

Full Length Research Paper

Clinical evaluation of the pediatric airway obstruction and radioimaging

Dr Nitin Sharma¹, Dr Shasanka Shekhar Panda¹, Dr M. Srinivas¹, Dr Amit Singh¹, Dr Mini Sharma², Dr Meely Panda³

¹Department of Pediatric Surgery, All India Institute of Medical Sciences, New Delhi, India, 110029

²Department of Pulmonary Medicine, All India Institute of Medical Sciences, New Delhi, India, 110029

³Department of Community Medicine, Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, Rohtak, Haryana, India, 124001

*Corresponding author email: nitinsharma4you@yahoo.in; Tel: 8800263830

Accepted 13 August, 2013

Acute airway obstruction due to any cause can be life threatening. Evaluation and management of a child with an airway obstruction is urgency, recognition of the condition and appropriate management at right time is what is required. In this review we have tried to compile the common causes of pediatric airways obstruction and the management protocol for these conditions. An extensive data search was done in pubmed, medline and google scholar regarding available literature and protocols on the topic and the results have been complied.

Keywords: Respiratory distress, airway obstruction, pediatric assessment triangle

Key Messages: Prompt diagnosis, Early identification, Proper protocol based approach.

INTRODUCTION

Caring for sick and injured children presents special challenges. There is an element of anxiety associated with them, treatment is the same as that for adults in most emergency situations. In this review we have tried to compile the common causes of pediatric airways obstruction and the management protocol for these conditions. An extensive data search was done in pubmed, medline and google scholar regarding available literature and protocols on the topic and the results have been complied.

On encountering cases of airway obstruction a rapid assessment of respiratory status to identify those who need resuscitation. For the critically ill child, a brief history should be obtained while emergent treatment is initiated. Details can follow once the child's condition is stabilized as suggested by Lopez-Herce et al, (2005).

Acute upper airway obstruction from any cause can be a life-threatening emergency. Complete obstruction will result in respiratory failure followed by cardiac arrest in a matter of minutes. This situation requires an immediate, aggressive response.

In contrast, a child with a partial obstruction may initially have an adequate airway. However, this condition can

deteriorate rapidly. Under these circumstances, providing supportive care and mobilizing resources for definitive airway management may be the most appropriate intervention.

Compared with adults, infants and young children have small airways and can quickly develop clinically significant upper airway obstruction. The increased work of breathing that result can rapidly progress to respiratory failure because these young patients have less respiratory reserve. Therefore, prompt recognition of airway compromise and the institution of appropriate therapy are necessary to prevent progressive deterioration in respiratory function and improve outcomes (Schindler et al, (1996); Young et al, (2004); Herlitz et al, (2005). In the evaluation of respiratory distress in children it is required to evaluate from top starting with the evaluation of the scene.

Causes of respiratory distress in children

- Upper airway
- 1. Infective/ inflammatory

Table 1. Immediately life threatening 'lethal six'

body]	Airway obstruction [foreign Tension Pneumothorax Cardiac tamponade Open pneumothorax Massive hemothorax Flail chest
-------	--

- Croup
- Retropharyngeal abscess
- Epiglottitis
- 2. Mechanical-
 - Foreign body aspiration
 - Lower airway
- 1. Inflammatory
 - Reactive airway disease / asthma
 - Allergic
- 2. Infectious
 - Bronchiolitis
 - Pneumonia
- 3. Mechanical
 - Foreign body inhalation
 - Pneumothorax
 - Hemothorax
 - Cardiac tamponade
 - Pleural effusion
 - Flail chest

Though most of the above mentioned causes manifest as respiratory distress there are certain causes which are lethal enough and need urgent evaluation and management (Todres, 1993; Goetting, 1994). Among all the life threatening lethal six which require urgent intervention are as mentioned in **table 1**.

It is important to identify the cause of the respiratory but above all urgent intervention and stabilisation of the child is the most important requirement. The management of cause starts with the identification of the cause and this can be done by careful evaluation of the scene because it not only gives us the idea about the possible cause and also guides about the intervention that are to be done at that point of time (Berg, 2010).

Scene evaluation

(American College of Surgeons, Committee on Trauma, Advanced trauma life support 1997)-

1. Evaluation the surroundings

This will help us in identifying the possible cause of distress specially when mechanical obstruction is suspected.this could also supplement and could give

additional findings.

2. Evaluation of the child

We need to observe the following points in a child

- The Position of the child.
- Condition of the home.
- Clues to child abuse.

Assessment of the child

(American College of Surgeons, Committee on Trauma, Advanced trauma life support 1997)-

It is the evaluation and examination of the child. It consists of

1. Initial assessment.
2. Detailed assessment.

Initial assessment

It begins before the child is touched .it helps in forming a general impression. It also helps in determining a chief complaint. Once a general impression is formed this is followed by proper initial assessment. A general assessment involves pediatric assessment triangle described below.

Pediatric assessment triangle [for general impression]

(American College of Surgeons, Committee on Trauma, Advanced trauma life support 1997)-

It has got three components which are assessed independently and includes appearance, work of breathing and circulation in the skin. Pediatric assessment triangle is shown **Figure 1** below.

Appearance

A normally stable child will be alert, awake and active any shift in the activity from this parameter will be reflected if there is any compromise.

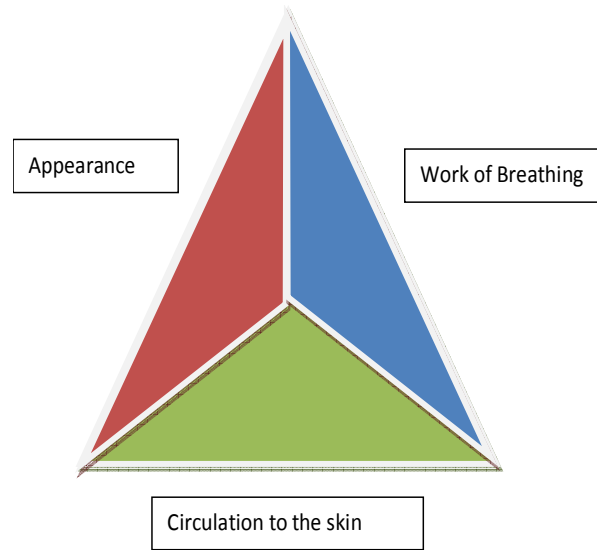


Figure 1. Pediatric assessment triangle [for general impression]

Normal appearance

It includes normal cry or speech. The child responds to parents or to environmental stimuli such as lights, keys, or toys. Good muscle tone. A normal child moves extremities well.

Abnormal appearance

It includes

- Abnormal or absent cry or speech.
- Decreased response to parents or environmental stimuli.
- Floppy or rigid muscle tone or not moving.

To sum up appearance includes the evaluation of

1. Tone
2. Interactiveness
3. Consolability
4. Look/Gaze
5. Speech/Cry

Work of breathing

A normal child breath smoothly, there are no abnormal sounds or positioning a deviation from the same needs to be assessed (King et al., 2004).

Normal breathing

Normally Breathing appears regular without excessive respiratory muscle effort or audible respiratory sounds.

Abnormal work of breathing

Increased/excessive (nasal flaring, retractions or abdominal muscle use) or decreased/absent respiratory effort or noisy breathing.

While evaluating for the work of breathing following points should be kept in mind

1. Abnormal airway sounds
2. Abnormal positioning
3. Retractions
4. Nasal flaring
5. Head bobbing

Circulation to skin

It is also an important component of pediatric assessment triangle because respiratory compromise in children also manifests as various skin changes specially in young children which includes Cyanosis, mottling, paleness/pallor or obvious significant bleeding.

Pediatric assessment triangle for initial assessment [ABC] (Terndrup, 1989; Melker, 1984; Berg, 1994; Kanter, 1987)- Figure 2.

Airway and Appearance (Open/Clear – Mental Status)-

Normal airway

It is clear and maintainable. The child is Alert on Continue assessment AVPU scale.

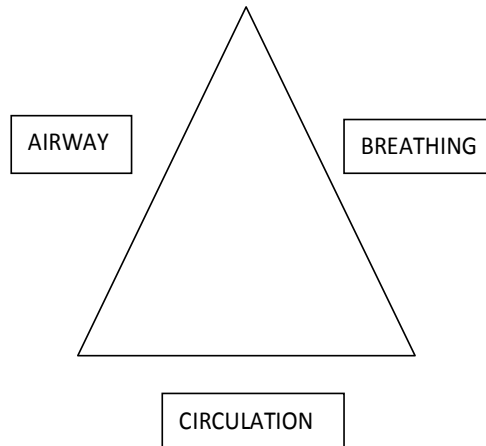


Figure 2. Pediatric assessment triangle for initial assessment [ABC]

Abnormal airway

We suspect an abnormality in the airway if there is Gurgling, stridor or noisy breathing. The child is Verbal, Pain, or Unresponsive on AVPU scale.

AVPU scale involves

A= Alert, V= Verbal, P= Pain, U= Unresponsive

Breathing (Effort / Sounds / Rate / Central Color)

Normal breathing

Normally a child has Easy, quiet respirations. Respiratory rate are within normal range. There is no central cyanosis

Abnormal breathing

It includes the presence of retractions, nasal flaring, stridor, wheezes, grunting, gasping or gurgling. It also includes respiratory rate outside the normal range. There is an associated Central cyanosis.

Circulation (Pulse Rate and Strength / Extremity Color and Temperature / Capillary Refill / Blood Pressure)-

Normal circulation

The colour is normal. Capillary refill at palms, soles, forehead or central body is ≤ 2 sec. Strong peripheral and central pulses with regular rhythm could be palpated.

Abnormal circulation

Includes

- i. Cyanosis, mottling, or pallor.
- ii. Absent or weak peripheral or central pulses;
- iii. Pulse or systolic BP outside normal range;
- iv. Capillary refill > 2 sec with other abnormal findings.

II. Detailed evaluation of respiratory distress (Hirschman, 1982; Field, 1986; Milner, 1998; Davidovic, 2005)

Background

A well child will have an otherwise smooth pattern of respiration and there won't be any jerky movements. However while assessing the respiratory state we have to keep certain basic things in minds like-

- Abnormal respirations are a common sign of illness or injury.
- Count respirations for at least 30 seconds.
- In children less than 3 years, count the rise and fall of the abdomen.
- Note the effort of breathing.
- Listen for abnormal sounds.

Signs and symptoms of respiratory distress

There are certain pointers which need to be taken seriously in the process of evaluation of the cases of respiratory distress as mentioned below.

- Decreased or absent breath sounds- on auscultation and assessment of this child we

would find either there will be a decrease or absence of breath sounds. This reflects that child is in a state of respiratory distress, because most of the child gets exhausted after the bout of hyperventilation which reflects in this way.

- Stridor- when a distress is due to a mechanical cause it can manifest in the form of abnormal sound like stridor.
- Retractions-in an effort to get air child may try to hyperventilate which may be manifested in the form of chest retractions. These are to be taken up seriously. A cause for retractions is that the accessory muscles of respiration are not well developed in children.
- Difficulty speaking- it may be a manifestation of respiratory distress in few other cases.

Signs of severe airway obstruction

- Signs and symptoms
- Ineffective cough (no sound).
- Inability to cry.
- Increasing respiratory difficulty, with stridor.
- Cyanosis.
- Loss of consciousness.

Evaluation of respiratory distress: auscultation

It forms an important parameter in the process of evaluation of respiratory distress. The chest needs to be auscultated nicely but of all the important sites for auscultation include mid axillary line, suprasternal notch, inframammary areas, interscapular areas. The interpretation of additional sounds on auscultation can be-

- Stridor: Upper airway obstruction
- Wheezing: Lower airway obstruction
- Grunting: Poor oxygenation; pneumonia, drowning, pulmonary contusion
- Crackles: Fluid, mucus, blood in airway
- Decreased / absent breath sounds: Obstruction

Localization of site of airway obstruction based on physical findings

Upper airway obstruction

- Sniffing position-neck is flexed with head extended[an attempt to open airways]
- Nasal flaring
- Prolonged inspiration
- Abnormal voice [hoarseness, hot potato voice]
- Stridor

- Barking cough
- Transmitted upper airways sound
- Retractions- supraclavicular, suprasternal

Lower airway disease

- Retractions- intercostals,subcostal
- Prolonged expiration
- Grunting, wheeze, crackles
- Pleural rub
- Bronchophony
- Pulsus paradoxus

Cardiac cause

- Gallop
- Cardiac murmur
- Jugular venous distention
- Hepatomegaly
- Cardiac tamponade

Central cause

- Abnormal pattern of respiration [chyne strokes, etc]

Metabolic cause

- Kussmaul respiration

Localization of cause based on presentations

- Cyanosis , dyspnoea- Hypoxia
- Stridor- laryngo-tracheo injury/Foreign body
- Subcutaneous emphysema- tracheo-bronchial/esophageal laceration
- Tracheal deviation-tension pneumo/hemothorax
- Increased JVP, Hypotension, pulsus paradoxus-cardiac tamponade/Hemothorax
- Systolic murmur with shock-Myocardial/ valvular injury.

Bed side evaluation tests: There are certain recordings/measurements that helps us in general assessment of the condition of the patient and accordingly guides us in further management. They include-

1. Pulse oximetry
2. Measurement of ET CO₂
3. ECG recording if a cardiac cause is suspected

The detailed description of the utility and basis of these recordings are beyond the confinements of this review

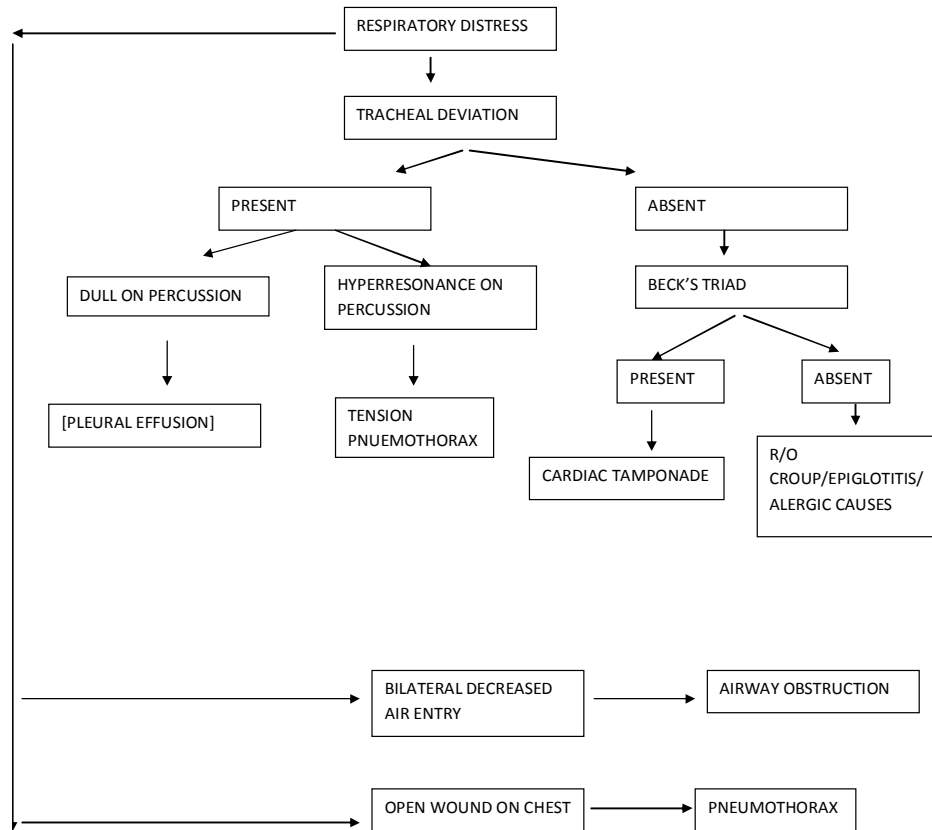


Figure 3. Protocol of evaluation of cause in respiratory distress

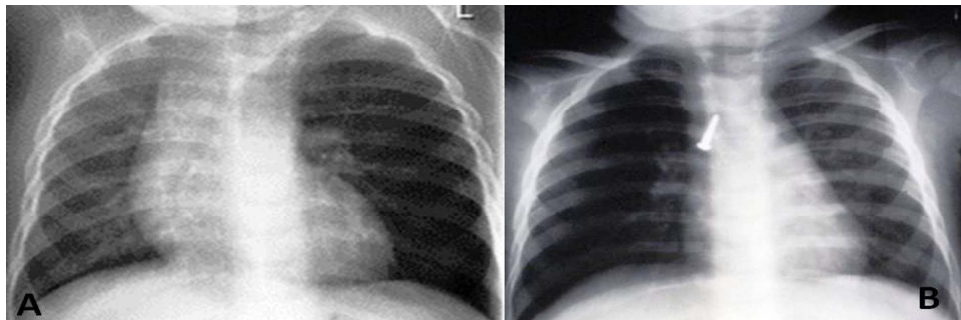


Figure 3a. Plain X-ray chest antero-posterior view showing hyperlucency of left lung (indirect evidence of radiolucent foreign body in left main bronchus).

Figure 3b. Plain X-ray chest antero-posterior view showing hyperlucency of right lung and radio opaque foreign body in right main bronchus.

Imaging studies: (RUBEN et al., 1961)

These are usually an add on to the clinical suspicion and helps us in reaching a diagnosis .the important radiological investigations in this ontext include

Plain X Ray

This is an important initial radiological investigation that

helps us in derieving to a diagnosis. Ironically organic foreign bodies are more common in children which are radio lucent and we have to depend on indirect evidences like hyperlucency (Figure 3A) or collapse in such case. A radio opaque foreign body can be well localized by a radiograph (Figure 3B) and accordingly help in the management. There are certain signs specific to inflammatory condition seen in plain radiograph viz, thumb sign in acute epiglottitis, steeple sign in laryngotracheobronchitis,etc

CT scan

It is an important contributory investigation in this condition however most of the times the acuteness of respiratory distress limits the performance of CT scan. CT is very contributory in sub acute conditions in making and contributing in diagnosis. Many a times CT also helps in defining the mechanical causes of respiratory distress including the foreign bodies. A virtual bronchoscopy can also help in the anatomical delineation of the airways.

USG1

It can be an important contributory investigation in locating and defining causes like pleural effusion and cardiac tamponade, but the lack of proper window for performance limits its use in condition like pleural effusion in older children, however it can be effectively used in younger children.

MRI chest

It is useful in localizing the sub acute causes of respiratory distress. But not of very much utility because most of the cases can be well localized by CT scans.

REFERENCES

American College of Surgeons, Committee on Trauma. Advanced trauma life support, 6th ed, American College of Surgeons, Chicago 1997.
Berg MD, Schexnayder SM, Chameides L (2010). Part 13: pediatric basic life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*; 122:S862.

Berg RA, Sanders AB, Milander M (1994). Efficacy of audio-prompted rate guidance in improving resuscitator performance of cardiopulmonary resuscitation on children. *Acad. Emerg. Med.* 1:35.
Davidovic L, LaCovey D, Pitetti RD (2005). Comparison of 1- versus 2-person bag-valve-mask techniques for manikin ventilation of infants and children. *Ann. Emerg. Med.* 46:37.
Field D, Milner AD, Hopkin IE (1986). Efficiency of manual resuscitators at birth. *Arch. Dis. Child.* 61:300.
Goetting MG (1994). Mastering pediatric cardiopulmonary resuscitation. *Pediatr. Clin. North Am*; 41:1147.
Herlitz J, Engdahl J, Svensson L (2005). Characteristics and outcome among children suffering from out of hospital cardiac arrest in Sweden. *Resuscitation*; 64:37.
Hirschman AM, Kravath RE (1982). Venting vs ventilating. A danger of manual resuscitation bags. *Chest*; 82:369.
Kanter RK (1987). Evaluation of mask-bag ventilation in resuscitation of infants. *Am. J. Dis. Child*; 141:761.
King BR, King C, Coates WC (2004). Critical procedures. In: *APLS: The Pediatric Emergency Medicine Resource*, 4th, Gausche-Hill M, Fuchs S, Yamamoto L. (Eds), Jones and Bartlett, Sudbury. p.692.
Lopez-Herce J, García C, Domínguez P (2005). Outcome of out-of-hospital cardiorespiratory arrest in children. *Pediatr. Emerg. Care*; 21:807
Ludwig S, Lavelle JM (2006). Resuscitation - Pediatric basic and advanced life support. In: *Textbook of Pediatric Emergency Medicine*, 5th, Fleisher GR, Ludwig S, Henretig FM. (Eds), Lippincott, Williams and Wilkins, Philadelphia. p.9.
Melker RJ (1984). Asynchronous and other alternative methods of ventilation during CPR. *Ann. Emerg. Med.* 1984; 13:758.
Milner AD (1998). Resuscitation at birth. *Eur. J. Pediatr.* 157:524.
Ruben HM, Elam JO, Ruben AM, Greene DG (1961). Investigation of upper airway problems in resuscitation. 1. Studies of pharyngeal x-rays and performance by laymen. *Anesthesiology*; 22:271.
Schindler MB, Bohn D, Cox PN (1996). Outcome of out-of-hospital cardiac or respiratory arrest in children. *N Engl. J. Med*; 335:1473.
Terndrup TE, Kanter RK, Cherry RA (1989). A comparison of infant ventilation methods performed by prehospital personnel. *Ann. Emerg. Med.* 18:607.
Todres ID (1993). Pediatric airway control and ventilation. *Ann. Emerg. Med.* 22:440.
Young KD, Gausche-Hill M, McClung CD, Lewis RJ (2004). A prospective, population-based study of the epidemiology and outcome of out-of-hospital pediatric cardiopulmonary arrest. *Pediatrics*; 114:157.