. Side effects include dry mouth, blurred vision, fever, tachycardia, constipation, urinary retention, CNS signs (dizziness, hallucinations, restlessness, fatigue, headache).	**Contraindicated** in glaucoma, obstructive uropathy, tachycardia, and thyrotoxicosis. **Use with caution** in patients sensitive to sulfites.
Calcium Chloride	Electrolyte	Hypocalcemia, hyperkalemia; hypermagnesemia; consider for calcium channel blocker overdose	**In cardiac arrest:** ***Infant/child:*** 20 mg/kg/dose IV Q10 min PRN, if effective, an infusion of 20–50 mg/kg/hr may be used **In non-arrest:** infuse over 30-60 minutes via central line if available.	Rapid IV infusion associated with bradycardia, hypotension, and peripheral vasodilation. May cause hyperchloremic acidosis.	Use IV with **extreme caution**. Extravasation may lead to necrosis. Hyaluronidase may be helpful for extravasation. Central-line administration is preferred IV route of administration. **Do not use** scalp veins. **Do not administer** IM or SC route.

PEDIATRIC RESUSCITATION MEDICATIONS

Drug	Classification	Indications	Dose/ Administration	Side Effects	Considerations
Dexamethasone	Corticosteroid	Airway Edema; Croup; Asthma	**Airway edema:** 0.5–2 mg/kg/24 hr IV/IM ÷ Q6 hr (begin 24 hr before extubation and continue for 4–6 doses after extubation) **Croup:** 0.6 mg/kg for one dose **Anti-inflammatory: Child:** 0.08–0.3 mg/kg/24 hr PO, IV, IM ÷ Q6–12 hr	Headache, insomnia, seizures, psychosis, weakness, irritability, visual difficulties, hypertension, thrombophlebitis, edema, tachycardia, osteoporosis, fractures, diarrhea, nausea, GI bleeding, flushing, acne, sweating, poor wound healing, hyperglycemia, sodium and fluid retention, hemorrhage, thrombocytopenia, hypokalemia	**Not recommended** for systemic therapy in the prevention or treatment of chronic lung disease in infants with very low birth weight because of increased risk for adverse events
Dextrose	Carbohydrate	Hypoglycemia	0.5-1g/kg Concentration: D50W: 1-2 mL/kg D25W: 2-4 mL/kg D10W: 5-10 mL/kg	Sclerosis of veins, hyperglycemia, Hyperosmolality	Do not administer during resuscitation unless hypoglycemia is documented; use point of care glucose monitoring
Diphen-hydramine	Antihistamine	Anaphylaxis after epinephrine	1 -2 mg/kg every 4 to 6 hours to a max dose of 50 mg	Dizziness, drowsiness, CNS symptoms, blurred vision, pupil dilation, dry nose/mouth/throat, hypotension, tachycardia, nausea, vomiting, urinary retention or frequency photosensitivity	Monitor oxygen saturations and BP; use with caution in presence of glaucoma, ulcer, hyperthyroidism
Dobutamine	Selective Beta-Adrenergic	Ventricular Dysfunction	2-20 mcg/kg/minute infusion, titrate to effect.	Tachycardia, arrhythmias (PVCs), and hypertension may occasionally occur (especially at higher infusion rates).	Dobutamine has been shown to increase cardiac output and systemic pressure in pediatric patients of every age group. However, in premature neonates, dobutamine is less effective than dopamine in raising systemic blood pressure without causing undue tachycardia, and dobutamine has not been shown to provide any added benefit when given to such infants already receiving optimal infusions of dopamine.

PEDIATRIC RESUSCITATION MEDICATIONS

Drug	Classification	Indications	Dose/ Administration	Side Effects	Considerations
Dopamine	Catecholamine vasopressor, inotrope	Ventricular dysfunction, cardiogenic or distributive shock	2-20 mcg/kg per minute infusion titrated to response	Should be administered through a central line or large vein. Extravasation may cause tissue necrosis; treat with phentolamine. **Do not administer** into an umbilical arterial catheter.	Monitor vital signs and blood pressure continuously. Correct hypovolemic states. Tachyarrhythmias, ectopic beats, hypertension, vasoconstriction, and vomiting may occur.
Epinephrine	Catecholamine vasopressor, Inotrope	Anaphylaxis, asthma, symptomatic bradycardia, croup, shock, cardiac arrest, toxins or overdose	**Anaphylaxis**: 0.01 mg/kg every 15 minutes to max of 0.3 mg **Asthma:** (1:1000) 0.01 mg/kg subcutaneous every 15 minutes to max 0.3 mg **Symptomatic bradycardia:** 0.01 mg/kg IV every 3-5 minutes to max dose of 1 mg **Croup:** 0.25 ml Racemic epinephrine solution via nebulizer **Cardiac arrest:** 0.01 mg/kg (1:10000) IV or 0.1 mg/kg (1:1000) per ET tube every 3-5 minutes **Shock:** 0.1-1 mcg/kg/ minute IV infusion **Toxins:** 0.01 mg/kg (**1:10,000**) IV to max dose of 1 mg, consider higher doses up to 0.1 mg/kg (0.1mL/kg of **1:1,000**)	Tremors, anxiety, insomnia, headaches, dizziness, weakness, ICH, confusion, hallucinations, dyspnea, SVT, VT, palpitations, hypertension, ST-segment elevation, post-resuscitation myocardial dysfunction, hyperglycemia, post-resuscitation hyper-adrenergic state, nausea, vomiting, hypokalemia, vasoconstriction, gluconeogenesis	

PEDIATRIC RESUSCITATION MEDICATIONS

Drug	Classification	Indications	Dose/ Administration	Side Effects	Considerations
Etomidate	Short acting sedative with no analgesic properties	Sedation for intubation (RSI) or for patients with hypotension or multiple trauma	0.2-0.4 mg/kg IV over 30 to 60 seconds with max dose of 20 mg that lasts 10-15 minutes.	Fast or slow respiratory rate, high or low blood pressure, tachycardia nausea, vomiting, cough, hiccups, adrenal suppression, myoclonus, injection site pain.	Sedation will last 10-15 minutes; monitor oxygen saturation, BP and respiratory function; Avoid use in septic shock
Furosemide	Loop diuretic	Pulmonary edema, fluid overload	1 mg/kg IV or IM to max dose of 20 mg for patient not on prolonged diuretics.	Headache, weakness, vertigo, hearing and vision problems, dry mouth, ECG changes, nausea, vomiting, diarrhea, abdominal cramping, polyuria, glycosuria, muscle cramps, sweating, hives, hyperglycemia, anemia, hypokalemia, hyponatremia, metabolic alkalosis	Monitor BP, BUN, serum creatinine and potassium
Hydrocortisone	Corticosteroid	Adrenal insufficiency associated with septic shock	2 mg/kg IV bolus to max dose of 100 mg	Psychological signs, infections, blurred vision, mood changes, hypertension, diarrhea, nausea, vomiting, osteoporosis, flushing, sweating, slow wound healing, hyperglycemia	Watch for signs of infection; hyperglycemia
Ipratropium Bromide	Anticholinergic bronchodilator	Asthma	**Nebulizer:** 250-500 mcg every 20 minutes via nebulizer for 3 doses	May cause anxiety, dizziness, headache, GI discomfort, and cough with inhaler or nebulized use. Epistaxis, nasal congestion, and dry mouth/throat have been reported with the nasal spray.	**Contraindicated** in soy or peanut allergy (for aerosol inhaler) and atropine hypersensitivity. **Use with caution** in narrow-angle glaucoma or bladder neck obstruction, though ipratropium has fewer anticholinergic systemic effects than atropine.

PEDIATRIC RESUSCITATION MEDICATIONS

Drug	Classification	Indications	Dose/ Administration	Side Effects	Considerations
Lidocaine	Antiarrhythmic	VF, pulseless VT, wide complex tachycardia, RSI	**VF/Pulseless VT, Wide-complex Tachycardia with pulse:** 1 mg/kg IV loading bolus followed by infusion of 20-50 mcg/kg/ minute infusion as maintenance **ET:** 2-3 mg/kg **RSI**: 1-2 mg/kg IV	hypotension, asystole, seizures, and respiratory arrest.	Monitor ECG and BP; May cause seizures; contraindicated for wide complex bradycardia
Magnesium Sulfate	Electrolyte/ Bronchodilator	Asthma; Torsade de pointes; hypomagnesemia	**Status Asthmaticus:** 25-50 mg/kg over 15-30 minutes IV, max of 2g. **Pulseless VT with torsades:** 25-50 mg/kg bolus, max 2g. **VT with pulse associated with torsades or hypomagnesemia:** 25-50 mg/kg over 10-20 minutes, max 2g.	hypotension, respiratory depression, complete heart block, and/or hypermagnesemia.	Monitor ECG, oxygen and BP; rapid bolus may cause hypotension and bradycardia; calcium chloride can be used if needed to reverse hypermagnesemia; contraindicated in renal failure
Methyl-Prednisolone	Corticosteroid	Asthma, anaphylactic shock	1 mg/kg/24 hr ÷ Q12 hr (max. dose: 60 mg/24 hr). Higher alternative regimen of 1 mg/kg/dose Q6 hr × 48 hr followed by 1–2 mg/kg/24 hr (max. dose: 60 mg/24 hr) ÷ Q12 hr has been suggested.	Depression, headache, weakness, hypertension, diarrhea, nausea, pancreatitis, ulcer, osteoporosis, hyperglycemia	Watch for rare anaphylaxis
Milrinone	Inodilator, Phospho-diesterase inhibitor	Cardiogenic shock or post-surgery CHF	**Loading dose:** 50 mcg/kg IV over 15 minutes **Maintenance dose:** 0.25-0.75 mcg/kg/ minute IV infusion and titrate to effect	headache, dysrhythmias, hypotension, hypokalemia, nausea, vomiting, anorexia, abdominal pain, hepatotoxicity, and thrombocytopenia.	**Contraindicated** in severe aortic stenosis, severe pulmonic stenosis, and acute MI.

PEDIATRIC RESUSCITATION MEDICATIONS

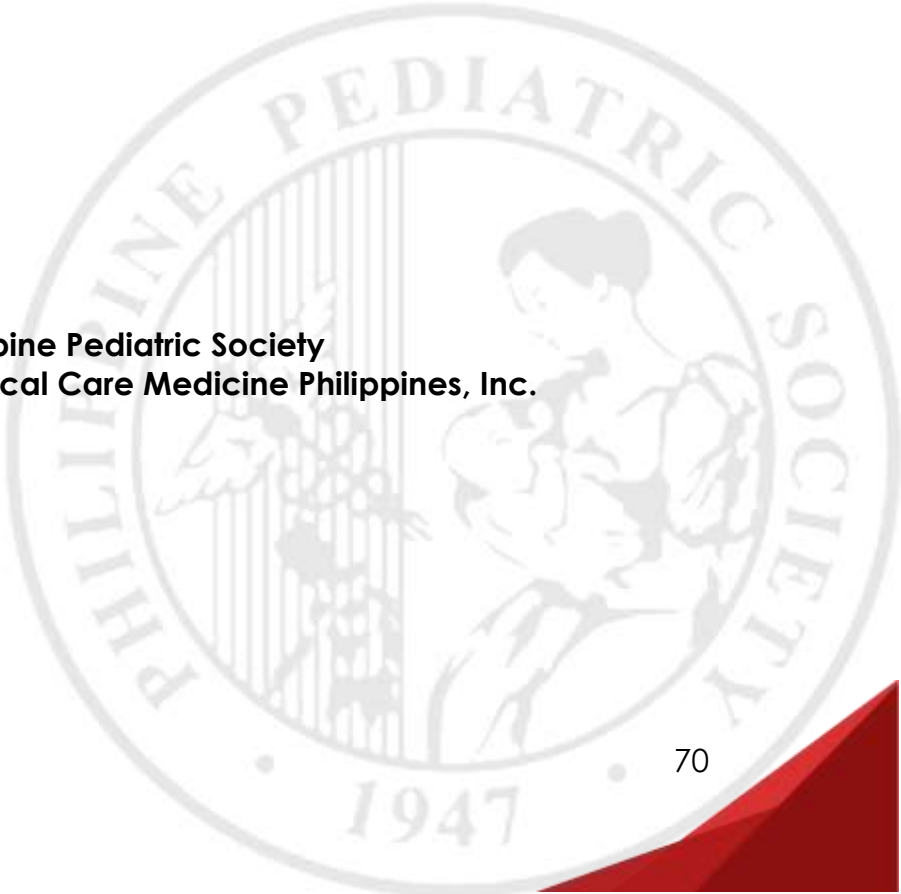
Drug	Classification	Indications	Dose/ Administration	Side Effects	Considerations
Naloxone	Opioid antagonist	Narcotic reversal	**Neonate, infant, child ≤20 kg or ≤5 yr:** 0.1 mg/kg/dose. May repeat PRN Q2–3 min. **Child >20 kg or >5 yr:** 2 mg/dose. May repeat PRN Q2–3 min. **Continuous infusion (child):** 0.005 mg/kg loading dose followed by infusion of 0.0025 mg/kg/hr has been recommended. A range of 0.0025–0.16 mg/kg/hr has been reported. Taper gradually to avoid relapse.	Will produce narcotic withdrawal syndrome in patients with chronic dependence. Abrupt reversal of narcotic depression may result in nausea, vomiting, diaphoresis, tachycardia, hypertension, and tremulousness.	Short duration of action may necessitate multiple doses. For severe intoxication, doses of 0.2 mg/kg may be required. If no response is achieved after a cumulative dose of 10 mg, reevaluate diagnosis. In the nonarrest situation, use the lowest dose effective (may start at 0.001 mg/kg/dose).
Nitroglycerine	Vasodilator anti-hypertensive	CHF, cardiogenic shock	**Continuous IV infusion:** Begin with 0.25–0.5 mcg/kg/min; may increase by 0.5–1 mcg/kg/min Q3–5 min PRN. Usual dose: 1–5 mcg/kg/min. **Max. dose:** 20 mcg/kg/min.	May cause headache, flushing, GI upset, blurred vision, and methemoglobinemia.	**Use with caution** in severe renal impairment, increased ICP, and hepatic failure. IV nitroglycerin may antagonize anticoagulant effect of heparin.
Nitroprusside	Vasodilator anti-hypertensive	Cardiogenic shock Hypertension	Start at 0.3–0.5 mcg/kg/min, titrate to effect. Usual dose is 3–4 mcg/kg/min. **Max. dose:** 8–10 mcg/kg/min.	Nitroprusside is nonenzymatically converted to cyanide, which is converted to thiocyanate. Cyanide may produce metabolic acidosis and methemoglobinemia; thiocyanate may produce psychosis and seizures.	Monitor for hypotension and acidosis. Dilute with D5W and protect from light.
Nor-epinephrine	Inotrope, Vasopressor, Catecholamine	Hypotensive shock	Start at 0.05–0.1 mcg/kg/min. Titrate to effect. **Max. dose:** 2 mcg/kg/min.	May cause cardiac arrhythmias, hypertension, hypersensitivity, headaches, vomiting, uterine contractions, and organ ischemia.	Monitor ECG and BP; IV infiltration may lead to tissue necrosis; ideally administered via central line; do not mix in alkaline solution

PEDIATRIC RESUSCITATION MEDICATIONS

Drug	Classification	Indications	Dose/ Administration	Side Effects	Considerations
Procainamide	Antiarrhythmic	SVT, atrial flutter, VT with pulse	**V. Tach with pulse:** 15 mg/kg over 30-60 minutes	May cause lupus-like syndrome, positive Coombs' test, thrombocytopenia, arrhythmias, GI complaints, and confusion.	Monitor ECG (particularly QT interval) and BP; expert consultation should be called before administration
Salbutamol	Bronchodilator, Beta-adrenergic agent	Asthma, bronchospasm, hyperkalemia	Nebulized at 0.05 to 0.15 mg/kg/dose as often as needed	Tachycardia, palpitations, tremor, insomnia, nervousness, nausea, and headache.	Consider cardiac monitoring and monitoring of serum potassium (hypokalemia).
Sodium Bicarbonate	Electrolyte to produce alkalinity	Severe metabolic acidosis, hyperkalemia, tricyclic overdose	1 mEq/kg slow IV bolus to max of 50 mEq **For overdose** 1-2 mEq/kg bolus repeating until pH >7.45 follow with infusion of sodium bicarb solution to maintain alkalosis	CNS symptoms, arrhythmia, hypotension, cardiac arrest, renal calculi, cyanosis, edema, metabolic alkalosis and other derangements, water retention	Monitor ECG, oxygen and ABGs; ensure adequate ventilatory support to reduce the chance of carbon dioxide accumulation; not recommended in cardiac arrest
Terbutaline	Bronchodilator, beta adrenergic agonist	Asthma, hyperkalemia	**Continuous infusion, IV:** 2–10 mcg/kg loading dose followed by infusion of 0.1–0.4 mcg/kg/min. May titrate in increments of 0.1–0.2 mcg/kg/min Q30 min depending on clinical response. Doses as high as 10 mcg/kg/min have been used. **SubQ:** 0.005–0.01 mg/kg/dose (**max. dose:** 0.4 mg/dose) Q15–20 min × 3; if needed, Q2–6 hr PRN.	Nervousness, tremor, headache, nausea, tachycardia, arrhythmias, and palpitations may occur.	Monitor ECG, oxygen and BP; use cautiously in children with hypokalemia
Vasopressin	Antidiuretic hormone analogue	Cardiac arrest, septic shock	**Cardiac Arrest:** 0.4-1 unit/kg bolus by 1 dose **Catecholamine-resistant Hypotension:** 0.0002 to 0.002 U/kg/min (0.2 to 2mIU/kg/min) continuous infusion.	Tremor, sweating, vertigo, abdominal discomfort, nausea, vomiting, urticaria, anaphylaxis, hypertension, and bradycardia.	Monitor BP and distal pulses; watch for signs of water intoxication; tissue necrosis may develop from IV extravasation; caution with asthma or cardiovascular disease.

MANUAL on

PEDIATRIC RESUSCITATION



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