

MINI REVIEW

Medicine Science 2021;10(2):664-9

Approach to critical ill child

 Adel Hamed Elbaih^{1,2},  Mohammad Raed Safi²

¹Suez Canal University, Faculty of Medicine, Department of Emergency Medicine, Ismailia, Egypt

²Emergency Medicine, Sulaiman Al-Rajhi University, Clinical Medical Science, College of Medicine, Saudi Arabia

Received 31 August 2020; Accepted 20 November 2020

Available online 17.01.2021 with doi: 10.5455/medscience.2020.08.176

Copyright@Author(s) - Available online at www.medicinescience.org

Content of this journal is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.



Abstract

Critically ill children are the children whom requiring, or potentially requiring, high reliance or serious consideration whether in medical, surgical or trauma- related fields. Pediatric ill cases regularly increase the incidence of Emergency Department (ED) Presentation in addition, induced a high percent of ED visitors. All child patients who are requiring urgent management in the ED, hospital wards, Intensive Care Unit (ICU) and Neonatal Intensive Care Unit (NICU). Initial assessment and management with a priority-based methodology to recognize potentially life-threatening conditions and to convey life-saving treatment. Collection of all possible available data about Critical ill child in the ED. By many research questions to achieve these aims so a midline literature search was performed with the keywords "Critical ill child ECG", "cardiac arrest in child", "emergency medicine", "principals of resuscitations skills", "pediatric life support". All studies introduced that the initial therapy is a serious condition that face patients of the emergency and critical care departments. Literature search included an overview of recent definition, causes and recent therapeutic strategies. Conclusion: Practitioner's experts should check that all the fitting equipment and supplies for various age bunches are accessible. It is pivotal to begin with Pediatric Assessment Triangle (PAT) trailed by Airway, Breathing, Circulation, Disability and Environment /Exposure (ABCDE) evaluation. After completing the initial evaluation and resuscitation, the pre-hospital specialist ought to perform progressing assessment to watch the intervention reaction and to manage changes in treatment.

Keywords: Critical ill Child, Emergency Department, management.

Introduction

Critically ill children are the children whom requiring, or potentially requiring, high reliance or serious consideration whether in medical, surgical or trauma- related fields. High percent of the emergency department visitors are pediatric patients. Especially during the night because the pediatric clinics are not working at that time. Multiple emergency departments contain specific separated pediatric patients care waiting rooms, so they won't be scared during their visit. Some of them have likewise extraordinary rooms with hues and designs to improve the experience of pediatric patients. Generally pediatric patients are assessed with their guardians, which may support the assessment or make it increasingly troublesome. It is critical to watch the way in which children connect with their guardians. It is very important to know that children are different. And the health

care of the sick children starts with early acknowledgment about his situation, and forceful stabilization and resuscitation. The critical ill child faces specific difficulties, as there are numerous novel highlights, in anatomy and physiology, that vary fundamentally to grown-ups [1,2].

The aim of study how to approach to the critically ill child is to normalize initial assessment and management with a priority-based methodology to upgrade dependability and improve the performance of the medical team, in addition, to recognize potentially life-threatening conditions and to convey life-saving treatment in a concurrent and constant way to forestall further disintegration. This will result in improving healthcare outcomes, decreasing the mortality rate, and knowing some of the wrong approaches applied by a physician in pediatric emergency cases [3].

Before begin talking about the contrasts between the children and the adults, we should know about some fundamental terms, the word 'child' in the manual alludes to the both infant (beneath 1-year-old) and children (1-year-old to adolescence). A neonate is an infant inside about a month of being born, while a newborn alludes to a neonate immediately following delivery [4].

*Corresponding Author: Adel Hamed Elbaih, Suez Canal University, Faculty of Medicine, Department of Emergency Medicine, Ismailia, Egypt
E-mail: elbaihzo@yahoo.com

Methodology

In this review paper, we have looked through the recent literature that discussed critical ill child its approach, diagnosis, and step of management. We also used text books and articles that discussed the difficulties of this condition's approach in the ED. Collection of all possible available data about Critical ill child in the ED. By many research questions to achieve these aims so a midline literature search was performed with the keywords "Critical ill child ECG", "cardiac arrest in child", "emergency medicine", "principals of resuscitations skills", "pediatric life support". All studies introduced that the initial therapy is a serious condition that face patients of the emergency and critical care departments. Literature search included an overview of recent definition, causes and recent therapeutic strategies.

Aim and outcome of the study: initial assessment and evaluate the suspected critical ill child presentation to recognize potentially life-threatening problem and to convey life-saving treatment so the key note here is that "stable child is a time."

The differences between the child and the adults include

Weight and size

One of the most evident contrasts between infants, children and adults is their diverse size and weight. Weight is significant because medications and liquids are recommended by body weight in pediatrics. The specific weight is anyway as often as possible inaccessible in emergency circumstances. There are various apparatuses to assess the child weight, the emergency medication dose and size of emergency equipment. One of these tools is an estimation of the child's weight by the use of a formula [5].

An infant weight approximately 3 kg at birth, 6 kg at six months and 10 kg at one year of age. For the age group between 1 and 14 years the following formula provides a rough approximation of weight: $\text{Weight (kg)} = [\text{age in years} + 4] \times 2$. In adolescents who are seem to be bigger than their real age, one should consider to adjust upwards and jump off at the next '10' for example, 40 is more appropriate than 35 for a big 13 years old child. Once we think that the weight is above 50 kg, it becomes preferable to use adult dosing schemes or use that 50 kg as an upper limit for calculation [6, 7].

Anatomy and physiology differences in child

There are fundamental features between children and adults. Generally, in children head is proportionately larger, neck is shorter, tongue is bigger in proportion to mouth, infants are breath by nose obligatory, in children the subglottic area is the narrowest region of the airway, children have poor cervical spine support, trachea is more malleable in children, epiglottis is shaped as horseshoe, larynx is higher and located more anteriorly, and finally tracheal rings have less rigidity [8].

Common pediatric emergencies

There are variant emergent conditions may affect the child, such as airway problems which includes tonsillitis, airway obstruction which caused by foreign-body, pneumonia, asthma, and bronchitis, in addition to cardiac arrest and respiratory failure. There is also abdominal pain diarrhea, nausea, and vomiting. Child also may face seizures, poisoning sudden infant death syndrome (SIDS), trauma,

burns and electrocutions and finally shock [9].

Epidemiology

- Each year around 16,000 children in the United States experience cardiac arrest [10].
- Patients with Bronchial asthma which more common in children than adults, more common in boys than girls, right now, there are about 6.2 million kids younger than 18 complaining from asthma and in 2017, 1 in 12 children had asthma [6].
- Each day more than 300 children in the United States are going to emergency department complaining from poisoning, and because of that, two children die [11].
- Around 35 million children the United States had one or more types of trauma in childhood [8].
- Every day around 340 children visit the emergency department because a burn injury [9].
- In the United States sudden infant death syndrome (SIDS) is the most common cause of children death in the ages between one month to one year [12].
- Regarding to the CDC, in 2017 the rate of sudden infant death syndrome (SIDS) was 35.4 deaths per 100,000 live births and there were about 3,600 sudden unexpected infant deaths (SUID) in the United State [13].

A problem or a lack of knowledge needed to be aware about it in the clinically approach to an ill child

- Begin the approach with PAT followed by ABCDEs.
- Recognize the three segments of the Pediatric Assessment Triangle (PAT).
- Evaluate the patient through the initial assessment (ABCDEs) accordingly to the specific features of the pediatric patient.

WHY this is a problem/WHY this study is necessary

- To normalize initial assessment and management with a priority-based methodology to upgrade dependability and improve the performance of medical team as evaluation tools as in table (5)
- To recognize potentially life-threatening conditions and to convey life-saving treatment in a concurrent and constant way to forestall further disintegration.

The research question: How to Approach to the Critically Ill Child?

The initial phase in assessing any child is to evaluate their general condition basely through the pediatric appraisal triangle (PTA). Followed by ABCDE evaluation. These evaluations ought to have a formatively suitable methodology and ought to be done in a brief timeframe.

Pediatric assessment triangle (PAT)

Appearance

The appearance assessment includes the assessment of muscle tone and mental status and reflects the adequacy of respiratory, circulatory and brain function.

- Being miserable, and unable to relax.
- Has a feeble cry; unusual discourse for age.
- Abnormal situating: inclination for situated position.

- Having seizures; unusual movements.
- No spontaneous development, unfit to sit or stand.
- Less alert or drew in with clinician or parental figure; not resisting of the examination.
- No interaction or eye-to-eye connection with individuals and the surrounding [14].

• Breathing

The breathing assessment is including the description of the respiratory status of the child, particularly how much the child must work to oxygenate and ventilate; abnormal sounds of breathing for example, hoarse speech, snoring, stridor and wheezing, retractions (working hard to breathe) supraclavicular retractions, intercostal retractions or substernal retractions and head bobbing and nose flaring during inspiration [15].

• Body color

The body color assessment is including the description of the child's circulatory function, primarily in terms of skin perfusion; any cyanosis (blue discoloration to the skin and mucous membrane), pallor (white discoloration to the skin and mucous membrane) and mottling (patchy skin discoloration caused by the various vasoconstriction degrees [16].

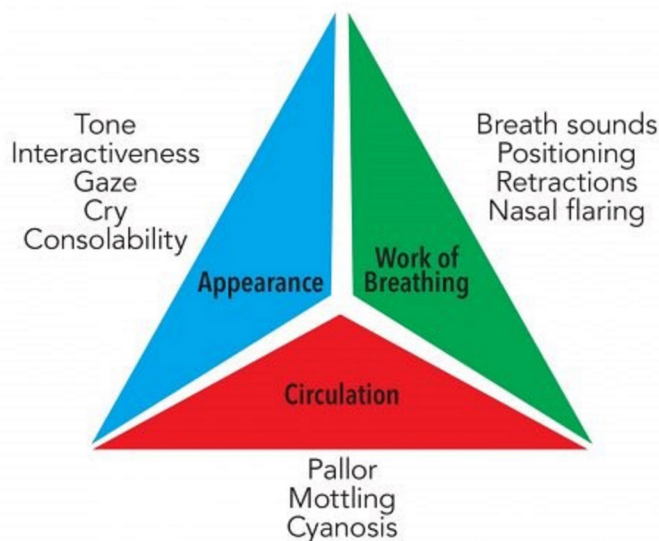


Figure 1. Pediatric assessment triangle

Primary assessment; ABCDE: (17-19)

It is important to consider the key differences in anatomy and physiology between children and adults and know their direct impact on the emergency care.

• Airway (A)

Differences need to be considered in children (Airway)

- The newborn child's head is generally enormous contrasted with the body, and in blend with the moderately big occiput, the head will in general become flexed on the neck in the supine position of the child, which may cause obstruction of the airway.
- The face and mouth of the child are small, and the generally enormous tongue effectively obstructs the airway in the

unconscious child. The mouth floor is likewise effectively compressible, and the obstruction of upper air way can be by pressure on under chin soft tissue.

- The infant is a special nose breather for the initial a half year of life; in this way anything that causes obstruction of the nose in newborns/infants can expand crafted by breathing and lead to respiratory failure.
- The larynx in the infant is located at C2 while in adults and older children it is located at C4-C5; the epiglottis has U-shaped, protruding towards the pharynx at 45°angle; they have short vocal cords. In less 8 years' children the larynx has a funnel shape, with the narrowest section that is located at the subglottic cricoid cartilage level [20].

The (Airway) assessment in children

The primary assessment starts with the evaluation of patency of the airway. This is done by the rule of "look, listen, feel"; you need to look for wall of the chest & movements of the abdomen. Listen for sounds of breath and check for noises at the mouth and nose (chest auscultation). Finally feel at the mouth and nose for flow of the air.

Specific obstructed airway support depending on the age of the child.

- Back blow or chest thrust for patients below 1 year.
- Abdominal thrust for patients above 1 year:

• Breath (B)

Differences need to be considered in children (Breath)

- At birth, the lungs are immature, with an air-alveolar interface of 3 m² when you compare it with the adult (70 m²).
- With age, the breathing mechanics alter. The diaphragm, which is the most important muscle for respiration in children with its downward movement during the inspiration process, make a vacuum, which draws the upper airway and the lungs air.
- The infants have a small lower airway that tend to collapse more easily in case of intrathoracic pressure increased due to forced expiratory effort.
- In the infant, the ribs are also pliable, and the muscles of intercostal are comparatively weak and ineffective when compared to the diaphragm. In more seasoned children, the intercostal muscles are progressively evolved and contribute essentially to ventilation mechanics; the ribs become hardened and work as secure backings just as framing an unbending structure that is less inclined to collapse in respiratory distress.
- The rate of respiration is higher in infants and young children when compared to adults. This because the children have a higher metabolic rate and oxygen consumption.
- The functional residual capacity in children is smaller and because of that less respiratory reserve. Desaturation will happen much faster. This is much progressively evident when in supine position [21].

The (Breath) assessment in children

After the appraisal of airway and finished with the important interventions made to acquire potency of the airway, one ought to continue to the breathing evaluation. This is done by evaluating: the respiratory rate which normal variations according to age of infant as in table 1, work of breathing, tidal volume and finally

oxygenation. Accordingly, the respiratory status may be classified to stable or compensated or decompensated respiratory failure. At that point, the intervention by then should be started by the degree of dysfunction of respiration and before proceeding to the evaluation of the function of circulation [22].

Table 1. Pediatric Respiratory Assessment

Respiratory rate (breath s/ min)	
Age	Rate
Infant	30 to 60
Toddler	24 to 40
Preschooler	22 to 34
Scoll-age vchild	18 to 30
Adolescent	12 to 16

• Circulation (C)

Differences need to be considered in children (Circulation)

- The volume of circulation in the neonate is 80 ml/kg, while in the adults it is around to 60-70 ml/kg.
- The rate of heart is higher in children when compared to adults due to the high metabolic rate in children and the output of the heart is higher in children. As stroke, volume cannot increment similarly as in adults, the children cardiovascular output is primarily dictated by heart rate.
- Blood pressure is lower in infants and small children when compared to larger children or adolescents.

The (Circulation) assessment in children

After the evaluation of breathing and the essential interventions have been made to help oxygenation and ventilation, one ought to continue to the assessment of circulation. In addition, this is finished by assessing: (5P's) pulse, pulses volume, peripheral perfusion, preload and blood pressure. Accordingly, the circulatory status will be determined as normal or as compensated or decompensated circulatory failure (shock). At that point, the intervention by then should be started by the degree of dysfunction of circulation [21].

Table 2. Heart rate with different ages

Normal Heart Rate for Different Ages		
Age	Rate	Average
Newborn	100-180	140
1 - 11 months	80-160	120
2 - 3 years	80-130	110
4 - 5 years	80-120	100
6 - 8 years	75-115	95
> 8 years	70-110	90

Disability (D)

Both the brain and the heart are the two organs that are exceptionally spared by the compensatory respiratory or circulatory failure mechanisms, henceforth-assessing function of brain is imperative to decide the physiological status of the child. Following suitable administration of ABC, and ideally before depressant medications are given, a neurological status assessment ought to be done to the child. While both respiratory and circulatory issues may have central neurological impacts, some neurological conditions (for example meningitis, status epilepticus or decompensated intracranial hypertension) may have respiratory, circulatory or other extreme outcomes. These conditions must be recognized during the essential assessment since they should be dealt with right away [11].

A quick assessment of the consciousness of the child can be done by using the score of Alert, Verbal response, Painful response and Unresponse (AVPU) and Pediatric Glasgow Coma Scale (PGCS) as the parameters in tables 3 & 4:

Table 3. Score of AVPU

Alert	Normal reaction
Verbal	Reaction after vocal stimulation
Pain	Only reaction after pain stimulus
Unresponsive	No reaction despite any stimulus

Table 4. Pediatric Glasgow Coma Scale (PGCS):

> 5 Years		< 5 Years
Eye opening		
E 4	Spontaneous	Spontaneous
E 3	To voice	To voice
E 2	To pain	To pain
E 1	none	none
C	Eyes closed (by swelling or bandage)	Eyes closed (by swelling or bandage)
Verbal		
V 5	Orientated (in person or place or address)	Alert, babbles, coos, words or sentences to usual ability (normal)
V 4	Confused	Less than usual ability, irritable cry
V 3	Inappropriate words	Cries to pain
V 2	Incomprehensible sounds	Moans to pain
V 1	No response to pain	No response to pain
T	Intubated	Intubated
Motor		
M 6	Obeys commands	Normal spontaneous movements
M 5	Localises to supraorbital pain (> 9 months of age) or withdraws to touch	Localises to supraorbital pain (> 9 months of age) or withdraws to touch
M 4	Withdraws from nailbed pain	Withdraws from nailbed pain
M 3	Flexion to supraorbital pain (decerebrate)	Flexion to supraorbital pain (decerebrate)
M 2	Extension to supraorbital pain (decerebrate)	Extension to supraorbital pain (decerebrate)
M 1	No response to supraorbital pain (flaccid)	No response to supraorbital pain (flaccid)

Environment – Exposure (E)

Toward the end, in the last piece of the essential assessment a rapid assessment is made if there are any hints to the patient's condition. Legitimate child presentation is fundamental. You have to evaluate any signs or nearness of trauma fever, injury, skin rashes and so forth. As the temperature regulation of children are immature, it is imperative to keep away from hypothermia. The child pain and discomfort need to be perceived and rewarded at the earliest opportunity after the initial ABCDE adjustment. Quest for pieces of information in environment to comprehend the problem or disease [22].

You need to take a focused history with detailed physical examination.

- Any allergy?
- Any medication that patient use?
- When was the last meal of the patient?
- Past medical history of the patient?
- Environment or exposure?

Steps of the right technique of this method point by point

- Start the assessment by the Pediatric Assessment Triangle (PAT)
- Follow the PAT assessment by the ABCDE assessment, with need to be focus on the anatomical and physiologic changes in the child.
- Reassess the vital signs again.
- Reassess the positive anatomic discoveries, physiologic disturbances anatomic discoveries and physiologic disturbances.
- Survey of viability and security of treatment [22].

Conclusion and Recommendations

The primary objective of realizing how to approach to the critically ill child is to have the option to give quick care to sick children, and to have the option to allude these patients to the hospital in the best possible time.

To be able to perform this mission you need to consider some recommendations:

- You need to give fitting clinical preparing to the staff.
- In addition, experts should check that all the fitting equipment and supplies for various age bunches are accessible.
- It is pivotal to begin with (PAT) trailed by ABCDE evaluation.
- After completing the initial evaluation and resuscitation, the pre-hospital specialist ought to perform progressing assessment to watch the intervention reaction and to manage changes in treatment.
- You need to recall, children are not youthful grown-ups, in this manner, significant contrasts in anatomy and physiology exist and you have to survey your patient appropriately.
- In expansion, you have to consider that each child is extraordinary, just as its families. Every one of them will react distinctively to a specific circumstance. The child's advancement level, past encounters, culture, and the condition itself all affects their responses.

Table 5. Checklist Evaluation Approach for Critically Ill Child

Patient Management		Good	Fair	Poor
Pediatric Assessment Triangle (PAT)				
1	Appearance.			
2	Breathing.			
3	Body color.			
Primary assessment; ABCDE				
4	Assess Airway.			
5	Assess Breathing.			
6	Assess Circulation.			
7	Assess Disability.			
8	Assess Environment /Exposure.			
NEED TO BE AWARE ABOUT				
9	The differences between the child and the adults in anatomy and physiology.			
10	Pediatric vital signs.			
11	AVPU score.			
12	Pediatric Glasgow Coma Scale (PGCS).			

Conflict of interests

The authors declare that they have no competing interests.

Financial Disclosure

The financial support no have.

References

1. Elbahi AH, Housseini AM. Validity of shock index, modified shock index, central venous pressure, and inferior vena cava collapsibility index in evaluation of intravascular volume among hypovolemic Egyptian patients. *Am J Diagnostic Imaging*. 2018;4;1:5–13.
2. Ismail MT, Elbahi AH. Principles of intravenous fluids therapy. *EC Emerg Med Critical Care*. 2020;4;6:24-46.
3. Soto-Martinez. Manuel. *The Critically Ill Child: Medical Observer*. 3rd edition. CRC Press, London. 2012;5:24-62.
4. Elbahi AH, Basyouni FH. Teaching approach of primary survey in trauma patients. *Int J Intern Emergency Med*. 2020; 3;3:1035.
5. Peterson-Carmichael, I Cheifetz. *The Chronically Critically Ill Patient: Pediatric Considerations*. Fourth edition. S Press, London. 2012;21-42.
6. Elbahi AH, Mousa MA. Review Article: Teaching Review on Approach of Esophageal Intubation as Complications in Emergency Airway Management. *Am J Surg Case Report*. 2020;2;3:2-6
7. Mahadevan, Swaminatha V, Garmel, Gus. *An introduction to clinical emergency medicine M*. Second edition. Cambridge: Cambridge University Press, 2011; 3-56.
8. Elbahi AH, Alissa ZK. The effect of cardiopulmonary resuscitation quality on cardiac arrest outcome. *J Emerg Med Care*. 2020;3;1:102.
9. Master ACLS/PALS: Pediatric cardiac arrest overview | ACLS-Algorithms. <https://acsls-algorithms.com/pediatric-advanced-life-support/cardiac-arrest-overview-p1> date access date 22.06.2020

10. El-Kelany A, Enany M, Elbaih AH. Salivary cortisol level as a marker of adrenal function in children with systemic inflammatory response syndrome in Egypt. *Ann Paediatric Rheumatol*. 2017;6;2:28-33.
11. Elbaih AH, Ahmed MY, Nemr NA, et al. Validity of systemic inflammatory response syndrome (SIRS) criteria, interleukin-6 and (MELD) score as prognostic tools in cirrhotic patients with acute renal failure admitted to emergency department in Suez Canal university hospital, Egypt. *Med Science*. 2017;6;2:319-27.
12. Elbaih AH, Morsy K, Ellabban G, et al. Incidence, Nature and outcome of emergency neonatal intestinal obstruction, Egypt. *Narayan Med J*. 2018;7;1:5-24.
13. Beware: Poisoning Prevention | Child Safety and Injury Prevention| CDC Injury Center. <https://www.cdc.gov/safechild/poisoning/index.html> date access date 12.05.2018
14. Elbaih AH, Elsayed ZM, El bahrawey MR, et al. Adherence of Emergency Physicians to Pediatric Emergency Care Applied Research Network-Clinical Decision Rule (PECARN-CDR) in Mild Head Trauma in Emergency Patients. *Open Scientific J Surg*. 1:43-56.
15. Master Pediatrics: Birth and Development of a Community Initiative: The Trauma-Resiliency Collaborative. <https://acestoohigh.com/2013/05/13/nearly-35-million-u-s-children-have-experienced-one-or-more-types-of-childhood-trauma/> date access date 28.06.2017
16. Taha M, Elbaih AH, Ellouly HA, et al Evaluation of effective management of sepsis in emergency department in Suez Canal university hospital. *NJMR*. 2016;6;2:155-8.
17. Elbaih AH, Taha M, Saker A, et al. Patterns of extremities trauma in children and their management in emergency department in Suez Canal University Hospital, Ismailia, Egypt. *Int Surg J*. 2016;3:887- 92.
18. Elbaih AH. Management and outcome of maxillofacial fractures. *SciMedCentral, J Trauma Care*. 2018;4;1:1031-2.
19. Elbaih AH. Different types of triage. *Arch Med Rev J*. 2017;26;4:441–67.
20. Elbaih AH et al., Sepsis patient evaluation emergency department (SPEED) score & mortality in emergency department sepsis (MEDS) score in predicting 28-day mortality of emergency sepsis patients, *Chinese J Traumatol*. 2020;22;6:316-22.
21. Taha M, Elbaih A. Review Article, Pathophysiology and management of different types of shock. *NMJ*. 2017;6:14-39.
22. Elbaih AH, Taha M, Elsakaya MS, et al, Alshorbagy ME. Assessment of cardiopulmonary resuscitation knowledge and experiences between emergency department nurses hospital pre and post basic life support training course, Egypt. *Ann Med Res*. 2019;26;10:2320-7.