# Upper airway obstruction

*PB Baines, RE Sarginson*

## INTRODUCTION

Upper airway obstruction in children is a life-threatening but treatable condition that is relatively rare. This article considers the more common acute causes:

- Epiglottitis
- Bacterial tracheitis
- Viral laryngotracheobronchitis (viral LTB or 'croup')
- Foreign bodies
- Airway trauma.

The management of each cause is also outlined.

## LARYNGEAL ANATOMY

A child's airway is different from an adult's airway (Hatch, 1985). Among other features, babies are obligate nasal breathers. The larynx is higher and more anterior in infants, with a long, floppy epiglottis (*Figure 1*). The narrowest part of the airway of a child is the cricoid ring.

When intubating infants and children, it is important to ensure that there is an audible gas leak at moderate inspiratory pressures to reduce the likelihood of damage to the subglottic mucosa. Ischaemic mucosal damage can cause mucosal oedema, post-intubation stridor and subsequent stenosis. As the airway of a child is narrower than the airway of an adult, an equivalent amount of mucosal swelling has a greater effect on the internal diameter of the child's airway.

Intrathoracic airways are opened on inspiration by the more negative pressure around them, but this situation is reversed on exhalation. Therefore, intrathoracic airway obstruction causes expiratory wheeze, especially in forced expiration. The pressure inside the extrathoracic airways is subatmospheric on inspiration but the surrounding tissues are at atmospheric pressure, thus extrathoracic airways collapse during inspiration, causing turbulent airflow.

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## CAUSES OF AIRWAY OBSTRUCTION

A complete description of the causes of airway obstruction may be given by considering anatomical sites sequentially, from nose to trachea, with potential for obstruction (*Table 1*).

## DIAGNOSIS AND MANAGEMENT

Careful assessment, including a history appropriate to the circumstances, is necessary to make a diagnosis that will enable specific treatment. Previous intubation, especially if prolonged, is important. If the child is acutely unwell, a more rapid deterioration suggests epiglottitis, whereas a slower course suggests croup. Longstanding conditions commonly present with acute deterioration.

Clinical examination can offer clues to the diagnosis; for example, subglottic haemangiomas are sometimes associated with cutaneous lesions. Restlessness may indicate hypoxia or hypercarbia and should not be ignored.

The child's temperature and blood pressure should be noted, as well as the

**TABLE 1. Causes of upper airway obstruction by anatomical site**

| Level of obstruction | Diagnosis |
|---|---|
| Nose | Choanal stenosis and atresia |
| | Craniofacial syndromes with maxillary hypoplasia |
| | Nasogastric tubes |
| Oropharynx | Micrognathic syndromes (e.g. Pierre Robin sequence) |
| | Adenotonsillar hypertrophy |
| | Burns, steam inhalation |
| | Macroglossia |
| | Retropharyngeal abscess |
| | Mucopolysaccharidoses |
| | Cystic hygroma |
| Larynx, glottic inlet | Epiglottitis |
| | Cord palsy |
| | Laryngomalacia |
| | Laryngospasm |
| | Laryngeal webs, granulomas, cysts, papillomata |
| Subglottis | Congenital subglottic stenosis |
| | Acquired subglottic stenosis |
| | Haemangioma |
| | Viral laryngotracheobronchitis |
| | Bacterial tracheitis |
| Intrathoracic trachea | Malacias and stenoses |
| | Vascular rings |
| | Mediastinal tumours |
| | Foreign bodies |
| Artificial airways | Laryngeal masks, naso- and oro-tracheal tubes, and tracheostomies can be displaced, kinked or obstructed |

heart rate. Specifically for respiratory assessment, the degree of dyspnoea, including the respiratory rate, recession and the degree of respiratory effort should be noted. Repeated assessment is important, as an alteration of the vital signs over time is of greater significance in the assessment of a child with airway obstruction than a single measurement.

No attempt to visualize the larynx should be made, as this may convert partial obstruction into complete obstruction. Similarly, in severe obstructions, interventions that may distress the child, such as blood tests or venous access, should be deferred until the child has improved or is intubated. Sedation is almost never indicated in children with airway obstruction.

## AIRWAY MANAGEMENT

Oxygen may be needed for hypoxia, which is more commonly recognized following the widespread use of pulse oximeters. Significant hypercarbia cannot occur without desaturation in a child breathing air. However, if added oxygen is used, carbon dioxide accumulation may occur without desaturation.

If the obstruction is of sufficient severity or is unresponsive to therapy, intubation is necessary. It is usually appropriate to transfer the child to the operating theatre, which is the safest place for intubation as it has the equipment necessary for airway management, and skilled assistance.

It is wise to have two experienced anaesthetists, enabling one anaesthetist to concentrate on the airway while the other sites a venous line after anaesthesia. An experienced ear, nose and throat surgeon may be necessary to undertake diagnostic endoscopy or perform tracheostomy if the airway cannot be secured.

With an obstruction of this degree of severity, interventions that will distress the child, such as blood tests, a throat swab or examination of the oropharynx with a tongue depressor, should be deferred until the child has been intubated.

A gaseous induction of anaesthesia is indicated in airway obstruction. Halothane in oxygen is now often replaced by sevoflurane for speed and palatability of induction. However, as sevoflurane is less soluble, anaesthetic depth fluctuates more rapidly.

The initial oral tube should be replaced with a nasal tube for prolonged intubation in the intensive care unit. Before the tube is changed, the child's stomach should be emptied as fully as possible with a nasogastric tube.

Once anaesthesia and relaxant have worn off, minimal sedation will allow the child to breathe, with the likelihood of less atelectasis and less sedation withdrawal. If there is coexisting parenchymal disease, ventilation may be required.

## SPECIFIC CONDITIONS

Sixty-seven children who presented over 3.5 years to paediatric intensive care in the UK with upper airway obstruction have been described (Durward et al, 1998):

- Just over 50% had viral croup
- Five (7%) had recurrent croup
- Six (9%) had bacterial tracheitis
- Ten children (15%), with a median age of 11 months, had subglottic stenosis
- Only two children (3%) had epiglottitis.

These more commonly encountered conditions are described in greater detail below.

## STRIDOR IN THE INFANT

A more varied group of conditions cause upper airway obstruction in infants. Of 155 children who presented with stridor at <6 months of age, 100 cases were congenital and 55 were acquired (Holzki et al, 1998). More than half of those infants with acquired stridor had evidence of intubation trauma, often following prolonged intubation (typically premature babies). A smaller proportion had airway inflammation as a consequence of gastro-oesophageal reflux.

Many different diagnoses were found in the 100 infants with congenital stridor, including tracheo-oesophageal fistula, laryngomalacia, bronchial stenosis, tracheomalacia and congenital subglottic stenosis (*Figure 2*).

Given the wide variety of underlying diagnoses for which specific treatment is required, early endoscopic examination is important in infants under 1 year.

## EPIGLOTTITIS

Epiglottitis is a cause of acute, progressive upper airway obstruction,

***Figure 1. Laryngeal anatomy in a 6-month-old infant, 5-year-old child and adult. C = cricoid; E = epiglottis; SP = soft palate; T = base of tongue.***

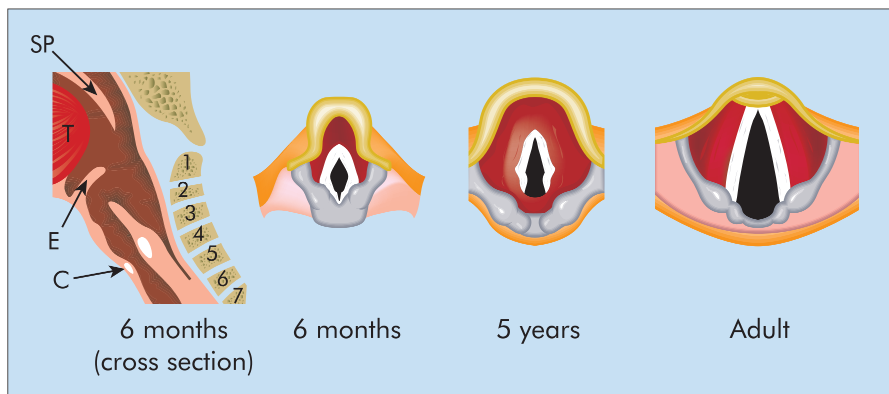
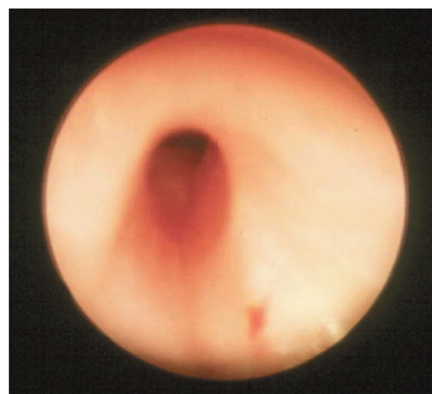



***Figure 2. Endoscopic view of subglottic stenosis in a child.***



with a peak incidence at 2 years of age. Epiglottitis is usually caused by *Haemophilus influenzae* type B (HIb), but other bacteria (including staphylocci or meningococci) may be responsible.

Characteristically children present with a short history. They may be toxic, flushed, have a high fever and tachycardia. Children avoid swallowing, as it is painful, and may drool. They often prefer to sit upright. A cough is rarely a prominent feature.

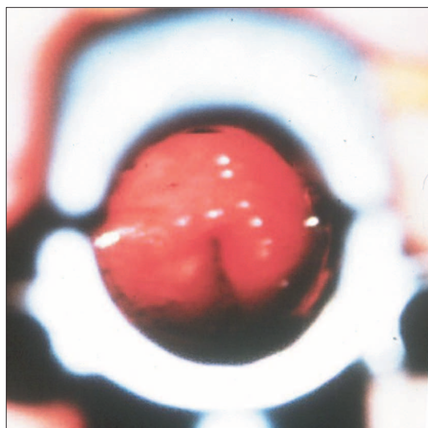
A lateral X-ray of the neck is sometimes taken to demonstrate the enlarged epiglottis. However, this investigation will not reliably exclude epiglottitis. The radiology department is an inappropriate place for a child with an obstructing airway, and should be avoided.

The diagnosis is confirmed by laryngoscopy after the induction of general anaesthesia, demonstrating a swollen, cherry-red epiglottis (*Figure 3*), with inflammation of all the adjacent tissues (more correctly a supraglottitis).

Management is with a third-generation cephalosporin (50 mg/kg cefotaxime every 6 hours) after a throat swab and blood cultures have been obtained.

Although some clinicians have advocated conservative management of epiglottitis, intubation is preferred; a nasal tube replaces the oral tube during the child's stay in the intensive care unit. With minimal amounts of sedation, spontaneous respiration may be maintained.

***Figure 3. Laryngoscopic view of an acutely inflamed epiglottis in a child, confirming epiglottitis.***



The duration of intubation in children with epiglottitis is short, as the disease resolves rapidly with antibiotic treatment (Butt et al, 1988; Durward et al, 1998).

Although the incidence of epiglottis dramatically declined following the introduction of the HIb vaccine, significant numbers remain. In 2001, 29 cases of epiglottitis were reported in vaccinated children in the UK (McVernon et al, 2003).

## BACTERIAL TRACHEITIS

The commonest cause of tracheitis is staphylococcal infection. Clinically, infected children may be sick, with high fever and tachycardia, but on laryngoscopy will have a relatively normal supraglottis. Copious quantities of purulent secretions may be aspirated from the endotracheal tube (*Figure 4*). Blockage of the endotracheal tube by the secretions is a concern. Appropriate antibiotics are necessary (e.g. 50 mg/kg cefotaxime every 6 hours and 2.5 mg/kg gentamicin every 8 hours).

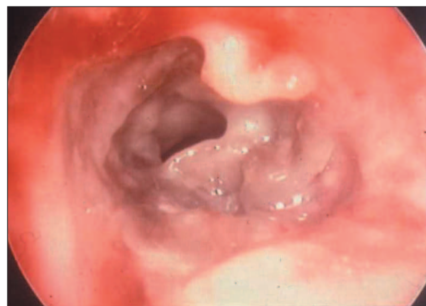
## VIRAL LTB (CROUP)

Croup is most often caused by parainfluenzae viruses, and usually follows a few days of upper respiratory tract infection. Croup is common, but only 1% of affected children require hospital admission, and a similarly small proportion of those admitted to hospital require intubation.

The child develops a harsh, barking cough and inspiratory stridor. Children with croup will be hoarse, although swallowing will be normal.

Mild croup will resolve spontaneously or with warm steam inhalation in the bathroom at home (for which there are no supportive studies).

***Figure 4. Copious quantities of slough in the trachea indicates tracheitis.***



More severe croup may resolve with nebulized steroids (nebulized budesonide 2 mg, single dose) given in casualty, after which children may be discharged home if they are improved.

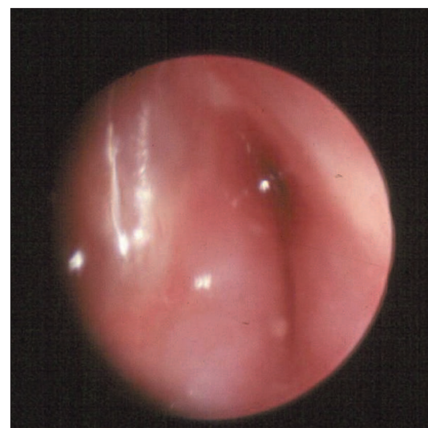
Even more severe croup may require nebulized adrenaline (0.5 ml/kg of 1:1000 adrenaline, up to a maximum of 6 ml, diluted in normal saline; Shann, 2001) in addition to steroid (Tibballs et al, 1992; Brown, 2002; Ausejo Segura et al, 2003). Deterioration may occur some hours after nebulized adrenaline. If frequent, repeated doses of adrenaline are needed or the child becomes exhausted, intubation is indicated (*Figure 5*).

Usually an endotracheal tube of internal diameter 0.5–1 mm smaller than would be predicted for the child's age will be required. Still smaller tubes may be necessary and should be available. Endotracheal tube secretions may be a problem, given the smaller tube diameter, and careful attention to humidification and suctioning is important.

The duration of intubation in children with croup is generally longer than children intubated for epiglottitis (Tibballs et al, 1992; Durward et al, 1998).

A spasmodic form of recurrent croup has been described, especially in atopic children, which responds well to steroids.

***Figure 5. Almost complete obstruction of the trachea in childhood croup.***



## FOREIGN BODIES

Foreign body aspiration is a rare cause of acute upper airway obstruction. Young children are more commonly affected, sometimes aspirating foodstuffs that they are unable to chew properly (e.g. peanuts), or parts of toys that they have placed in their mouths (Salcedo, 1998). Onset is usually sudden, although there may be no history of foreign body aspiration.

The features depend on the site where the foreign body is lodged. Objects lodged in the larynx may produce life-threatening stridor; these may be cleared by the Heimlich manoeuvre or an abdominal thrust. Most objects that pass through the larynx lodge in the main bronchi. Upper oesophageal foreign bodies may cause respiratory symptoms.

A chest radiograph will demonstrate a radio-opaque foreign body. If the foreign body is radiolucent, its position may be shown by over-expansion of the lung distally, but the radiograph is often unremarkable.

A foreign body will require retrieval under anaesthesia by airway endoscopy (Zellera et al, 1998).

## AIRWAY TRAUMA

Direct trauma is rare. Fires rarely cause direct thermal injury to the airway, but parenchymal lung damage may be a result of smoke inhalation in an enclosed space.

## OTHER CAUSES

There are many other causes of upper airway obstruction, which together make up a substantial proportion of the causes, although they are individually rare. Some of these causes are shown in *Table 1*.

### KEY POINTS

- Upper airway obstruction is relatively rare, but may be life threatening.
- Maintaining a clear airway is the most important aspect of management.
- A more varied group of conditions cause airway obstruction in infants. Early endoscopy may enable specific management.
- Epiglottitis still occurs despite vaccination.
- Examination or procedures that cause distress to a child with a compromised airway may result in complete airway obstruction.

## CONCLUSIONS

Although airway obstruction is an infrequent cause of disease in children, it may be life threatening. Maintaining a clear airway and, if necessary, securing it surgically is the most important part of treatment. Appropriate treatment usually produces a complete cure. HM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