



## REVIEW

## Management strategies for the difficult paediatric airway

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## S U M M A R Y

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Airway problems remain a leading cause of perioperative morbidity and mortality in children. Proficiency and expertise in airway management are, therefore, key elements for the safe conduct of anaesthesia in children. Clear strategies must be in place to successfully manage children with a normal, acutely impaired and expected difficult airway. Simple, forward only, easy to memorize and practice algorithms are essential in daily practice in preparation for the unexpected difficult paediatric airway. The child with the acutely impaired normal airway and known difficult airway is the domain of the experienced anaesthesiologist in an appropriately staffed and equipped paediatric setting. The following review describes current concepts and developments in the management of the difficult paediatric airway.

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## 1. Introduction

Airway problems are a leading cause of morbidity and mortality in children undergoing general anaesthesia.<sup>1,2</sup>

Airway related morbidity is difficult to assess in children as endpoints and their consequences are poorly defined. Significant and persistent peri-operative hypoxia (<80% for >1 min) has recently been reported from a single tertiary centre without documenting the outcome or resolution. This transient but severe hypoxia is age dependent (approximately 25% of neonates, 10–15% of <1 year olds and 5% of all other children).<sup>3</sup> Hypoxia is also common during rapid sequence induction in children (3.5%) and again is more common in smaller children.<sup>4</sup> However, defining the effects of such severe hypoxia as the result of airway problems on long-term outcomes and potentially neurodevelopment requires attention and further clinical investigation.

Airway problems are common in healthy children without any signs or symptoms of airway anomalies (unexpected airway problems), and are also frequently encountered in the impaired normal airway (infections, bleeding, foreign bodies). The abnormal or unexpected difficult paediatric airway remains a challenge even for the experienced paediatric anaesthesiologist. [Table 1] This review addresses the management strategies according to this suggested classification.

## 2. The 'normal' paediatric airway

Routine paediatric airway management is usually easy in experienced hands using predictors of difficult intubation such as restricted mouth opening, mandibular hypoplasia or facial asymmetry. The paediatric larynx is fairly anterior and loosely embedded in the surrounding structures when compared with adult patients. The laryngeal structures can easily be moved into a position where direct visualisation is possible. Children have, when compared to adults, an increased oxygen consumption and a decreased oxygen reserve. Therefore, the apnoea tolerance in children is very low (measured in seconds) quickly resulting in significant hypoxaemia and subsequent profound bradycardia.<sup>5,6</sup>

Prevention, early recognition of unexpected difficulties in the 'normal' difficult airway as well as time critical concepts is, therefore, required for the anaesthesiologist caring for paediatric patients. Such a simple proposal for the management of the unexpected difficult paediatric airway was recently published<sup>7</sup> and subsequently adapted by other paediatric anaesthetic societies such as the German Workgroup of Paediatric Anaesthesia (WAAKA).<sup>8</sup>

A clear separation between oxygenation/ventilation and tracheal intubation has to be made. Whereas the incidence of unexpected failed intubation is estimated at 0.6% in children less than 1 year old, 0.1% in pre-school children and 0.05% in the older children, impossible face mask ventilation (read oxygenation) in the otherwise healthy, asymptomatic child does not exist.<sup>9</sup> Oxygenation and ventilation have absolute priority at all times. Key to this is

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**Table 1**

Classification of the child with the difficult airway. 'Time' describes the urgency of the situation, 'Place' most likely occurrence, 'Who' the medical and nursing staff involved and 'Recommendation' the essence of treatment.

Unexpected – normal paediatric airway
Time: critical
Place: anywhere
Who: anyone
Recommendation: established paediatric airway algorithm essential
Suspected – Impaired normal paediatric airway
Time: urgent
Place: anywhere, consider transfer to specialist centre
Who: expertise required, consider ENT support
Recommendation: anaesthetic intervention dictated by rate of deterioration
Expected – Known difficult paediatric airway
Time: Normally elective, planning essential
Place: Paediatric specialist centres only
Who: Specialist expertise required, ENT support essential
Recommendation: Exception life/limb saving surgery out with a paediatric centre

the prevention, recognition and treatment of anatomical and functional airway obstructions:

## 2.1. Management of the 'normal' paediatric airway

### 2.1.1. Anatomical airway obstructions

The main causes and treatments for anatomical airway obstructions are illustrated in Table 2. A good basic technique perfected by daily practice and teaching is the key to a good outcome. Mechanical obstructions due to foreign bodies regurgitation, blood and secretions can easily be noticed and treated by removal or suction under direct laryngoscopy. The trachea should be intubated allowing effective lung recruitment and gastric decompression but only if the glottis is open. Forced tracheal intubation must be avoided at all costs in order to avoid trauma to the paediatric airway. Subglottic problems should be treated using a smaller tracheal tube. If no foreign body or other contents are detected during direct laryngoscopy and the trachea cannot be intubated, a laryngeal mask airway (LMA) or another supraglottic airway device (SAD) should be used in order to overcome any potentially missed underlying anatomical supraglottic anomalies.

### 2.1.2. Functional airway obstructions

Functional airway problems due to inadequate depth of anaesthesia, laryngospasm, bronchospasm and opioid induced glottic closure are far more frequent in children.<sup>10,11</sup> Laryngospasm and

**Table 2**

Airway obstructions, causes and treatment.

Anatomical airway obstruction	
<b>Aetiology</b>	<b>Action</b>
Inadequate head position	Repositioning/re-opening/oro/nasopharyngeal airway
Poor face mask technique	Two-hand/two-person technique
Foreign body, vomit secretions, blood	Direct laryngoscopy, removal and subsequent tracheal intubation
Functional Airway Obstruction	
<b>Aetiology</b>	<b>Action</b>
Insufficient anaesthesia	Deepen anaesthesia, if haemodynamically stable otherwise muscle relaxation
Laryngospasm	Deepen anaesthesia, if haemodynamically stable otherwise muscle relaxation
Opioid induced muscle rigidity	Muscle relaxation
Bronchospasm	Intravenous epinephrine

inadequate depth of anaesthesia require early treatment. The administration of additional hypnotics is often advocated but may come at a cost of significant hypotension.<sup>12,13</sup> Muscle paralysis is more appropriate especially when severe hypoxia, bradycardia and impending cardiovascular collapse threaten the patient.<sup>14,15</sup> Severe opioid induced muscular rigidity with or without glottic closure requires muscle paralysis.<sup>16</sup> A firm recommendation about which muscle relaxant or route in the child without IV access cannot be made and depends on departmental guidelines. Acute severe bronchospasm in children requires immediate available intravenous epinephrine (1 µg/kg body weight).

A 'rescue' option is frequently incorporated into the management of the 'cannot intubate-cannot oxygenate' (CICO) algorithms. Principally, the choice is between a surgical airway, needle cricothyotomy and rigid bronchoscopy. There is insufficient evidence to firmly endorse any of these options in children. A child with a normal airway can always be ventilated providing that the basic rules are followed and adequate anaesthesia including muscle paralysis is provided.<sup>8,9</sup>

## 3. The impaired 'normal' airway

The subglottic area is the narrowest part of the paediatric airway. The attached submucosa contains a large number of mucous glands and capillary vessels. Oedema, enhanced mucous production and hyperaemia produce swelling in cases of acute inflammation. The cricoid ring restricts the ability of the subglottic part of the larynx to expand, confining any swelling to the interior of the lumen that produces airway obstruction.<sup>17</sup> Airway obstruction can arise in cases of infection, foreign body aspiration, airway trauma, tumours/hemangiomas and postoperative swelling.

### 3.1. Acute infections

Acute infections are the most common reasons for airway obstruction in children.

#### 3.1.1. Croup

Acute laryngotracheitis (viral croup) usually affects children from 6 months to four years who present acutely, in most cases at night with inspiratory stridor, hoarseness and a barking "seal-like" cough which is often preceded by a short period of rhinitis. The pharynx is minimally inflamed; the children may have a fever and are able to manage their secretions. Specific treatment consists of basic management, e.g. application of humidified air, nebulised epinephrine, oxygen and steroids. Intubation and mechanical ventilation may be necessary in patients who do not respond to medical treatment.<sup>17–19</sup>

#### 3.1.2. Epiglottitis and bacterial tracheitis

Acute epiglottitis is a serious, life-threatening disease and an airway emergency. It is now rarely seen, due to the widespread immunization against *Haemophilus Influenza* type B. It typically affects children aged 2–7 years presenting with high fever, sore throat, drooling, dysphagia and anxiety.<sup>19</sup> The onset is usually acute and symptoms can progress rapidly within hours. These children often prefer to sit upright rather than lie back, bringing the head into a sniffing position with their head extended, to maximize airway opening. Complete airway obstruction leading to respiratory arrest may occur suddenly with no warning and could be provoked bringing the child into a supine position. If epiglottitis is highly suspected, the child should be allowed to stay in the most comfortable position and immediate intubation is advocated in every patient.<sup>17</sup> The child should be transferred to the operating theatre accompanied by the doctor and the parent where

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