PALS Update 2010

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During the past decade, guidelines for cardiopulmonary resuscitation have focused on the importance of high quality CPR. The purpose is to temporarily maintain a circulation to vital organs until specialized treatment is available. In, essence, it has been a revolution in pediatric resuscitation in terms of “coming full circle” to the 1960s when basic CPR was first developed. A fifth component to the pediatric chain of survival has been added with emphasis on integrated post cardiac arrest care. With mounting scientific evidences, American Heart Association published new Pediatric Advanced life support 2010 guidelines in accordance with the established five yearly cycle of guideline changes.

Key words: *Cardiac arrest, Cardio-pulmonary resuscitation, Pediatric advanced life support.*

Cardiac arrest in infants and children are often the end result of progressive respiratory failure or shock. Hypoxemia, hypercapnea, and acidosis often in combination lead to bradycardia and hypotension, progressing to cardiac arrest. The current guidelines have again laid emphasis on “high Quality Cardio- Pulmonary Resuscitation (CPR)”. These guidelines have replaced those published in 2005 in accordance with the established five-early cycle of guideline changes. The guidelines have highlighted the need of medical emergency teams (METs) or rapid response team (RRTs) for reducing the risk of respiratory or cardiac arrest in hospitalized pediatric patients [1]. Some of the key changes in the pediatric basic life support have been published earlier [2]. This article further summarizes the major changes by American Heart Association 2010 guidelines to the pediatric advanced life support (***Table* I**).

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TABLE I COMPARISON OF CHANGES IN PALS GUIDELINES

PALS 2010 (1)	*PALS 2005 (3)*	*Comments*
Pediatric Chain of Survival		
Includes five components i.e. prevention, early CPR, prompt access to emergency response system, rapid Pediatric advanced life support, followed by integrated post cardiac arrest care	Included only four components i.e. prevention, basic CPR, prompt access to emergency response system, prompt Pediatric advanced life support.	Emphasis is on effective CPR with post arrest care.
Airways		
Oxygen		
There is insufficient evidence and no studies in infants and children to suggest the optimal inspired oxygen concentration during resuscitation from cardiac arrest, though ventilating with 100% oxygen seems reasonable. However once the circulation is restored an arterial oxyhemoglobin saturation of at least 94% should be maintained.	Use 100% oxygen during resuscitation and monitor patient. Hypoxemia is defined as arterial oxygen saturation <94%.	Avoid hyperoxia with adequate delivery of oxygen to the tissues.
Endotracheal tubes (ET)		
Both uncuffed and cuffed tubes can be used in infants and children in emergency intubation. In intensive care settings the risk of complications in infants and children is no greater with cuffed tubes than with uncuffed tubes. However, the cuff inflation pressure should be as per the manufacturer's instructions (Less than 20 to 25 cm H_20).In an emergency intubation of an infant less than 1 year and ≥3.5 Kg, select a 3.0 mm internal diameter (ID) cuffed tube. For children between 1 to 2 years of age, select 3.5 mm ID cuffed endotracheal tube. After 2 years of age, use the formula ID (mm) = (age in years/4) + 3.5 for estimating the size of cuffed endotracheal tube.	In-hospital cuffed ET tube is as safe as uncuffed for infants beyond the newborn period and children [4]. Cuffed tubes were preferable in conditions like poor lung compliance, high airway resistance, and large glottis air leak. Keep cuff inflation pressure < 20 cm H_20. For cuffed tubes ID (mm) = (age in years/4) + 3 (Khine formula).	Cuffed tubes may decrease chances of aspiration and reintubation rates. Aggressive rounding of age by Khine, *et al* resulted in 0.5 mm ID smaller size tube estimation [5].
Bag and mask Ventilation		
In out of hospital resuscitation, particularly if the transport time is short, bag and mask ventilation is recommended over tracheal intubation in infants and children. It can be as effective and may be safer than endotracheal intubation in out of hospital setting. [6] Bag and mask ventilation is not recommended for a lone rescuer during CPR, instead he should use mouth-to-mouth barrier devices for ventilation. [7].	Bag & mask can be as effective as endotracheal tube ventilation for short periods and may be safer.	Out of hospital intubation has greater failures, and complications. Bag and mask ventilation requires complex steps, proper training is required for providing effective breaths.
Laryngeal mask airway (LMA)		
In situations where both bag –mask ventilation and endotracheal intubation have failed, then LMA is acceptable when used by an experienced provider in children. However, LMA insertion is associated with a higher incidence of complications in young children compared with older children and adults.	No data to support or refute use of LMA in pediatric cardiac arrest. The LMA may be an acceptable airway adjunct in difficult intubations for experienced providers in pediatric cardiac arrest [8].	Bag and mask remains the preferred technique for emergency ventilation.
End tidal CO_2 monitoring ($ETCO_2$)		
When available continous capnography or colorimetry is recommended to confirm the placement of endotracheal tube in neonates, infants and children with a perfusing cardiac rhythm in all settings	In pre-hospital, in-hospital and intra-hospital to confirm ET placement in infants (>2 kg) and children with perfusing rhythm.	Studies have shown a strong correlation between ET CO_2 and interventions that increase cardiac output during

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(prehospital, emergency, inpatient,ICU, operating room) and during transport [9]. It also provides a feed back on the effectiveness of chest compression. If the $ETCO_2$ is consistently <15 mm Hg, improve the quality of chest compressions and avoid excessive ventilation.		resuscitation from shock or arrest.
Cricoid pressure		
There is insufficient data to show that Cricoid pressure is effective in preventing aspiration during rapid sequence or emergency tracheal intubation in infants or children. Therefore, it should be discontinued if it hampers effective ventilation or interferes with the speed or ease of intubation [10].	Cricoid pressure is effective for preventing gastric inflation and subsequent vomiting and aspiration during ventilation in an unconscious victim.	Preference should be given to timely intubation
Compression –ventilation ratio for newborn		
The data is insufficient regarding the optimal Compression –ventilation ratio for infants in the first month of life. For ease of training newborns (intubated or not) requiring CPR in NICU would receive 3:1 Compression –ventilation ratio with a pause for ventilation. However, newborns who require CPR in other settings (prehospital, emergency, PICU, etc) should receive CPR as per the infant CPR guidelines (without pause). Newborns with primary cardiac etiology of arrest should preferably be resuscitated according to the infant guidelines with more emphasis on chest compression.	Newborn should receive 3:1 compression ventilation ratio with a pause for ventilation.	Emphasis is again on effective cardiopulmonary resuscitation esp. chest compressions.
Defibrillation		
The lowest energy dose for effective defibrillation and the safe upper limit of defibrillation in infants and children is not known. An initial dose of 2-4J/kg (for teaching purpose 2J/kg as initial dose), followed by 4 J/kg, and even higher energy dose can be given, but not to exceed 10J/kg (or the adult maximum dose).	An initial dose of 2 J/kg, followed by 4 J/Kg for the second and subsequent shock is recommended.	Energy doses >4J/kg (upto 9 J/kg) have effectively defibrillated children and pediatric animals with minimal side effects.
Pediatric Algorithms		
• The narrow complex tachycardia has been defined as QRS duration ≥0.09 seconds and wide complex as QRS duration >0.09 seconds. • In older children, carotid sinus massage or Valsalva maneuvers are safe [11]. • An IV/IO Verapamil (0.1-0.3 mg/kg) is also effective in terminating SVT in older children, but may cause myocardial depression, hypotension, and cardiac arrest in infants [12]. • Trauma has been removed from the 5T´s as one of the reversible cause of cardiac arrest.	Narrow complex tachycardia is when QRS duration is ≥ 0.08 sec. Do not apply ocular pressure or provide carotid massage. Verapamil should not be used routinely to treat SVT in infancy. Dose in older children is 0.1mg/kg.	Verapamil is equally effective in children and adults, alongwith its cost effectiveness.
Shock		
• There are no pediatric studies regarding the best timing or extent of volume resuscitation in		Early assisted ventilation as part of protocol driven

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children with hemorrhagic shock after trauma. • There is insufficient evidence to support or negate the use of endotracheal intubation of infants and children in shock before the onset of respiratory failure.		strategy may be considered.
Congenital heart diseases Specific resucitative (pre-arrest and arrest) procedures and guidelinem have been added for proper management of cardiac arrest in infants and children with single ventricle anatomy, Fontan or hemi-Fontan/ Glenn physiology, and pulmonary hypertension.	No recommendations.	
Drugs Routine use of Sodium bicarbonate is not recommended in cardiac arrest. It should be used only in some toxidromes or hyperkalemic cardiac arrest.	May be considered for prolonged cardiac arrest. Used in severe metabolic acidosis, hyperkalemia, and sodium channel blocker overdose.	Its use decreases survival in some studies.
The maximum dose of Adrenalin that can be given in pediatric resuscitation is 1 mg by IV/IO route, and 2.5 mg via endotracheal route. No benefit of high dose (>100 mcg/kg) of adrenalin.	Consider higher doses if needed. Max IV dose is 1 mg and 10 mg by ET route.	No improvement in survival or neurological outcome with >1 mg adrenalin.
Etomidate should not be routinely used in pediatric septic shock However,it facilitates endotracheal intubation in infants and children with minimal hemodynamic effects.	No recommendations.	Etomidate increases risk of adrenal insufficiency.
Therapeutic hypothermia Temperature of 32ºC to 34ºC may be considered for children who remain comatose after resuscitation from cardiac arrest (13). It is reasonable for adolescent and adults resuscitated from sudden, witnessed, out of hospital VF cardiac arrest, and in asphyxiated newborns. It may be considered for children who remain comatose following resuscitation from cardiac arrest.	Post cardiac arrest temperature of 32ºC to 34ºC may aid brain recovery for 12-24 hours or longer in children.	Metabolic oxygen demand increases by 10-13% for each degree rise in temperature.
Sudden unexplained deaths In sudden unexplained cardiac arrest in children and young adults, obtain a complete past medical and family history, review previous ECGs, and where facilities are available, have a complete autopsy. Appropriately preserve the tissues for genetic analysis.	No recommendations.	Sudden death in infants, children, and young adults may be associated with genetic mutations causing cardiac ion channelopathies.

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