

CHAPTER 42

PAEDIATRIC UPPER AIRWAY OBSTRUCTION

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Introduction

Upper airway obstruction in children is a serious and a potentially life-threatening problem. As such, the most important aspect is to establish the level of obstruction to instigate appropriate treatment without worrying too much about the diagnosis in the first instance.

Listening to the breathing is vital.

Stertor is a pharyngeal noise that sounds like a rough, bubbly snore and is usually inspiratory. Swellings in the pharynx, such as tonsillitis, glandular fever, burns, diphtheria, and space-occupying lesions (e.g., lymphoma) will often have stertor. Obstruction at this level can be bypassed with intubation or tracheostomy.

Stridor can be inspiratory, bifid (two way), or expiratory:

- *Inspiratory stridor* is usually caused by problems at the vocal cord level and above. It can be relieved by intubation or tracheostomy.
- *Bifid stridor* may involve the larynx but comes largely from the trachea, which is not distensible, hence the two-way nature of the noise. It may be relieved by intubation or tracheostomy providing the lesion is not at the distal end of the trachea.
- *Expiratory stridor* is termed *bronchospasm*, and comes from the bronchus. It is due to an inhaled bronchial foreign body and cannot be relieved by tracheostomy or intubation.

Neonates are obligate nose breathers and congenital bilateral choanal atresia (see below) is therefore an acute airway problem that needs immediate recognition and management.

The volume of the noise of breathing is not important, but the breathing characteristics (quality) are important. In addition, a rising pulse and respiratory rate with increasing recession of intercostal muscles and indrawing of the neck are signs that the obstruction is worsening. Cyanosis is a very late sign and one of impending doom.

The minimal requirements for successful management of upper airway obstruction are:

- oxygen;
- hydrocortisone and/or dexamethasone;
- nebulised adrenaline (epinephrine);
- antibiotics: chloramphenicol, ampicillin, and/or cefuroxime; and
- facilities and an ability to perform endotracheal intubation and tracheostomy.

Classification

For convenience it is easier to think along the lines of congenital and acquired airway obstructions. The congenital group normally presents at birth. The acquired group can be divided into acute and chronic. The acute group is further divided into *infective or noninfective* upper airway obstruction.

Congenital Upper Airway Obstruction

Choanal Atresia

Choanal atresia is due to failure of the buccopharyngeal membrane to canalise in embryonic life. This may leave a membranous or bony atresia or occasionally just a stenosis. It is often seen with the CHARGE association. (CHARGE is an acronym for coloboma, heart defects, choanal atresia, developmental retardation, genitorenal defects, and ear abnormalities.) It may be unilateral or bilateral. If the atresia is unilateral, there is usually no need for any acute treatment and feeding and a good airway is possible by suction of mucus from the patent nasal airway. If bilateral, the oral airway is kept in place and oral tube-feeding may be necessary until surgery can be carried out in the first few days of life, provided the child is fit enough and features of the CHARGE association have been excluded.

Diagnosis

Since babies are obligate nose breathers bilateral atresia presents acutely at birth. If the standard midwife practice is followed and nasal catheters are routinely passed the obstruction is easily diagnosed.

Management

The first aid management is to introduce an oral airway. If computed tomography (CT) scanning is available, the nose is cleared of mucus by suction prior to the scan to allow the radiologist a clear view to determine whether it is a stenosis or a bony or membranous atresia. If there is no CT scanner, then a plain x-ray, instilling a drop of radio-opaque dye into the previously cleaned out nose with the child supine will give an indication as to whether there is a stenosis or atresia present.

Surgery

There are many ways of dealing with the problem of upper airway obstruction, but the most sophisticated is via endoscopic nasal surgery by using minute endonasal drills, but these are not always available. The technique described here, however, is reliable and safe with the equipment readily available.

Under general anaesthesia (GA) and with the child intubated, the mucosa of the nose is vasoconstricted with 0.5% ephedrine nose drops. The child is placed supine, and a tonsil gag is used to open the mouth. Curved urethral bougies are gently passed through the nose, using a small size first with the curved tip pointing to the nasal surface of the hard palate. Even if there is a bony stenosis, it is penetrated easily and the tip of the bougie appears in the oral cavity from behind the soft palate. Gradually, larger bougies are introduced to dilate the atresia. Finally, it is necessary to splint the stenosis open with cut-down endotracheal tubes, which will need regular suctioning and should stay in place for about a month.

Results

Sadly, all techniques often need revision, and this one is no exception. The revision rate is about 33%. By the time the child reaches about 3 months of age, oral breathing is established and the acute problem is over.

Unilateral cases need have no surgery until the child is 5 or 6 years of age, and then only if unilateral nasal discharge is a problem.

Laryngomalacia

Laryngomalacia is the most common cause of neonatal obstruction. The pathology is vague, but it is assumed that the laryngeal and often the tracheal cartilages are immature, resulting in lack of stiffness and support for the larynx on inspiration.

Clinical features

Usually, there are no signs of obstruction until the baby is a few days old and becomes more active. Classically, there is an inspiratory stridor only when the baby is agitated or crying. The stridor is more obvious when the child is supine, and it improves when the child is prone. The voice is normal. Feeding can be difficult, however.

Natural history

The vast majority of cases settle down within 6 months and no audible stridor is present at 18 months of age. Failure to thrive is the main reason to interfere.

Diagnosis

The classic history is usually enough for diagnosis, but if in doubt, microlaryngoscopy under GA with spontaneous breathing is necessary.

The findings are of an omega-shaped epiglottis that is pulled backwards as the aryepiglottic folds are pulled forward on inspiration. This results in a supraglottic obstruction. The rest of the larynx and upper trachea are inspected to rule out coexisting lesions.

Management

If the failure to thrive is mild, a wait-and-see policy can be tried. In more severe cases, aryepiglottopexy, which is an easy procedure whereby the aryepiglottic folds are snipped with sharp micro scissors or divided with a laser, is a successful blood-free operation, usually with immediate results.

Tracheostomy should be avoided because often there is coexistent tracheomalacia, and extubation becomes very difficult.

Vocal Cord Palsy

Bilateral abductor vocal cord palsy is very rare, but is sometimes associated with hydrocephalus, causing prolapse at the foramen magnum affecting the vagus nerves. Acute inspiratory stridor and a weak cry are present. Laryngoscopy will confirm the diagnosis and tracheostomy is necessary.

Unilateral palsy is usually on the left side and due to inadvertent damage during ligation of a congenital patent ductus arteriosus. A weak cry and usually mild stridor are present, and if the recurrent laryngeal nerve has been traumatised rather than divided, it may recover in about 6 weeks.

Congenital Subglottic Stenosis

Congenital subglottic stenosis is far less common than acquired stenosis, which is often due to prolonged intubation in neonatal life. There will often be a bifid stridor because the lesion is a congenital narrowing of the only complete ring of the trachea, namely, the cricoid cartilage. The cry is normal, but due to respiratory distress, urgent intubation is necessary when the expected diameter tube for the weight of the child is determined to be too wide and a narrower tube is necessary, and often that is also too tight.

Mild stenosis will often grow with the child, and no action is necessary in early life.

More severe stenosis requires treatment. An anterior cricoid split is sometimes effective whereby a vertical incision is made through the anterior arch of the cricoid and a larger endotracheal tube inserted as a dilator for a period of time. Failing this, a tracheostomy will be necessary and reconstruction of the trachea carried out at about the age of 2 years.

Laryngeal Web

A total laryngeal web is incompatible with life and is due to lack of canalisation of the developing larynx. Additional minor webs usually

occur between the anterior ends of the vocal cords. The presenting features are inspiratory stridor and a very weak voice. The web is often thin and can be split surgically.

Posterior Laryngeal Cleft Larynx

Posterior laryngeal cleft larynx is rare and difficult to diagnose and may range from a small defect in the interarytenoid muscles to a complete division of the posterior arch of the cricoid. The symptoms are very similar to a tracheo-oesophageal fistula, and complex repair surgery is necessary to stop aspiration.

Haemangioma

Inspiratory or bifid stridor in a child with a cutaneous haemangioma should always raise suspicion of a laryngeal haemangioma. Diagnosis is made via laryngoscopy; symptoms are often absent at birth but become more severe as the lesion grows naturally. The commonest site is the subglottis. Usually there is no more enlargement and at about 6–12 months, natural regression takes place and often no treatment is necessary. If the airway is becoming compromised, a tracheostomy while waiting for natural regression is the safest option.

External Compression

Rare lesions, such as cystic hygroma (see Chapter 41), may compress the pharynx, larynx, or trachea.

Acquired Upper Airway Obstruction

The acquired causes can be divided into *acute* or *chronic*. The acute causes can be further subdivided into *infective* or *noninfective*. The infective causes will be *pyrexial*, and the noninfective will be *apyrexial*. A simple thermometer (not placed in the mouth) will distinguish between these two groups.

Acute Acquired Airway Obstruction

Acute noninfective upper airway obstruction

Foreign bodies, burns, and angioneurotic oedema need to be considered.

- *Foreign bodies* (FB) in any body cavity are common in children, but an inhaled FB constitutes an emergency. There is usually a history of ingestion or inhalation, and the child will be apyrexial. The level at which the FB is trapped now needs to be determined.

Gagging will be the main symptom of a pharyngeal FB, such as a fish bone stuck in the tonsil. This may be seen and removed with forceps.

Inspiratory stridor suggests the FB is at the laryngeal level, and urgent removal by thumping the child on the back with the child in the prone and head-down position or carrying out the Heimlich manoeuvre is mandatory.

The technique most useful for infants is as follows (see Figure 42.1):

1. Lay child prone with head down over the knee.
2. Give five pats on the child's back with the heel of the hand.
3. Check the child's mouth for a foreign body that can be removed.
4. Repeat.

The Heimlich manoeuvre for older children, to be used if the technique shown in Figure 42.1 isn't successful, is as follows (see Figure 42.2):

1. Stand behind the child.
2. Make a fist with one hand and place it just below the child's lower sternum.
3. Place your other hand over the fist.
4. Pull into and upwards to the child's upper abdomen five times.
5. Check the child's mouth for a foreign body that can be removed.
6. Repeat as necessary.

If either of these techniques is not successful and a skilled laryngologist is not available, then emergency cricothyrotomy or tracheostomy will be necessary to bypass the obstruction. A FB lodged in the upper oesophagus may give very similar symptoms.

Expiratory stridor preceded by bouts of coughing suggests

a bronchial FB, usually in the right main bronchus in older children, but in either bronchus in infants. Vegetable FBs (such as peanuts) are more dangerous than inert objects because vegetables contain oil that can cause a local pneumonitis and they tend to crumble. Antibiotics are probably wise while waiting for treatment. The situation is usually not desperate, and assessment and investigation can be carried out.

Clinical examination may show the trachea deviated to either side. If there is a valve effect, then air will go in but little will go out due to bronchospasm, in which case the affected lung will be hyperinflated and the trachea deviated away from the affected side. If there is complete obstruction, then the lung will collapse and the trachea will deviate towards the affected side. Percussion of the chest and a chest x-ray in inhalation and exhalation will confirm the diagnosis.

Treatment is rigid ventilation bronchoscopy by a skilled ear, nose, and throat (ENT) surgeon and removal using appropriate forceps. Physiotherapy prior to bronchoscopy is not advised because the FB might be impacted further, compounding the situation. Postoperative physiotherapy is essential to help the lung expand.

- Burns: Inhalational burns are extremely dangerous. The cause may be chemical—from ingestion of bleaches or other caustic chemicals often stored in inappropriate containers (e.g., soda bottles) or from inhalation of smoke and flame. Airway obstruction may not develop immediately and may be missed while dealing with burns to other parts of the body. If there is airway obstruction, intensive care unit (ICU) admission, large doses of hydrocortisone (4mg/kg body

weight, intravenously (IV), 6-hourly), antibiotics, and intubation or tracheostomy are required.

- Angioneurotic oedema is usually caused by ingestion or inhalation of an allergen to which the child is sensitive. Common allergens are nuts, penicillin, and some foods. There may well be other signs of systemic shock that need appropriate management, but airway obstruction from a grossly swollen tongue or larynx is an urgent problem, as is acute asthma. Early recognition of the problem can avoid emergency tracheostomy. Adrenaline (10 mgm/kg body weight, intramuscular (IM)), nebulised adrenaline (5 ml of 1 in 1000 with 100% oxygen), and hydrocortisone (4 mg/kg body weight, IV, over 15 minutes) is the first aid management and usually will avoid intubation or tracheostomy.

Acute infective upper airway obstruction

The following infective causes need to be considered and a diagnosis rapidly made because, especially in the case of the epiglottitis, acute deterioration will lead to asphyxiation and death: laryngotracheobronchitis (common “croup”), epiglottitis, bacterial tracheitis, tonsillitis (rarely), glandular fever, retropharyngeal abscess, and diphtheria.

Certain rules exist for the safe management of upper airway obstruction, the most important being not to frighten the child, which will often make the stridor worse. The child’s temperature is taken, preferably with an ear thermometer; if there is no fever, the diagnosis is not one of the infective causes discussed in this section. The mother can give a good relevant history, with the child staying on her knee without any interference such as blood tests or throat examination, especially if the stridor has come on rapidly, suggesting epiglottitis.

Table 42.1: Various symptoms of acute infective causes of upper airway obstruction.

Symptoms	Laryngotracheobronchitis (LTB)	Epiglottitis	Retropharyngeal abscess	Diphtheria	Glandular fever/ tonsillitis
Speed of onset	Days	Hours	Days	Days	Days
Age	18 months	2–5 years	Any	Any	Any
Preceding upper respiratory tract infection (URTI)	Yes	No	Yes	Yes	Yes
Voice	Hoarse	Muffled/“hot potato”	Normal	Normal	Normal
Position	Lying down	Sitting up and leaning forward	Sitting up	Any	Any
Drooling/swallowing	No drooling/can swallow	Copious drooling and unable to swallow	Some	Some	Some
Stridor	Noisy	Quiet	Often none or stertor	Variable	Often nil or stertor
Appearance	Pale lips and struggling	Pale lips and frightened	Toxic	Toxic	Variable
Need for alternative airway	Less than 5%	90%	Surgical drainage usually relieves obstruction	If antibiotics and antitoxins fail	Rarely



Figure 42.1: Technique for thumping child on the back in a prone position to remove foreign body.



Figure 42.2: Heimlich manoeuvre to remove foreign body.

X-rays for the diagnosis of acute epiglottitis are dangerous in that they distress the child and waste valuable time; if a retropharyngeal abscess is suspected, however, a lateral neck film is useful. Cyanosis is a sign of imminent disaster and indicates the child needs an urgent alternative airway. Increasing pulse and respiration rates are also good signs that the child's condition is worsening.

Table 42.1 distinguishes among the various causes of acute infective upper airway obstruction that can be determined from the history and observation of a child. It particularly distinguishes epiglottitis from other causes so that urgent action may be taken with reasonable diagnostic certainty.

Laryngotracheobronchitis

Laryngotracheobronchitis (LTB, or croup) is a viral condition and is the most common infection that causes stridor. Most cases occur at around 18 months of age, and there is always a history of upper respiratory infection in the preceding week. There may be a history of previous attacks. Mild cases present with a barking seal-like cough with a hoarse cry and inspiratory stridor, which is worse if the child gets agitated when an expiratory component can also be heard.

Rarely is there any need for intubation (less than 5%) and the management is to calm the child and reassure the mother. Avoid

injections and nasal airways, as they only upset the child

Observations and management of LTB are as follows:

- A slowing pulse and reduced respiration rate are good signs.
- Humidified air, or oxygen if necessary, is given via a mask held in front of the child's face.
- Oral fluid is given.
- Antibiotics are not necessary except for the more severe cases when oral cephalexin (25mg/kg body weight, every 6 hours) or chloramphenicol (2.5mg/kg body weight, every 6 hours) are given.
- Steroids (dexamethasone, 0.6mg/kg body weight) given orally twice a day as necessary will help.
- Nebulised adrenaline (5 ml of 1 in 1000) given via a face mask is a good way to reduce oedema in the more severe cases. This may need repeating every 2 hours while the condition is monitored with a transcutaneous oxygen probe and careful pulse and respiratory rates are recorded.
- Severe cases will need intubation or, occasionally, tracheostomy.

As children grow, the subglottic lumen increases oedema from LTB has less effect on narrowing the airway, which is why this condition is usually seen only in children under 2 years of age.

Acute Epiglottitis

Epiglottitis is a frightening emergency airway problem to deal with, but if handled correctly will lead to a child rapidly restored to health from a potentially fatal situation. It is an infection caused by *Haemophilus influenzae* in a nonimmunised child, usually around the age of 5 years. It is very much rarer than LTB, especially in countries where *H. influenzae* vaccine immunisation is routinely given. Rapid diagnosis is essential to ensure urgent life-saving treatment. It is safe to assume all children will require a temporary alternative airway, usually intubation if the skills are present to carry out what is a potentially difficult procedure; otherwise, a tracheostomy is necessary.

The following points should be heeded in the management having suspected the diagnosis based on the information in Table 42.1:

- *Never* examine the throat except in a facility where intubation can be immediately carried out.
- *Never* do anything invasive or attempt to lie the child down. The child is much safer sitting up, leaning forward, drooling, and in the clothes in the child had been wearing.
- *Never* carry out a lateral neck x-ray. The thumb sign seen in most textbooks is not necessary to make the diagnosis, and the performance of moving and positioning a child for a neck x-ray may precipitate a sudden airway crisis.
- *Always* reassure the child and the mother.
- *Always* arrange urgent transfer to an anaesthetic room, having first called an anaesthetist and ENT surgeon to be present so that an alternative airway can be performed.
- *Always* use humidified oxygen given by a face mask held close to the child's face while being transferred to a resuscitation room.

Once the appropriate personnel are present, general anaesthesia is induced while the child is in the sitting position, and the child is laid prone once asleep. The diagnosis is now made with an intubating laryngoscope when a "cherry red" epiglottis is seen. Intubation is carried out at the same time. If this is impossible, a thump on the chest will often produce a bubble of air, indicating where the tube should be aimed. If the swelling is so great that a flexible tube will not pass, the ENT surgeon should be able to pass a rigid bronchoscope through the obstruction. A useful trick is to use a Magill nasal sucker, which has a blunt end and a gentle curve, allowing easy intubation. If either of these rigid instruments

has been used, do *not* remove them but continue anaesthesia via the bronchoscope and carry out a tracheostomy onto the rigid bronchoscope.

Once the airway is secure, blood cultures and a throat swab are carried out and IV chloramphenicol (50mg/kg body weight) is given, followed by 25mg/kg every 6 hours.

The next step is to transfer the child to an ICU where the alternative airway can be managed. Rapid response to treatment is usual, and extubation is possible within 24–72 hours.

Retropharyngeal Abscess

Retropharyngeal abscess is a condition most often seen in infants and young children and may mimic epiglottitis in that the symptoms of inspiratory stridor, drooling, and a muffled voice are similar, but there is always a long period of fever and general debility prior to the diagnosis. It is due to the breakdown of a retropharyngeal adenitis into an abscess and is frequently associated with tonsillitis. The child will usually have a stiff, painful neck, which is held to one side because the midline raphe attached to the anterior cervical spine pushes the abscess to one side. The organisms are usually *Streptococcus haemolyticus*, *Staphylococcus aureus*, or anaerobes. This condition is sometimes seen in cases of tuberculosis (TB) where the cervical spine is involved and caseous breakdown occurs.

Due to the long history of preceding URTI symptoms, unlike for epiglottitis, it is permissible to examine the throat where an asymmetric pharyngeal swelling is seen. The next stage is a lateral neck x-ray, which shows a lack of the normal lordosis and a widened space between the spine and the pharyngeal airway. If the organism is anaerobic, a gas bubble may be seen in the soft tissue swelling.

The management involves urgent surgical drainage and culture of the drained pus. If GA and intubation are difficult, then a No 11 blade wrapped in tape (except for its point) can be used to lance the abscess. A large IV cannula could also be tried. IV antibiotics depending on the gram stain of the organism are necessary in large doses. Mediastinitis is the most serious complication, with a mortality rate of 40–50%.

Diphtheria

Diphtheria is seen only where low immunisation levels are present. Infants are often protected by maternal antibodies, and the usual age group for diphtheria is 2–4 year olds.

The disease nearly always affects the pharynx, and a thick white/gray membrane caused by the toxin covers the tonsils and pharyngeal walls and bleeds if it is separated from the underlying structures. The membrane may extend to the larynx, causing stridor. Frequently, large cervical lymph nodes give the appearance of a “bull neck.”

Toxaemia, which may vary from mild to severe, is the other main feature of diphtheria apart from the respiratory symptoms. Severe toxaemia may result in cardiovascular collapse and neuropathy and include myocarditis and palatal palsy.

The diagnosis is made by examining the throat and sending a piece of membrane for urgent gram stain. The management is to deal with the toxins and support the airway:

- *Benzylpenicillin* (50 mg/kg body weight, IV, 4-hourly). Once drinking is established and the child is less toxic, a change is made to oral penicillin. Erythromycin is an alternative.
- *Dexamethasone* (0.6 mg/kg, twice daily, IV) if there is stridor or gross neck swelling.
- *Antitoxin* is essential (60,000 units IM/IV). A test dose should be given first to ensure there is no reaction (0.1 ml of 1 in 1000 in saline intradermally).
- Consider *tracheostomy* if airway compromised.
- Oxygen.
- Cardiac monitoring.
- *Bed rest* for 2 weeks.
- *Nasogastric feeding* if there is palatal palsy.
- *Immunisation* of patient and close contacts before discharge.

Glandular Fever

Glandular fever (infectious mononucleosis) is a viral infection due to the Epstein-Barr virus, which may cause airway obstruction due to massive tonsillar enlargement. Stertor rather than stridor is evident, examination of the neck shows large cervical glands, and the tonsils are covered with a white membrane. The other main symptom is extreme tiredness and lethargy. The liver and spleen may be enlarged and a general lymphadenopathy may be present.

Treatment is mainly symptomatic with bed rest, fluids and analgesia. Ampicillin should not be given since a widespread rash may occur.

If the airway obstruction is present large doses of IV steroids will usually relieve the obstruction and intubation or tracheostomy is rarely necessary.

Bacterial Tracheitis

Bacterial tracheitis is a rare but nasty condition in which the tracheal mucosa sloughs off to form thick crusts in the airway that are difficult to remove. Measles is not infrequently complicated by this bacterial infection, often due to *Streptococcus pneumoniae* or *Haemophilus influenzae B*.

Children with bacterial tracheitis frequently require intubation and ICU management if only to clear the thick secretions. The child is much more toxic with this bacterial infection than in viral LTB and the absence of swallowing and drooling problems distinguish it from epiglottitis. Bronchial complications are common, and prolonged treatment with antibiotics, humidification, and physiotherapy are necessary once the acute airway management has been completed.

Key Summary Points

1. If epiglottitis is suspected, do not examine the throat except at the time of resuscitation.
2. Hypoxaemia and cyanosis are very late signs.
3. Dexamethasone (0.6 mg/kg body weight orally) should be given early. (The oral form is as effective as injected if the child is able to swallow.)
4. Nebulised epinephrine (1 ml in 1/1000 in 3 ml of 0.9% saline) should be available.
5. History taking and resuscitation should take place at the same time.
6. Immunisation against *H. influenzae* should be administered.
7. In recurrent croup, suspect subglottic stenosis.
8. Antibiotics chloramphenicol, cefuroxime, and ampicillin should be available.
9. Oxygen must be available.
10. If intubation is considered, make sure personnel are available to carry out tracheostomy in case intubation fails.

Suggested Reading

Gleeson M, ed. Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 7th ed, Vol. 1. Hodder Arnold, 2008. See, especially:

- Chapter 86, Stridor, David Albert, pages 1114–1126.
- Chapter 87, Acute laryngeal infections, Susanna Leighton, pages 1127–1134.
- Chapter 88, Congenital disorders of the larynx, trachea and bronchi, Martin Bailey, pages 1135–1149.

Lissauer T, Clayden G. Illustrated Textbook of Paediatrics. St. Louis, MO: Mosby Elsevier, 1997.