Chapter

22

The Compromised Paediatric Airway*

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Introduction

The incidence of a difficult paediatric airway is rare with risk of difficult laryngoscopy estimated at 1.35%. Familiarity with the differences in anatomy and physiology, thoughtful planning, clear communication and a thorough knowledge of specialised paedatric airway equipment are essential. Anaesthetists will be required to provide airway stabilisation for either elective surgical situations in a child with a known difficult airway or to establish a definitive airway in a child in an emergency with most likely a normal airway. An unpredicted difficult pediatric airway is extremely rare.

A compromised airway can be considered to occur when a trained anaesthetist experiences difficulty with face mask ventilation, difficulty with tracheal intubation or both. A Cormack and Lehane grade 3 or 4 airway is considered difficult, though other abnormalities can compromise the airway even when the grading is less.

The causes of difficulty are largely infections or congenital abnormalities (see Table 22.1). Infections often present acutely and in children with no other comorbidity. Children with a known difficult airway may present for planned investigations or surgery but may also present acutely with symptoms exacerbated by respiratory infection. Congenital abnormalities associated with dysmorphic features, macroglossia, limited submandibular space (retrognathia, micrognathia, mandibular hypoplasia) and limited neck or temporomandibular joint (TMJ) mobility all lead to difficult bag mask ventilation, difficult intubation or both.

Even maintaining the airway in a normal neonate or infant under anaesthesia can prove a challenge for the inexperienced practitioner, further highlighting the need for knowledge of the anatomy and paediatric airway equipment and the difficulties likely to be encountered. It is only with knowledge and experience that clear formulation of a plan can be put in place to avoid complications and achieve successful intubation.

A major recent study found that occurrence of complications is associated with more than two tracheal intubation attempts, a weight of less than 10 kg, short thyromental distance and three direct laryngoscopy attempts before an indirect technique is attempted. All these factors will be exacerbated when associated with an inexperienced operator unaware of the likely challenges of a paediatric airway with little experience of using specialised paediatric airway equipment.

Features of the Paediatric Airway

It is easy for management of a normal airway to spiral out of control if one does not realise that the prominent occiput of an infant tends to cause neck flexion and the tongue is relatively large. These factors contribute to airway obstruction, as pharyngeal tone is lost. Simple techniques such as chin lift (avoiding compression of the structures of the floor of the mouth), application of continuous positive airway pressure (CPAP) and insertion of a Guedel airway (if the child is adequately anaesthetised) are useful. The supraglottic airway (SGA) has an important role in managing the difficult airway in children of all ages.

The upper airway mucosa is loosely adherent to the submucosa in infants and prone to oedema, except over the vocal cords and laryngeal surface of the epiglottis. Laryngeal oedema from repeated intubation attempts may convert a difficult intubation into an impossible one. The diameter of the airway at the cricoid in neonates is only 4–5 mm, and even 1 mm of oedema, for instance from infection, results in significant reduction in

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Table 22.1 Common causes of upper airway obstruction in children

Congenital		Acquired	
Choanal atresia		*Infections*	Croup (laryngotracheobronchitis) Epiglottitis Bacterial tracheitis
Craniofacial malformations	Pierre Robin syndrome Treacher Collins syndrome Goldenhar syndrome Midfacial hypoplasia		Quinsy Ludwig's angina Diphtheria
Macroglossia	Down syndrome Beckwith–Wiedemann Mucopolysaccharidoses	*Physical obstruction*	Foreign body Trauma Adenotonsillar hypertrophy Thermal or chemical burns
Larynx	Laryngomalacia Laryngeal web Laryngeal cleft Vocal cord palsy Subglottic stenosis Haemangioma		Postintubation oedema Postoperative oedema Angio-oedema Acquired laryngeal or subglottic stenosis Rheumatoid arthritis Tumours Cysts
Tracheal	Tracheomalacia Tracheal stenosis Vascular rings	*Neurogenic*	Lymph nodes Depressed consciousness Nerve palsy

cross-sectional area and an increase in resistance (Poiseuille's law). The cartilaginous structures of the chest wall are compliant in infants and young children, and increased respiratory effort causes sternal and subcostal recession with decreased mechanical efficiency. The metabolic rate and oxygen consumption are high, the functional residual capacity is relatively small and the diaphragm has fewer fatigue-resistant fibres, all limiting respiratory reserve. The infant with severe respiratory infection is easily exhausted, and airway obstruction leads to rapid desaturation.

In some cases, progression to severe airway compromise is rapid, and immediate intervention is required. In others, problems may develop over days or weeks, or the child may present for elective surgery unrelated to the airway. In any situation, it is important to assess the airway carefully, to formulate a clear plan, including contingency plans should the first one fail.

Assessment of the Airway

The diagnosis of a narrow or compromised airway may be obvious, for instance in a child with a known congenital condition or a child who presents with loud stridor or marked respiratory distress. Sometimes the signs may be very subtle, and it is easy to underestimate the degree of airway compromise. This is particularly the case where there is a slowly worsening fixed narrowing when there is often minimal stridor and little sign of increased work of breathing at rest. An example of this is the child with subglottic stenosis or airway complications of caustic ingestion.

Airway assessment in terms of the typical measurements in adults (Mallampati grade, thyromental and sternomental distances) have not been validated in children, and the paediatric population may not be keen to comply in any case. Instead, assessment of the airway requires a careful clinical history, from often well-informed parents, and examination to obtain an indication of the likely cause and whether the problem is supraglottic, glottic, subglottic or lower down the respiratory tract. Investigations are rarely helpful or appropriate in the acute situation but may have a role in the stable child.

History

In addition to the normal anaesthetic history, questions should be targeted at airway problems.

Is this a previously normal airway? Consider previous airway problems or airway surgery and previous episodes of intubation and ventilation, especially for ex-premature infants. Even short periods of intubation can lead to the development of subglottic stenosis or cysts that may not cause any issues until the next intubation attempt. Previous cardiac surgery or repair of a tracheoesophageal fistula can make vocal cord palsy or tracheomalacia more likely.

Pay attention to previous respiratory problems such as asthma, especially if diagnosed at a particularly young age, atypical or not responding to treatment.

Have the parents heard stridor or other respiratory noise? Has there been a witnessed coughing or choking episode suggestive of an inhaled or swallowed foreign body?

Ask the questions:

Is the noise constant or intermittent; what are the effects of positioning or exertion? Is it getting worse or better?

Ask about the onset and duration of the problem.

Are there any exacerbating or relieving factors?

In addition, ask if the parents have noticed a change to the child's voice or cry; weakness, hoarseness or aphonia suggest a laryngeal pathology.

Airway obstruction should also be considered. Question the parents regarding the presence of snoring, periods of apnoea and what position the child adopts for sleeping. A child with an obstructed airway may adopt odd positions to help maintain their airway during normal sleep. Children who obstruct their airways during sleep will almost certainly obstruct on induction of anaesthesia, and the anaesthetist should be prepared to manage this.

It is useful to assess respiratory reserve by asking if the child can keep up with their peers in the playground and during sport. For infants, ask about feeding and thriving. A child who is using up too much energy to breathe or struggling to breathe will not feed well or gain weight and may be requiring nasogastric feeds.

Examination

In the case of a compromised airway, examination may be best done from a distance so as not to cause further distress and deterioration.

Are they expected size for age?

- If small, are they an ex-premature infant, or is faltering growth due to chronic airway obstruction?
- Note BMI, which may lead to rapid desaturation in obese children, especially since you may not be able to effectively preoxygenate.

Look at the child's position:

- Are they maintaining a tripod position or extended neck to optimise their airway?
- Do they have torticollis? This may suggest neck pain associated with a retropharyngeal abscess.

Look at the pattern of breathing:

- Signs of increased work of breathing: tracheal tug, sternal recession, subcostal recession, head bobbing, nasal flaring, grunting and tachypnoea are concerning.
- Further deterioration of the child is evidenced by signs of hypoxaemia or hypercapnia such as tachycardia, pallor, peripheral or central cyanosis, agitation and confusion. Rapid intervention is needed before apnoeas (signalling total exhaustion) commence.
- Other signs such as prolonged expiration may suggest laryngeal or subglottic narrowing, whereas drooling suggests pain or inability to swallow due to epiglottitis, laryngeal foreign body or a retropharyngeal abscess.

Listen to the breathing:

- Abnormal breath sounds often indicate the site of airway narrowing. The loudness of the stridor does not, however, relate to the severity of obstruction; a child with a critically obstructed airway may be almost silent.
- Stridor: a high-pitched sound on inhalation or exhalation
  - Inspiratory stridor is classically associated with a narrowing above the cords.
  - Expiratory stridor is associated with narrowing below the vocal cords or an intrathoracic problem.
  - Biphasic stridor is associated with narrowing at or just below the cords.
- Stertor: heavy snoring inspiratory sound
  - Obstruction at the tongue base or larynx
- Croupy cough
  - Subglottic pathology

- Hoarse cry or breathy voice
  - Vocal cord pathology

In assessing the airway, a great deal of useful information can be gained even from a distance. Determine whether laryngoscopy or face mask ventilation are likely to be challenging; syndromic facies, retrognathia and micrognathia (most obvious when the child is viewed in profile) increase the likelihood of difficulty.

Check for adequate mouth opening, examine the teeth and the tongue and consider whether the oral cavity will allow access for a standard laryngoscope, videolaryngoscope or an SGA Also assess neck flexion and extension.

Examine the chest to check for any problem that is potentially reversible, such as bronchospasm or infection. Decreased respiratory reserve may cause rapid desaturation during induction of anaesthesia. In addition, pyrexia and increased metabolic rate and oxygen consumption may also exacerbate this.

Remember to assess venous access, as this may be difficult in the ex-premature infant or any child who is unwell.

Monitoring

Pulse oximetry is well tolerated and allows continuous monitoring of heart rate as well as oxygen saturation. In an acutely unwell child, the respiratory rate must be checked frequently. Increased rate suggests increased work of breathing; a marked decrease in rate suggests exhaustion. Frequent documentation of these observations will highlight the trends and allow faster recognition of deterioration, which may require urgent intervention to secure the airway.

Investigations

Investigations and imaging are often inappropriate in an acutely compromised child. Attempts to take a sample for blood gas analysis or site a cannula may cause agitation and crying, increase turbulent airflow, worsen respiratory distress or precipitate complete airway obstruction. In a stable child, anteroposterior (AP) and lateral soft tissue neck X-rays may be helpful in diagnosis, for example in croup or retropharyngeal abscess. In children with a chronic problem, MRI and CT scans or a barium swallow to look for tracheal compression may be helpful. Increasingly, ENT surgeons are using awake nasendoscopy in children. These investigations may give detailed information about the size and site of narrowing. Children with obstructed breathing during sleep may have a sleep study or overnight oximetry recording.

Management: Acute Airway Compromise

In acute airway compromise, medical management will sometimes resolve the problem or avoid the need for immediate intubation. The use of inhaled or intravenous steroids and nebulised adrenaline in the treatment of croup reduces the duration of illness and the need for intubation (dexamethasone 600 mcg kg^{-1} PO to a maximum of 8 mg or nebulised budesonide 2 mg; nebulised adrenaline 0.5 ml kg^{-1} 1:1,000 solution to a maximum of 5 ml). These treatments may also 'buy time' and stabilise the child whilst preparations are made to secure the airway. Occasionally, inhaling a helium–oxygen mixture (heliox, usually 21% O2 in helium) is helpful in reducing work of breathing and preventing exhaustion and may allow time for steroids to act.

Planning Management of Acute Airway Problems

Based on your assessment, decide what difficulties you anticipate and how you will manage these with the skills and equipment available. It is likely that more hands will be required, so call for help early. Two experienced anaesthetists are often needed along with a skilled anaesthetic assistant and a surgeon capable of performing a rigid bronchoscopy and tracheostomy. The familiar environment of an anaesthetic room or theatres with the staff and equipment you need to safely manage the situation is often most suitable but must be balanced against the risk of transferring the child with an unsafe airway from the ward or emergency department.

Parental presence can help to keep the child calm and cooperative, but you must clearly discuss the risks and plan in detail with them and the child without causing distress.

Parents need to know what problems you anticipate, what to expect in the anaesthetic room, and how they can help their child. If appropriate, the possibility of death, disability and tracheostomy need to be discussed, including

plans for postoperative care on the intensive care unit. It may be useful to have the parents present for induction, but be aware of time spent trying to remove parents from the anaesthetic room at this critical moment and assign someone who will swiftly but gently escort them away.

Prepare your 'Plan A' airway management and for contingency plans, as these may need to be employed in light of changing circumstances. Having decided what equipment you require, you must check it personally, ensure that it is all working and that you have it in a range of appropriate sizes.

Cognitive skills, teamwork and clear communication are essential to success. A team brief and WHO checklist should be undertaken to ensure the correct team is present, to communicate the roles and responsibilities of the team members and to ensure the whole team understands the plans.

Only rarely in paediatrics is the airway secured awake, either by fibreoptic intubation or tracheostomy under local anaesthetic. Children, particularly those most likely to have a difficult airway, are unlikely to cooperate, and this can result in a chaotic and uncontrolled situation. In most acute cases where the exact pathology and degree of narrowing is unknown, general anaesthesia is required.

Induction of anaesthesia can be inhalational or intravenous, depending on the anaesthetist's preference and experience. The aim of induction in a compromised airway is to achieve anaesthesia whilst maintaining spontaneous respiration. Intravenous induction agents should be used cautiously; tolerance can be unpredictable, causing apnoeas and deterioration of the situation. If the anaesthetist is comfortable performing an inhalational induction with sevoflurane in oxygen, generally it will allow a more gradual deepening of anaesthesia and continuation of respiration. Apnoeas can also occur with this technique once the child is deep, but the operator should be able to monitor respiratory depth and effort more easily and reduce sevoflurane early enough to prevent apnoea. Each case needs individual assessment of whether to insert a cannula before induction or whether this would cause distress and worsening of symptoms. Similarly, the application of full monitoring prior to induction may not be appropriate, but pulse oximetry is generally well tolerated. If the child is adopting a particular position to optimise their airway, anaesthesia should be induced in this position. Atropine was once used as standard in these cases, either 20 mcg kg^{-1} after intravenous access is obtained or orally pre-induction (20–30 mcg kg^{-1}), but this requires over an hour to be effective. It is no longer used routinely, but in cases with copious secretions, atropine can prove useful.

Be prepared to wait some time to achieve the required depth of anaesthesia, particularly when the airway is extremely narrow and there is little gas moving with each breath. If in doubt, wait a little longer and keep assessing the respiratory pattern and depth. The operator must be careful to maintain a patent airway but not cause pain or stimulation whilst doing so, as this may lead to laryngospasm. An oropharyngeal airway may be used to assist achieving airway patency, but this should only be placed once the anaesthetist is sure of adequate depth of anaesthesia. A nasopharyngeal airway may be used and is often better tolerated in lighter planes of anaesthesia, but it should be well lubricated, as bleeding from insertion will only add to the risk of laryngospasm and impair laryngoscopy.

To achieve control of the airway and allow depth of anaesthesia to be reached, gentle, basic airway opening manoeuvres such as chin lift and jaw thrust are used. Application of CPAP via face mask is almost always helpful, acting as a dynamic splint to increase the airway diameter, decrease atelectasis and reduce thoracoabdominal asynchrony. If holding the airway is difficult, immediately convert to a two-person technique with one anaesthetist holding the face mask to gain a good seal and the other maintaining CPAP. Aim for 5–10 cm of CPAP but beware that too much pressure can cause gastric distension. If this does occur, the stomach may be deflated with an oro- or nasogastric tube. If holding a face mask continues to be difficult but the child is anaesthetised, you can consider placing a supraglottic airways device (SGA) as an interim step before attempting intubation.

Opinion varies regarding the use of neuromuscular blocking drugs (NMBDs) in these cases. Some would prefer to achieve adequate depth of anaesthesia and perform direct laryngoscopy without NMBDs to prevent a 'cannot intubate, cannot ventilate' situation. Others argue that it is possible to take over the child's ventilation when the child is deeply anaesthetised, giving the operator

confidence that they can ventilate should they give an NMBD and intubation fails. In addition, it is argued that an NMBD should be given to provide the best conditions for intubation on the first attempt.

Intubation in difficult circumstances should be undertaken by the most experienced anaesthetist. Remember that you may need a much smaller tracheal tube than expected for age. If you do not get a good view or cannot pass a tube at the first attempt, return to face mask ventilation or insert an SGA. Think carefully about how you will proceed.

Recent publications show that in a difficult paediatric airway, first-attempt success rates at intubation with direct laryngoscopy are extremely low at around 3% compared to a success rate of 55% with fibreoptic bronchoscopy, and 55% with video laryngoscopy. The complications were associated with more than two intubation attempts.

Therefore, carefully consider whether there any point in repeating laryngoscopy with the same laryngoscope. Is it likely that a shoulder roll, bougie, stylet or different sized tracheal tube will achieve intubation?

After two unsuccessful attempts at direct laryngoscopy, the operator should change technique. The choice of technique depends on the equipment available and the skills and experience of the anaesthetist.

Advanced Techniques for Managing the Airway

Indirect Laryngoscopy

There is a range of video larygoscopes/endoscopes available, including the McGrath®, Airtraq®, Glidescope® and C-MAC™. C-MAC and McGrath have specific paediatric airway blades which are useful in these situations. There is a learning curve associated with each, so practice on elective surgical lists should take place.

There are situations, however, when an indirect laryngoscope alone will not affect intubation and then more advanced techniques are required.

Flexible endoscopy:

A flexible fibreoptic scope is another option depending on availability and experience. If the child is breathing spontaneously, anaesthesia and oxygenation can either be maintained with a circuit attached to a short tracheal tube used as a nasopharyngeal airway or using a face mask or angle piece with a fisheye through which you can insert your fibreoptic scope. If the patient has been paralysed, intravenous anaesthesia will be required.

Table 22.2 Minimum tracheal tube sizes for different sized endoscopes

Endoscope diameter	Minimum tracheal tube size
2.2 mm	2.5
2.8 mm	3 fits tightly, ideally 3.5
3.7 mm	4 fits tightly, ideally 4.5

Flexible endoscopy can be performed via the nasal or oral route. In a difficult paediatric airway with an anterior larynx, the nasal route is likely to be easier; the nasal anatomy is easy to follow, with fewer angles to be navigated by the scope. The nose should be prepared with a local anaesthetic agent and vasoconstrictor before starting. Even a small amount of blood can obscure the view.

Be aware of the endoscopes available in your hospital and the correctly sized tracheal tubes which can be preloaded onto them (see Table 22.2).

Combined Technique: Indirect Laryngoscope with Endoscopy

An additional method is to use a videolaryngoscope combined with a fibreoptic scope acting as a manoevreable bougie. This method can quickly secure the airway but does require two skilled anaesthetists who are familiar with the equipment and technique (Figure 22.1). The first anaesthetist operates the videolaryngoscope to obtain an optimal view of the larynx whilst a second anaesthetist operates the endoscope with a tracheal tube preloaded onto the scope.

Fibreoptic Intubation via an SGA

A further method is to use an SGA as a conduit for fibreoptic intubation using a guidewire and airway exchange catheter. This is especially useful if there is no availability of small fibreoptic scopes.

This technique was originally described using the classic LMA™ (cLMA), which is made from silicone so that the fibreoptic scope usually passes smoothly between the epiglottic bars. If a disposable SGA is used, you may encounter resistance

Figure 22.1 Combined videolaryngoscope–fibreoptic scope technique. One operator uses a videolaryngoscope to visualise the larynx, whilst a second operator uses the fibreoptic scope as a manoevreable bougie.

passing the fibreoptic scope through the epiglottic bars, and it is better to remove them before starting or to use a Fannin SGA. It is essential to check meticulously that any bars that are removed are identified and disposed of well away from the equipment trolley.

The larynx is usually easily visualised or the scope can be manipulated past the epiglottis to get

a view. Once the scope is positioned above the larynx, topical lidocaine 1% (3 mg kg^{-1}) is applied via the suction port either using an epidural catheter or a 5 ml syringe containing the topical anaesthetic plus a few millitres of air to spray the larynx. Alternatively, a muscle relaxant may be administered and ventilation maintained via the SGA.

A J-tipped guidewire can then be passed through the suction port and into the distal trachea, and the fibreoptic scope removed.

An 8 Fr paediatric airway exchange catheter is railroaded over the guidewire and the wire removed. It is easier to intubate over the stiff airway exchange catheter, as inserting the tube over the guidewire alone usually results in oesophageal intubation. A capnograph can be attached to the airway exchange catheter to check for CO_2.

The SGA is removed, leaving the airway exchange catheter in place. The tracheal tube can now be inserted over the airway exchange catheter and the position checked in the usual way.

There are occasions where intubation is not possible. There may be a mass obstructing the airway or unrecognisable anatomy. The airway may be too narrow for the smallest tube, or the difficult intubation equipment may not be successful. Multiple repeated attempts at laryngoscopy and intubation will cause oedema and bleeding.

In these situations, maintain spontaneous ventilation and consider the following options:

- Wake the child up. This may not be possible with the child with acute airway compromise but should always be considered.
- Secure the airway with an SGA.
- Secure the airway with ENT surgical support and a rigid bronchoscope or tracheostomy.

It may be necessary to allow the surgeons to remove a mass or aspirate a cyst under spontaneous ventilation or proceed to a surgical airway using only a face mask or SGA.

Effective decision-making is crucial. Repeated attempts at laryngoscopy and intubation will only cause further complications. The airway may already be narrow and inflamed, and the situation can rapidly spiral out of control. Discussion should occur between anaesthesia, intensive care, ENT surgery and the local paediatric transport service; communication will need to be clear and concise.

Elective Intubation of the Child with a Known Difficult Airway

Elective intubation of a child with a known difficult airway requires the same detailed assessment as for acute airway compromise. There is a wide spectrum of difficulty, from easy face mask ventilation but difficult laryngoscopy, to airways in which every aspect of management is challenging. Previous anaesthetic records may be helpful but must not be relied on, as the airway may change as the child grows. Parents often have extremely useful information about previous anaesthetic experiences.

Ideally, informed discussion and consent should take place well in advance of the surgery in the setting of a preoperative assessment clinic. A multidisciplinary team meeting may be required to ensure the surgery is worth the risk of anaesthesia. The parents and child should have a clear explanation about anticipated difficulties and strategies for managing the airway and discussions regarding the possibility of an emergency or planned tracheostomy should take place. The possibility of waking the child up if the airway cannot be safely managed must also be emphasised.

Many of the known difficult airways in children are associated with anatomical abnormalities as part of a syndrome such as Pierre Robin sequence. In general, it is not difficult to maintain oxygenation after induction of anaesthesia, and there is time for controlled intubation using a videolaryngoscope or flexible fibreoptic technique. In some children, maintaining oxygenation may be very difficult, and other cofascemorbidities can make airway management very challenging. For instance, children with mucopolysaccharidoses may have limited oxygen reserve, cardiac valve disease, an unstable neck and copious airway secretions, as well as being anatomically difficult to fit mask airways and perform laryngoscopy. The options for airway management are the same as for the compromised airway, but the planning, preparation and communication should be in place well in advance. The option to wake the child up in these elective cases is also more likely to be possible. Two experienced anaesthetists should be present.

Extubation and Continuing Care of Children with Airway Compromise

A child undergoing a difficult intubation requires a plan for extubation. Many children will need to

remain intubated in the intensive care unit for a period whilst airway oedema and infection resolve, and they may require a further airway examination under anaesthesia before extubation. Some will require tracheostomy either permanently or until all foreseen surgical procedures have taken place. In some children, natural growth may be needed for development of a safer airway.

Preparation for extubation should include checking for a leak around the tracheal tube, this is not always possible to hear but if present can give some confidence that airway swelling has settled. Dexamethasone 0.25 $mg.kg^{-1}$ IV should be used whenever possible to reduce oedema. It is best administered intraoperatively and continued in the lead-up to extubation.

Patients should be completely off sedation and awake with minimal secretions. They may be extubated on the intensive care unit, or at times returning to the theatre suite may be appropriate. The plan for extubation should be as clear as the plan for intubation and the team and equipment for reintubation should be fully prepared and present.

It is best to extubate the child in an upright position and apply positive end expiratory pressure (PEEP) with a face mask immediately after the tracheal tube has been removed. A nasopharyngeal airway inserted before waking can also be considered and is well tolerated in an awake child. Any patient previously receiving CPAP or BIPAP will most likely benefit from extubation directly to their preoperative machine and settings.

Placement of a guidewire through the tracheal tube, into the trachea and taped in place after extubation has been described with the thought that if emergency reintubation is required, a small airway exchange catheter can be passed over the wire and a tube railroaded over. In paediatric practice, this is uncommon, and the wire is unlikely to remain in the correct place once the child is extubated unless they are extremely compliant.

Difficult airways in children are uncommon, and elective intubations of children with known difficult airways are important opportunities for teaching and mutual sharing of experiences and knowledge. It is important to document findings, with a clear description of how difficulties were managed. Parents also need to be informed, as the child may present subsequently at a time and place where the anaesthetic records are not available. Giving the family an airway letter or airway 'passport' detailing relevant history to carry with them is useful for future hospital visits.

Difficult Airway Guidelines and 'Cannot Intubate, Cannot Ventilate' Scenarios

The Association of Paediatric Anaesthetists of Great Britain and Ireland and the Difficult Airway Society have published a series of algorithms for difficult airways in children: difficult mask ventilation in a child 1 to 8 years of age; unanticipated difficult intubation; and cannot intubate and cannot ventilate (see www.apagbi.org.uk/publications/apa-guidelines). In children with compromised airways, oxygenation is often difficult, but it is rarely impossible. If the situation does deteriorate to 'can't intubate, can't oxygenate', hypoxia and bradycardia will rapidly ensue and a transtracheal airway must be achieved immediately. In a small infant, the options are very limited, and there is little evidence in the literature to guide practice.

Transtracheal Techniques

Cricothyroidotomy as a rescue technique is very rarely required in children, and surgical tracheostomy may be a safer option. However, paediatric ENT support is not available in every hospital where children are anaesthetised, and occasionally an anaesthetist may need to insert a transtracheal airway with a patient in extremis.

In the small infant, the cartilages of the larynx are difficult to palpate and identify, and the cricothyroid membrane measures only 2.6 × 3 mm. In a neonate or small infant, the cricothyroid membrane is so closely related to the mandible that it is virtually impossible to access at the required angle even with the neck in full extension. These rescue attempts are highly unlikely to be successful.

An 18 G intravenous catheter can be inserted between the tracheal rings if the cricothyroid membrane cannot be identified. The catheter should be inserted with a syringe attached to the end of it, and the operator should continually aspirate as they insert. As soon as air is easily and successfully aspirated, further forward movement of the needle should be stopped and the cannula advanced into

the trachea, the needle should be removed and air aspiration should be checked again. Oxygenation can be achieved by jet ventilation, but only if a device with adjustable pressure and flow is available. Start at low pressure (0.4 bar) and slowly increase to see the chest rise. Exhalation must occur through the natural airway, so the rate of jetting needs to be very slow. If you do not have a jet ventilation device, then the connector from a 3 mm tracheal tube will fit into the hub of an intravenous cannula, which then allows connection with any standard bag valve device.

In the older child, cannula cricothyroidotomy or a percutaneous cricothyroidotomy may be performed as in an adult, the latter allowing insertion of a small tracheostomy tube. Several manufacturers make devices in paediatric sizes. Positive pressure ventilation is possible through these tubes.

Key Points

- An unanticipated paediatric difficult airway is rare, but getting the basics wrong can cause an easy airway to become difficult. Be aware of the pitfalls of managing the paediatric airway.
- Gain knowledge and experience of at least one advanced airway technique in paediatrics. Practice with equipment as regularly as possible on elective lists.
- Call for appropriate help early, including a second consultant anaesthetist, and prepare your team well.
- Have a clear plan and aim for the highest quality of communication both within your team and with the family involved.

Further Reading

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