Pediatric Resuscitation Revised: A summary of the updated BLS/NALS/PALS recommendations

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Abstract

In 2005, The American Heart Association (AHA) published its revised recommendations for basic and advanced life support, emphasizing the importance of effective cardiopulmonary resuscitation (CPR). It also simplified the original guidelines, providing standard CPR criteria across all age groups. This work reviews the major changes made in the guidelines for the pediatric and neonatal groups and provides a modified algorithm to help rescuers care for children and infants with cardiac/hypoxic arrest.

MeSH Words: Cardiopulmonary resuscitation, American Heart Association, pediatric advanced life support, neonatal advanced life support, basic life support.

Introduction

In 2005, the American Heart Association issued its revised recommendations for basic and advanced life support in order to improve survival after cardiac arrest. The new guidelines emphasized effective cardiopulmonary resuscitation (CPR) and standardized the criteria for CPR across all age groups to make training and implementation easier. The pediatric age group was defined as age 1-8 years for lay rescuers and age 1 year to puberty (about 12-14 years) for health care providers. Individuals below these ranges were categorized as neonates, and individuals above, as adults. This article summarizes the main revisions that apply to the pediatric and neonatal age groups.

Basic Life Support (BLS)

The goal of the new AHA guidelines was to increase the number of victims with out-of-hospital cardiac arrest who receive early, high-quality CPR and defibrillation. The revisions were prompted by studies showing that although CPR provided by lay rescuers at least doubles patient survival [1], only one-third of all hospitalized victims of cardiac arrest in the United States receive CPR prior to the arrival of Emergency Medical Services (EMS) [2], and in those who do, it is usually not provided efficiently.

To improve these rates, the AHA formulated management priorities. CPR is the first priority for unresponsive infants and children. Because hypoxic arrest is the most common type of arrest in the younger age groups, in situations of sudden witnessed collapse and a lone rescuer, CPR should be started before emergency medical services (EMS) are activated. However, in situations of sudden unwitnessed collapse and a lone rescuer, EMS should be activated first. EMS is also best activated first in situations of sudden witnessed collapse with more than one rescuer. Preferably, an automated external defibrillator should be used for CPR.

A rescuer confronted with an unresponsive child should first check for "adequate" breathing. If breathing is inadequate, rescue breaths should be delivered. The rescuer should try "a couple of times" to deliver 2 effective rescue breaths [3]. If the victim is not breathing but has a pulse, only respirations should be delivered, without compressions. The healthcare provider should administer 12-20 breaths per minute (1 breath every 3-5 seconds) for infants and children.

To open the airway of both injured and uninjured victims with hypoxic arrest, the lay rescuer should perform the head-tilt-chin-lift maneuver in both trauma and nontrauma situations. This procedure is also recommended for the healthcare provider in nontrauma settings. In trauma situations, when a cervical spinal injury is suspected, the health care provider should perform the jaw-thrust maneuver without a head tilt, while manually stabilizing the head and neck. The jaw thrust is no longer recommended for lay rescuers because it is difficult to learn and perform, may be ineffective and may cause spinal movement [4]. Rescue breaths should be given over 1 second, with enough volume to create visible chest rise.

When the airway is blocked by a foreign body, the victim may exhibit difficulty breathing, inability to speak or breathe poor air exchange, or a silent cough. To relieve an airway obstruction in an infant, the rescuer should deliver 5 back blows and 5 chest thrusts; in older children, the Heimlich maneuver is recommended. It is unadvisable to perform blind finger sweeps. If the individual is still unresponsive, the rescuer should activate the EMS and then perform CPR.

Effective chest compressions as part of CPR are crucial to improving survival. Studies have shown that chest compressions performed in emergency situations are for the most part too few, too shallow (37%), and too weak. Excessive ventilations (61%) with too many interruptions in chest compressions can yield ineffective CPR [5]. Therefore, the AHA now recommends to "push hard and push fast". Interruptions, in order to place an advanced airway or defibrillation device for example, should be limited to less than 10 seconds. Rhythm checks should be performed every 2 minutes or every 5 cycles of CPR. In addition, when performing chest compressions, rescuers should be changed, if possible, at these intervals to decrease fatigue. The switch should be performed in less than 5 seconds [6]. Once an advanced airway is in place, compressions and breaths should be delivered continuously, without interruption.

Chest compressions are performed in children and infants if the heart rate is less than 60 beats/minute or the pulse is absent. The compression-to-ventilation criterion for initiating compression has been revised by the AHA to a ratio of 30:2 in all age groups for the lone lay rescuer and to 15:2 in children when there are 2 or more professional rescuers. These ratios apply to all cardiac arrests, including hypoxic arrest. Compressions should be performed at a rate of 100 per minute in children and 120 per minute in newborns. For adequate compressions in children, the rescuer should use the heel of one or both hands to push the lower half of the sternum to a depth of 1/2-1/3 of the chest diameter [7]. In infants, the AHA now recommends pressing with both thumbs on the sternum, with the hands encircling the chest and squeezing the thorax.

In the community, sudden witnessed collapse is most often secondary to ventricular fibrillation or rapid ventricular tachycardia. Therefore, AEDs are useful for increasing survival, and should be applied as soon as available. There is sufficient evidence of the safety of AEDs for victims over one year of age [8]. . However, if the collapse is unwitnessed, CPR should be performed, for 5 cycles or 2 minutes, prior to application of the AED. In children (aged 1-8 years), a single shock should be administered at a dose of 2 J/kg. If the pediatric dose is unavailable, the adult dose is a reasonable alternative. Each shock should be followed immediately by CPR, because although the first shock eliminates 90% or more of all cases of ventricular fibrillation [9], in cases in which it does not, CPR is of great value. These algorithms will be discussed in more detail later in this paper.

Neonatal Resuscitation

The major goal of neonatal resuscitation is to establish effective ventilation and oxygenation. The revised AHA guidelines focus on oxygen use during resuscitation, clearing of meconium, and advanced airway techniques.

The AHA now recommends initiating neonatal resuscitation with an oxygen concentration of less than 100% or room air. If there is no improvement after 90 seconds, supplemental oxygen should be administered. . The standard is 100% fractional concentration of oxygen in inspired gas (F_iO_2). For babies who have central cyanosis but are breathing adequately, free-flow oxygen is indicated. The overall objective is to balance oxygen delivery with tissue demand. Both high-concentration oxygen and oxygen deprivation have been shown to have adverse effects on the respiratory physiology and cerebral circulation of newborns [10].

Positive pressure can be provided in newborns via a self-inflating bag, a flow-initiating bag, or a T-piece valved device which regulates flow [11]. In general, the best indicator of successful ventilation is an increase in heart rate. Correct placement of an advanced airway should be confirmed by detection of exhaled CO_2 [12]. The recommended compression-to-ventilation ratio is 3:1, with 90 compressions and 30 breaths per minute, for a total of 120 events per minute. When compressions are given continuously, the rate should be 120 compressions per minute.

In its revised recommendations, the AHA further clarified the management of neonates born with meconium-stained amniotic fluid. Instead of oropharyngeal and nasopharyngeal suctioning at the perineum, infants who are not vigorous warrant endotracheal suctioning immediately after birth.

In newborn resuscitation, drug therapy is rarely indicated [13]. The AHA has replaced its recommendation for high-dose epinephrine with epinephrine at a dose of 0.01-0.03 mg/kg. The intravenous route is preferred, at a concentration of 1:10,000, because the endotracheal route is too unpredictable (for any drug delivery). However, when access is difficult to obtain, epinephrine may be administered via endotracheal tube at a concentration of 1:1000. Naloxone is no longer recommended for primary resuscitative efforts, and prior to its administration, the rescuer should attempt to restore the heart rate and color through ventilatory support [4]. In addition, naloxone is no longer administered to neonates by the endotracheal route.

There has been much controversy in recent years regarding the issue of temperature control in post-resuscitation care. The AHA recommends maintaining a normal body temperature; to do so, polyethylene bags may be helpful [14]. It is important to avoid hyperthermia, especially in victims with hypoxic-ischemic events and very-low-weight infants.

The AHA has also included guidelines for withholding or withdrawing resuscitative efforts in neonates, optimally with parental consent. It may be reasonable to withhold resuscitation in conditions associated with an unacceptably high mortality rate, and to provide resuscitation in conditions with a high survival rate. Otherwise, in babies with an uncertain prognosis, borderline risk of survival, or high risk of morbidity with a high anticipated burden, resuscitative efforts are dictated by parental desire. If continuous adequate resuscitation yields no response (heartbeat or respiratory effort) after 10 minutes, its discontinuation is reasonable.

Pediatric Advanced Life Support (PALS)

In advanced pediatric life support, the emphasis is on effective bag-valve-mask technique. Endotracheal tube placement is the preferred approach to airway maintenance for trained providers. When impossible, a laryngeal mask airway (LMA) is a reasonable alternative. Because the insertion of an advanced airway may cause a prolonged interruption in compressions, the provider needs to weigh the risks and benefits. The AHA now recommends cuffed endotracheal tubes for hospitalized children at any age group except neonates, with attention to tube size, position, and pressures. For children 1-8 years of age, the endotracheal size can be calculated by the following formulas [15]:

The size of a cuffed endotracheal tube is determined by:

Size (mm ID) = (age in years/4) + 3

The size of an uncuffed endotracheal tube is determined by:

Size (mm ID) = (age in years/4) + 4

Once the endotracheal tube is in place, cuff pressure should be maintained at <20 cmH_2O [16]. Correct placement needs to be verified by clinical assessment, auscultation of breath sounds, and exhaled CO_2 measurement; however, the use of calorimetry or capnography is limited to patients exhibiting a perfusing rhythm [17]. An esophageal detector may be considered for patients weighing more than 20 kg [18]. Verification should be repeated during transport and after movement of the patient. Respirations should be administered simultaneously with chest compressions. The AHA now recommends a lower rate than before, of 8-10 per minute. Hyperventilation may be harmful and should not be used [19].

The majority of cardiac arrests in children are a consequence of shock and respiratory failure. In situations of sudden witnessed collapse, immediate defibrillation is warranted, followed immediately by CPR, followed by drug administration. CPR is important in this setting, because it provides some blood flow, delivering oxygen and substrate to the heart muscle. This "primes" the heart for the next defibrillation attempt and helps to abort ventricular fibrillation. It is also effective in treating pulseless electrical activity (PEA). According to the new guidelines, the starting defibrillation dose should be 2 J/kg, and subsequent doses 4 J/kg, regardless of the type of defibrillator. Owing to the time it takes to deliver stacked shocks, the AHA now recommends a single shock followed by uninterrupted CPR for 5 completed cycles or 2 minutes. At this point, a pulse/rhythm check should be made. In cases of asystole or PEA, CPR should be initiated immediately.

Specifically, the treatment of each rhythm disturbance is classified according to the tachycardia algorithm, shown in Figure 1. It is of note that sinus tachycardia with adequate perfusion is no longer included in the algorithm. In addition, polymorphic ventricular tachycardia is now considered most likely to be an unstable rhythm. Therefore, unsynchronized rather than synchronized shocks are recommended. It is currently recognized that low-energy synchronized shocks have a high likelihood of provoking ventricular fibrillation [3].

For the most part, the algorithm drug dosages have undergone few changes in the 2005 guidelines. Drug delivery should not interrupt CPR, and its timing is less important than minimizing chest compressions. Furthermore, intravenous or intraosseous routes are preferred for vascular access and for the administration of all drugs: Like in neonatal resuscitation, the endotracheal tube is considered too unpredictable. However, if vascular access is unavailable, the lipophilic LEAN drugs (lidocaine, epinephrine, atropine, narcan) may be administered at higher doses through the endotracheal tube [20].

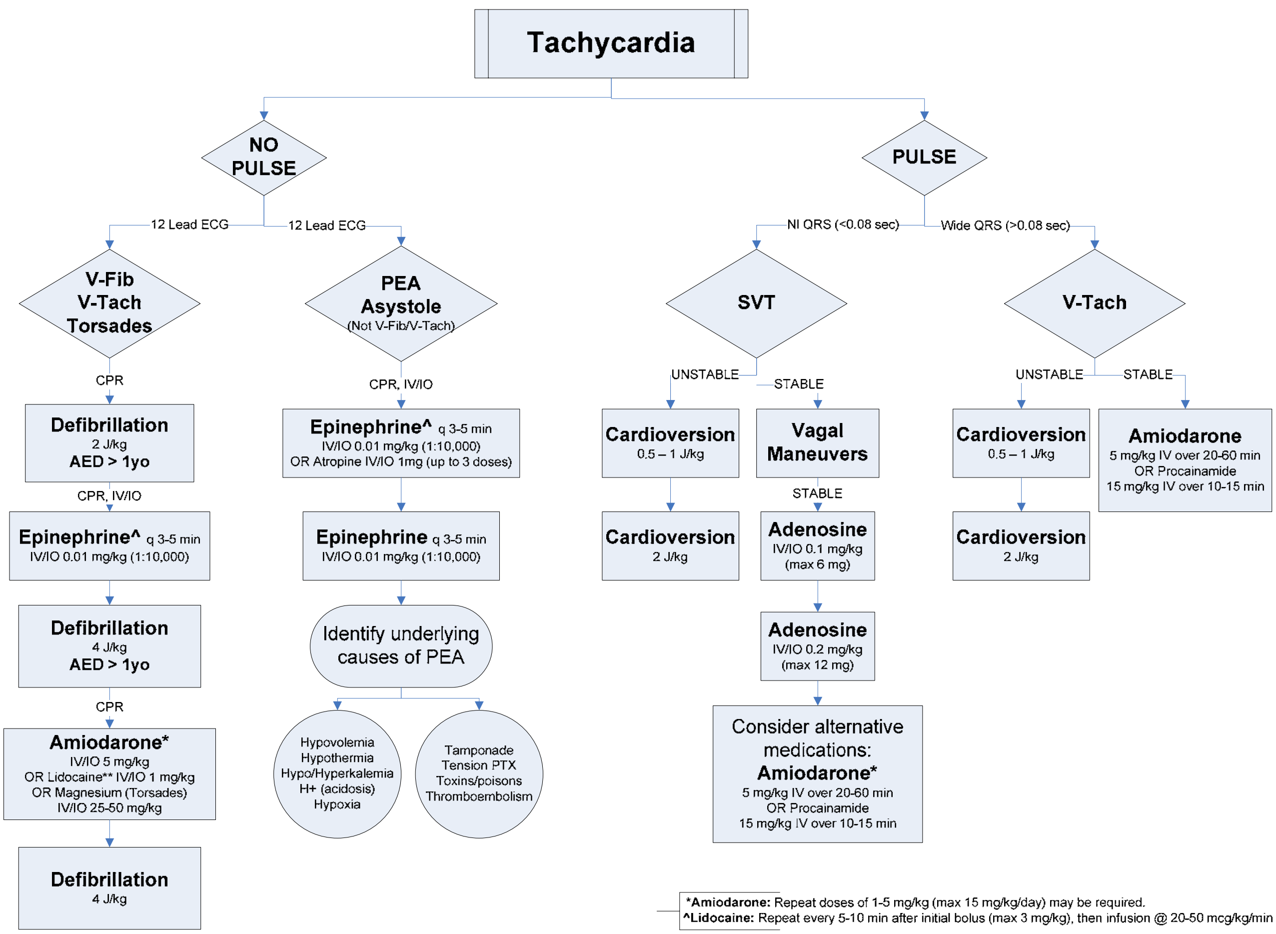
The standard recommended dose of epinephrine is 0.01 mg/kg (0.1 cc/kg) administered intravenously or intramuscularly, or 0.1 mg/kg if the endotracheal route needs to be used. High doses should not be administered except in cases of β blocker overdose, because they may actually worsen outcome [21]. In cases of pulseless arrest, amiodarone is more effective; when unavailable, lidocaine is a good second choice [22]. In the 2005 guidelines, lidocaine has been replaced by amiodarone and procainamide in the stable ventricular tachycardia algorithm (Figure 1). However, amiodarone and procainamide should not be administered together, because this can lead to severe hypotension and prolonged QT interval.

Post-Resuscitative Care

Hyperthermia should be avoided during resuscitative efforts. However, induced hypothermia (32-34 ^{O}C) for 12 to 24 hours following successful resuscitation may be beneficial [23]. The new guidelines also recognize the probable benefits of vasoactive medications, including ionodilators (inamrinone, milrinone), in the treatment of post-resuscitation myocardial depression.

New evidence suggests that the duration of resuscitation is not an adequate prognostic indicator of survival. Intact survival has been reported even in cases of prolonged resuscitation and 2 doses of epinephrine [24].

Figure 1. Algorithm for the management of tachycardia in children. Data adapted from PALS Provider Manual and AHA update [3,4]



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