

# Chapter 14

## Respiratory Emergencies in Children

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### Key Points

- Focused clinical observation is the key in the initial recognition of respiratory distress in an acutely ill child.
- Early diagnosis and urgent treatment improve the chances of recovery in critically ill child, presenting with respiratory distress or failure.
- Diagnosing the underlying aetiology is usually possible on clinical grounds, and laboratory investigations are very few and are carried out only after the initial stabilisation.
- Monitoring and management in PICU particularly ventilatory support for both invasive and non-invasive has improved the prognosis to a greater extent.

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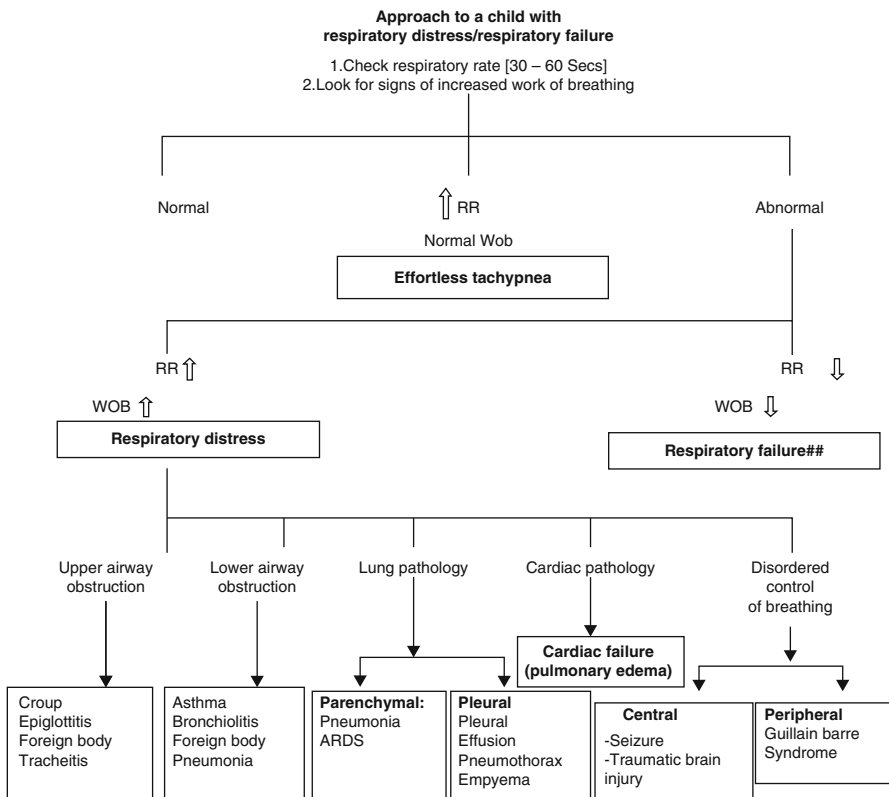
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# An Approach to a Child with Respiratory Distress and Respiratory Failure

## Introduction

Fever and respiratory distress are the most common reasons for hospital visit by an acutely ill child. A child with respiratory distress (RD) can quickly worsen to respiratory failure (RF) and finally to cardiac arrest if left untreated [1]. Hence a precise recognition and management is essential (Flowchart 14.1). As a part of the initial primary survey, look for the three “E”– effort, efficacy and effect of breathing [2].

- Effort of breathing** – Increased effort or work of breathing if the following is present: tachypnoea, sternal/subcostal/intercostals recession, use of accessory muscles, flaring of ala nasi and stridor/wheeze/grunt. Subcostal recession is more significant than intercostal recession. Bradypnoea is a sign of exhaustion and suggests impending respiratory arrest. Increased work of breathing may be absent in central causes like CNS depression and peripheral nervous system failure as in Guillain-Barre syndrome. Check respiratory rate for 30–60 s (Table 14.1).



**Flowchart 14.1** Approach to a child with respiratory distress/respiratory failure

**Table 14.1** Differences between effortless tachypnoea and respiratory distress

Effortless tachypnoea	Respiratory distress
1. RR alone increased	1. RR is increased
2. WOB normal	2. WOB increased
3. No noisy breathing	3. Noisy breathing may be present
4. No respiratory findings on auscultation	4. Diminished breath sounds, crepts or wheeze on auscultation
5. SpO <sub>2</sub> may be normal in room air	5. SpO <sub>2</sub> may be decreased
6. Occurs due to non-respiratory causes (DKA, renal failure, poisoning with salicylates or isoniazid, etc.)	6. Occurs due to respiratory causes

- *Efficacy* – Impaired efficacy of breathing is suggested by reduced chest expansion, diminished air entry and reduced SpO<sub>2</sub> on pulse oximeter.
- *Effort of breathing* – Cyanosis, tachycardia and altered mental status such as confusion or agitation would suggest reduced oxygen delivery. As per Integrated Management of Neonatal and Childhood Illnesses (IMNCI), fast respiratory rate (RR) was found to be the only clinical sign with high specificity and sensitivity in the diagnosis of pneumonia. RR has to be counted meticulously for 30–60 s in every child seeking medical help. Bradycardia in the presence of a respiratory distress would suggest impending cardiac arrest.

### ***Underlying Causes of Respiratory Distress/Failure***

There are many causes for respiratory distress, important ones are listed below:

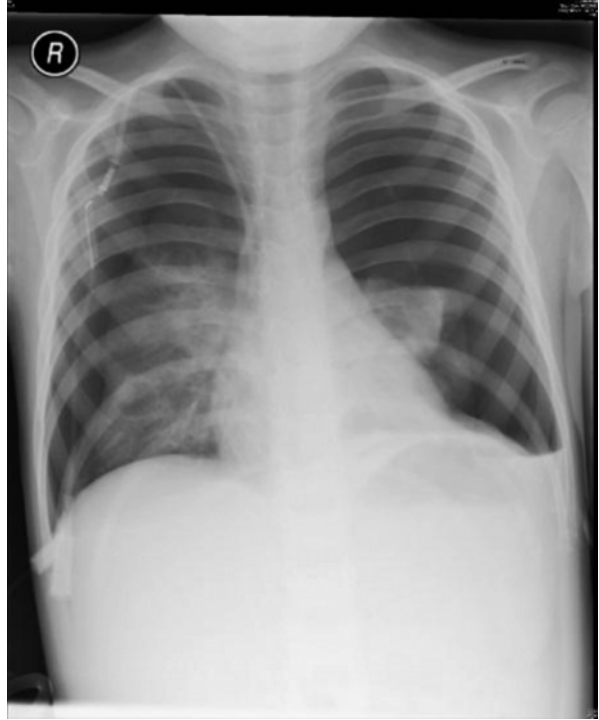
1. Upper airway obstruction: Viral croup, epiglottitis, diphtheria, bacterial tracheitis, retropharyngeal abscess
2. Lower airway obstruction: Bronchiolitis, viral wheeze, asthma and foreign body airway
3. Lung parenchymal disease: Pneumonia, ARDS, collapse
4. Pleural disease: Pneumothorax (Fig. 14.1)
5. Cardiac illness: Pulmonary oedema (Fig. 14.2)
6. Neurological causes for pump failure or respiratory failure: Central causes – drug poisoning, traumatic brain injury, Guillain-Barre syndrome, etc.

### ***Relevant Questions and Stepwise Management***

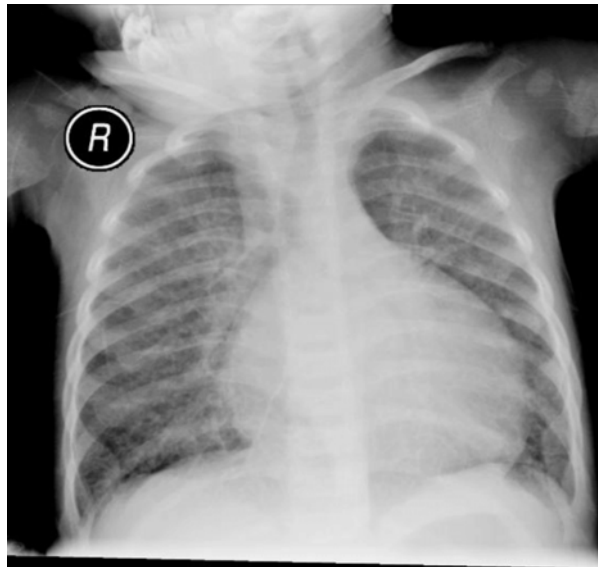
Following questions should be raised, and answers sought while evaluating a child with respiratory distress or respiratory failure.

1. Does the child have features of respiratory failure or respiratory distress?
2. What is the initial management?
3. What is the anatomical diagnosis?

**Fig. 14.1** Bilateral pneumothorax



**Fig. 14.2** Vitamin D deficiency cardiomyopathy with features of cardiac failure



**Table 14.2** Identifying the anatomical site based on clinical signs

Anatomical diagnosis	Noisy breathing	Rise in respiratory rate	Predominant retractions	Resonance	Others
1. Upper AW obstruction	Stridor	++	Suprasternal sternal	Normal	
2. Lower AW obstruction	Wheeze	+++	Intercostal recession (ICR), subcostal (SCR)	Normal	
3.a. Lung parenchymal	Grunting	++++	ICR, SCR	Impaired	
3.b. Pleural	Same	Same	Same	Stony dullness	
3.c. Cardiac	Same	Same	Same	Normal	Gallop, murmur, hepatomegaly, oedema
4. Disordered control of breathing	No	Normal or bradypnoea	No	Normal	Shallow breathing, see-saw respiration, low voice volume

4. Which laboratory tests need to be done?
5. What is the specific management plan?

RD is an early stage of physiological disturbance. After the initial steps to correct hypoxia (this may require high-flow nasal cannula or non-invasive ventilation or intubation), specific management should be provided based on the underlying illness. Respiratory rate, respiratory effort, level of consciousness, trends in oxygen saturation via pulse oximeter (SpO<sub>2</sub>), response to oxygen therapy and looking for signs of improvement or worsening are the most important components of monitoring.

Exact anatomical site of the underlying disease can be inferred by careful stepwise evaluation (Table 14.2).

- If the child is presenting with wheeze, absence of fever, or cardiac symptoms and past history of response to nebulisation, it will support the diagnosis of under-five wheeze or asthma in children above 5 years.
- Child (6 months to 2 years of age) with rhinorrhoea, low-grade fever, cough followed by noisy breathing, stridor and sternal and suprasternal retractions – viral croup causing stridor.
- Child above 3 years of age with high-grade fever, soft stridor, toxæmia, drooling, dysphagia with sniffing position – epiglottitis, rare but potentially fatal disease.
- Toddler developing breathlessness for the first time, dramatic onset, found to be playing with small round objects such as a button battery or a coin (Fig. 14.3) – choking due to foreign body in the airway presenting with obstructive emphysema or collapse.
- Child with high-grade fever, cough, fast breathing, grunting, subcostal and intercostal retractions, no past history of breathlessness – pneumonia. Suspect empyema if there is stony dullness and absent breath sounds on one side.

**Fig. 14.3** Button Battery in the cricopharynx



- Child with acute-onset breathlessness, grunting without fever, lethargy, puffiness of face, disproportionate tachycardia, gallop with or without murmur, hepatomegaly – myocarditis or dilated cardiomyopathy.
- With the above said features, if the child has pericardial rub or muffled breath sounds and pulsus paradoxus suspect pericardial effusion.
- If the child has low voice volume, floppiness, weak cough, bradypnoea, see-saw breathing and shallow breathing, it is indicative of acute flaccid paralysis affecting respiratory muscles – respiratory failure due to disordered control of breathing.
- Similar situation in a different presentation will be seen in a child with acute seizures.

### ***Laboratory Investigations***

- Common indications for CXR in a child with respiratory distress are pneumonia, pulmonary oedema, suspected pneumothorax and foreign body inhalation. Cardiomegaly, collapse or congenital anomalies like eventration of diaphragm, congenital lobar emphysema, bronchogenic cyst or diaphragmatic hernia are sometimes seen as surprise.

- See chapter on Stridor for other disease-specific investigations.
- Blood counts and blood culture: Any radiological shadow in the background of fever is an indication for antibiotic in paediatric emergency department, but FBC and CRP will aid in suggesting a bacterial aetiology if not confirming. Blood culture is rarely positive in pneumonia unless there is septicaemia.
- In viral infections like H1N1, PCR of respiratory tract secretions is a useful investigation when a child presents with pneumonia during an epidemic situation particularly with normal WBC count and negative CRP.

## ***Management***

Specific management:

1. Management of asthma – see relevant section in this chapter.
2. For management of croup – see relevant section in this chapter.
3. Once the diagnosis of epiglottitis is suspected, PICU team, ENT surgeon and anaesthetist are involved in the management early. Antibiotics such as cefotaxime should be given early. Child should be admitted in high dependency unit (HDU) or paediatric intensive care unit (PICU). Airway has to be secured early by intubation or tracheostomy because they can deteriorate very fast.
4. If pneumothorax or empyema is suspected, diagnosis should be confirmed by CXR and ultrasonography of the chest. Immediate needle thoracocentesis will relieve the respiratory distress, and it should be followed by intercostal drainage.
5. Appropriate antibiotics to treat the underlying pneumonia or empyema.
6. For management of foreign body, see relevant chapter under ENT.

## ***Prognosis***

In most of the situations, early recognition and management in HDU or PICU will help in good recovery.

## **Asthma in Children**

Asthma is a cause of reversible airway obstruction secondary to chronic airway inflammation and bronchial hyperreactivity. Approximately 10 % of the children are affected, and about 50 % of them will attend their GP or an ED before the age of 10 years. They often present with wheeze and shortness of breath. Occasionally the presenting complaint is that of cough at night or early morning, cough brought

on by exercise/cold weather and limitation in carrying out sporting activities (exercise tolerance).

- Look out for a family history of asthma or atopic disease such as hay fever, eczema or allergy.
- Based on the number of episodes experienced, asthma can be classified into three subgroups:

*Infrequent* (<4 episodes/year) – three out of four asthmatics will fall into this category (75 % of cases).

*Frequent* (episodes every 2–4 weeks) – one in five asthmatics will fall into this category (20 % of cases).

*Persistent* (three or more episodes every week) – 1 in 20 asthmatics will fall into this category (5 % of cases).

#### Severity of Asthma [3]

<p><b>Moderate</b></p> <p>SpO<sub>2</sub> &gt; 92 % Normal vital signs, Mild wheeze, Talking in full sentences No severe signs (PEFR 50 % or better)</p>	<p><b>Severe – any of the following</b></p> <p>SpO<sub>2</sub> &lt; 92 % HR &gt; 140 (2–5 years) or 125 (over 5's) RR &gt; 40 (2–5 years) or 30 (over 5's) Can't talk/Can't feed Using accessory muscle (PEFR &lt; 50 %)</p>	<p><b>Life Threatening – Severe signs plus any of the below</b></p> <p>Silent chest Cyanosis Poor Respiratory Effort Agitated/Altered consciousness</p>
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### Management

- Salbutamol 10 puffs via spacer for the moderate to salbutamol 2.5 (2–5 years of age)–5 mg (over 5's) nebulised (in oxygen) every 20 min for 1–2 h for the severe/life-threatening types.
- Consider adding ipratropium 250 mcg every 20 min for 1–2 h.
- Continuous oxygen by facemask or nasal cannula.
- Give prednisolone 10 mg <2 years, 20 mg or 30–40 mg (max 40 mg unless on regular oral steroids) within 1 h or hydrocortisone 4 mg/kg iv.
- Reassess after 15 min.
- Consider adding 150 mg MgSO<sub>4</sub> to each nebuliser in the first hour if life-threatening in severity.

***If poor response/deteriorating, call ED consultant, consultant general paediatrician and/or PICU team.***

Consider in this order:

1. Salbutamol 15 mcg/kg IV bolus (max 250 mcg) or 5 mcg/kg in under 2s

*Reassess.*



2. Magnesium 40 mg/kg IV bolus (max 2 g) over 30 min

*Reassess.*

3. Salbutamol IV infusion (1–2 mcg/kg/min)

Consider CXR.

Blood gas and measure serum K<sup>+</sup>.

ECG monitoring.

### ***Indications for Ventilation***

- Exhaustion.
- Worsening hypoxia.
- RR >60 despite treatment or falling RR without clinical improvement.
- Normal or rising CO<sub>2</sub>.
- Prepare fluid bolus of 20 ml/kg and adrenaline bolus of 0.1 ml/kg of 1:10,000.

### ***Induction***

- Atropine 20 mcg/kg
- Ketamine 1–2 mg/kg or thiopentone 1–2 mg/kg
- Suxamethonium 1–2 mg/kg

### ***Ventilation***

- Largest possible cuffed ET tube
- Permissive hypercapnoea: PH >7.2, keep PIP <45 mmHg and TV 5–10 ml/kg, RR 10–15. PEEP 5–7

### ***Sedation***

- Midazolam and fentanyl
- Regular suctioning and chest physio

### ***Discharge Criteria***

- *All severe and life-threatening cases should be admitted.*
- No life-threatening signs at any time.
- On 4 hourly bronchodilators.
- SpO<sub>2</sub> 95 % or higher.

### **Discharge Plan [3]**

- Weaning regime of bronchodilator.
- Prednisolone for 3 days.
- Consider regular inhaled steroids, i.e. beclomethasone 100–200 mcg BD, if:
  - Needing B2 agonist >3 times per week
  - Nocturnal symptoms disturbing sleep more than once per week
  - Exacerbations requiring oral steroids

In children under 5 years with viral-associated wheeze, steroids (oral and inhaled) may not be beneficial.

### **Follow-Up [3]**

- GP follow-up within 48 h
- If >2 attendances to ED within 1 year or two courses of oral steroid, refer to asthma clinic for urgent review.

## **Bronchiolitis**

Bronchiolitis is a common respiratory tract infection in infancy and a common cause for admission in young children and often leads to a lot of morbidity in infants. It is typically caused by viruses and the common aetiologic agent being the respiratory syncytial virus. Usual age group is 2 months to 2 years.

Bronchiolitis is practically defined as the first episode of wheezing in a child younger than 12–24 months who has physical findings of a viral respiratory infection and has no other explanation for the wheezing, such as pneumonia or atopy [4]. It is usually a seasonal viral illness characterised by low-grade fever, nasal discharge and dry, wheezy cough. On examination there are fine inspiratory crackles and expiratory wheeze. Within 1–2 days of these prodromal symptoms, the cough worsens and child may also develop rapid respiration, chest retractions, irritability, poor feeding and vomiting. Though, in majority of cases, the disease remains mild and recovery starts in 3–5 days, some of these children may continue to worsen and become sick, and prompt management is needed.

<p><b>Mild</b> Minimal Respiratory Distress RR &lt; 50 SpO<sub>2</sub> ≥ 92 % Feeding Well No Risk Factors</p>	<p><b>Moderate (any of)</b> Moderate Respiratory Distress RR 50–70 SpO<sub>2</sub> &lt; 92 % in air Difficulty Feeding / Dehydration Risk Factors</p>	<p><b>Severe (any of)</b> Severe Respiratory Distress RR &gt; 70 SpO<sub>2</sub> &lt; 90 % in air Apnoea Looks unwell/toxic</p>
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### ***Factors Increasing the Likelihood of Severe Disease***

- Chronological age less than 6 weeks
- History of apnoea before assessment
- Known structural cardiac anomaly (e.g. VSD)
- Known pre-existing lung disease (e.g. cystic fibrosis)
- Significant prematurity (<32 weeks)

The diagnosis of bronchiolitis is mostly clinical, and laboratory investigations have a limited role in diagnosis and management.

Bloods	<i>Bloods (FBC, U&amp;E and CRP) should only be done if child is having IV line inserted. Blood cultures if fever &gt;39 or in infants &lt;60 days old</i>
CXR	If deteriorating/needing ventilatory support/needing HDU/PICU or prolonged or atypical course. Most don't need them
CapGas	If tiring or poor saturations despite FiO <sub>2</sub> >40 % (ABG is alternative)
NPA	For viral immunofluorescence/rapid antigen test if decision to admit

The current management primarily consists of supportive care:

- Widely accepted line of management is adequate hydration, supplemental oxygen and careful monitoring of vital signs and SpO<sub>2</sub>.
- At this point, there is no other specific treatment for bronchiolitis for which there is a strong or convincing evidence of effectiveness and the role of each modality is debatable [5].
- Hypertonic saline nebulisation with salbutamol 2.5 mg may reduce the length of stay for admitted children.
- Consider nebulised epinephrine if considering ventilation.
- Consider 1–3-month course of montelukast (4 mg at night) [6] as it may reduce risk of relapse/recurrent wheeze.

### **Acute Laryngotracheobronchitis (Croup)**

This is one of the most common causes of stridor in children presenting to the emergency department. It is most commonly due to a viral illness caused by parainfluenza virus which accounts for 80 % of the cases [7].

Children often present with typical barking cough and harsh stridor. These symptoms are often preceded by a viral prodrome of low-grade fever, running nose and cough. Usually the children are not toxic and they do not have drooling of saliva. The illness usually lasts for 2–5 days. If obstruction worsens, the child becomes increasingly tachypnoeic with respiratory distress indicated by retractions. Rarely respiratory failure occurs. Cyanosis, tachycardia and altered level of consciousness if present indicate that there is hypoxia and it needs prompt management. Westley croup score

is helpful in assessing the severity [8]. Croup is essentially a clinical diagnosis. Steeple sign seen in x-ray is seen in croup but is not pathognomic of the condition. Chest x-ray is done only when there are chest retractions and diagnosis is in doubt.

## Treatment

- Keep the child in the mother's lap. Administer oxygen in a nonthreatening manner if needed.
- *Steroids* [9] are the drug of choice in managing croup. There is role for IV, IM, oral and inhaled corticosteroids. Their action usually starts 1–2 h after administration. Popularly a single oral or intramuscular dose of dexamethasone 0.15 mg/kg for the mild variety up to 0.6 mg/kg in severe cases is used in the emergency room/OP and is sufficient. Rarely the second dose is administered after 8–12 h based on clinical need. Oral prednisolone 1–2 mg/kg/day for 24 h is another option. Inhaled budesonide 2 mg in 3 ml normal saline also has rapid effect and is found to be useful.
- Epinephrine nebulisation is used in cases of moderate to severe croup, whenever there is evidence of respiratory distress and retractions are present even at rest. Nebulised adrenaline (epinephrine) solution 1 in 1,000 (1 mg/mL) should be given with close clinical monitoring in a dose of 400 µg/kg (maximum 5 mg) repeated after 30 min if necessary. Administration of three doses of nebulised adrenaline within 60 min has caused dysrhythmia and myocardial infarction in children. The effects of nebulised adrenaline last 2–3 h; the child should be closely monitored/observed for at least 4 h after giving.
- There is no role for antibiotics unless when croup is thought to be caused by a *Mycoplasma pneumoniae* infection.

### Indications for ventilations in croup

Exhaustion  
Worsening hypoxia  
RR>60 despite treatment OR falling RR without clinical improvement  
Normal or rising CO<sub>2</sub>

### Westley croup score

	0	1	2	3	4	5
Stridor	Nil	When agitated	At rest			
Intercostal recession	Nil	Mild	Moderate	Severe		
Decreased air entry	Normal	Mild	Severe			
Cyanosis	None				When agitated	At rest
Consciousness level	Normal					Altered

Possible score 0–17: 0–3 = mild croup, 4–6 = moderate croup, >6 = severe croup

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