Guidelines 3 (AIDAA)

# All India Difficult Airway Association 2016 guidelines for the management of unanticipated difficult tracheal intubation in Paediatrics

**Address for correspondence:**
Dr. Jeson Rajan Doctor, Department of Anaesthesiology, Critical Care and Pain, Tata Memorial Hospital, Dr. Ernest Borges Road, Parel, Mumbai - 400 012, Maharashtra, India.
E-mail: jesonrdoctor@gmail.com

*Dilip K Pawar, Jeson Rajan Doctor[1], Ubaradka S Raveendra[2], Singaravelu Ramesh[3], Sumalatha Radhakrishna Shetty[2], Jigeeshu Vasishtha Divatia[1], Sheila Nainan Myatra[1], Amit Shah[4,5], Rakesh Garg[6], Pankaj Kundra[7], Apeksh Patwa[4,5], Syed Moied Ahmed[8], Sabyasachi Das[9], Venkateswaran Ramkumar[10]*

Department of Anaesthesiology, All India Institute of Medical Sciences, New Delhi, [1]Department of Anaesthesiology, Critical Care and Pain, Tata Memorial Hospital, Mumbai, Maharashtra, [2]Department of Anaesthesiology and Critical Care, K. S. Hegde Medical Academy, Nitte University, Mangalore, [3]Chief Consultant Anaesthesiologist, Kanchi Kamakoti CHILDS Trust Hospital, Chennai, Tamil Nadu, [4]Consultant Anaesthesiologist, Kailash Cancer Hospital and Research Centre, [5]Consultant Anaesthesiologist, Vadodara Institute of Neurological Sciences, Vadodara, Gujarat, [6]Department of Onco-Anaesthesiology and Palliative Medicine, Dr. BRAIRCH, All India Institute of Medical Sciences, New Delhi, [7]Department of Anaesthesiology and Critical Care, JIPMER, Puducherry, [8]Department of Anaesthesiology and Critical Care, J N Medical College and Hospital, AMU, Aligarh, Uttar Pradesh, [9]Department of Anaesthesiology, North Bengal Medical College, Darjeeling, West Bengal, [10]Department of Anaesthesiology, Kasturba Medical College, Manipal, Karnataka, India

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## ABSTRACT

The All India Difficult Airway Association guidelines for the management of the unanticipated difficult tracheal intubation in paediatrics are developed to provide a structured, stepwise approach to manage unanticipated difficulty during tracheal intubation in children between 1 and 12 years of age. The incidence of unanticipated difficult airway in normal children is relatively rare. The recommendations for the management of difficult airway in children are mostly derived from extrapolation of adult data because of non-availability of proven evidence on the management of difficult airway in children. Children have a narrow margin of safety and mismanagement of the difficult airway can lead to disastrous consequences. In our country, a systematic approach to airway management in children is lacking, thus having a guideline would be beneficial. This is a sincere effort to protocolise airway management in children, using the best available evidence and consensus opinion put together to make airway management for children as safe as possible in our country.

**Key words:** Paediatric airway, paediatric guidelines, unanticipated difficult intubation

## INTRODUCTION

A majority of children with difficult airways can be identified during pre-anaesthetic assessment. The reported incidence of difficult intubation in infants is 0.24%–4.7% and 0.07%–0.7% in older children.[1,2]

In view of insufficient data and lack of evidence, recommendations for the management of difficult airway in children are mostly derived from extrapolation of adult data. However, compared to adults, the consequences of mismanagement of paediatric airway are more serious and could lead to increased incidence of morbidity and mortality.[3,4]



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This is probably because of narrow margin of safety resulting from the unique anatomical features of the paediatric airway, as well as physiological differences such as high oxygen consumption and reduced functional residual capacity.[4]

In India, a large number of children are anaesthetised by anaesthesiologists without specialised training in paediatric anaesthesia. The All India Difficult Airway Association, (AIDAA), therefore decided to have guidelines to facilitate difficult airway management in children. These guidelines will be useful for both specialist paediatric anaesthesiologists as well the anaesthesiologists who occasionally anaesthetise paediatric patients. These guidelines should be used in conjunction with "All India Difficult Airway Association 2016 Guidelines for the Management of Unanticipated Difficult Tracheal Intubation in Adults".[5]

## METHODS

The methodology adopted for the development of AIDAA guidelines including unanticipated difficult tracheal intubation in paediatrics has been explained in detail in the section on AIDAA guidelines for unanticipated difficult intubation in Adults.[5] A thorough literature search was done using databases/ search engine (Medline, PubMed, Google Scholar and websites of National Societies for airway guidelines) till September 2016. The articles were manually searched from cross referencing. All manuscripts and abstracts published in English were searched. The key words used included 'unanticipated difficult intubation', 'difficult airway', 'difficult mask ventilation', 'supraglottic airway', 'cricothyroidotomy', 'paediatric tracheostomy', 'transtracheal puncture' and 'high pressure jet ventilation'. Furthermore, opinions of experts and members of the societies were taken for paediatric-related concerns not having definite evidence.

## UNANTICIPATED DIFFICULT FACE MASK VENTILATION

When there is unanticipated difficulty in spite of appropriate equipment, following aspects should be considered:

- Adequate depth of anaesthesia. This can be achieved with intravenous (IV) anaesthetics such as propofol for faster action or with inhalational agents
- Upper airway is kept patent with chin lift and jaw thrust during mask ventilation while ensuring that soft tissue is not being pushed by the fingers holding the mask.[3] In addition, care should be taken not to inadvertently compress the external nares while holding the face mask
- Head is maintained in neutral position for children and use of a shoulder roll is recommended in children <6 months.[3,6] Lateral position should be considered in the presence of adenotonsillar hypertrophy or lingual tonsil or when mask ventilation is not improved by other techniques described here in supine position.[7] Airway adjuncts such as correct sizes of oropharyngeal and nasopharyngeal airways may be helpful
- Ventilation with two-person bag-mask technique should be considered when face mask ventilation is difficult. This is particularly useful in children who are obese, syndromic and have micrognathia
- Laryngospasm should be ruled out whenever there is failure during mask ventilation. Laryngospasm is a common cause of difficult mask ventilation in children, unlike adults. Noxious stimuli at inadequate depth of anaesthesia, hyperactive airway due to upper respiratory tract infections and secretions are common causes of laryngospasm.[8] Initial management is with administration of continuous positive airway pressure ventilation, 100% oxygen and increasing the depth of anaesthesia with IV propofol.[9,10] If laryngospasm is not relieved and/or desaturation ensues IV suxamethonium is the drug of choice
- Gastric distension is a sequel of improper face mask ventilation and should be managed by insertion of an oro/nasogastric tube. Whenever there is a rise in peak airway pressure, gastric distension occurs resulting in further difficulty in mask ventilation due to splinting of the diaphragm[6]
- Administration of a neuromuscular blocker can be considered if not already paralysed. However, this decision should be taken by a qualified and experienced anaesthesiologist based on sound clinical judgement.

## OPTIMISING LARYNGOSCOPY AND TRACHEAL INTUBATION

### Equipment

Children below 12 years require specialised airway equipment appropriate to their age and weight. In the

absence of these, it is safer not to attempt management of a paediatric difficult airway. The equipment should include all the correct sizes of equipment mentioned in the difficult airway cart.

### *Prerequisites*

- Before laryngoscopy, an IV access must be secured
- Appropriate monitoring in the form of electrocardiogram, pulse oximeter, non-invasive blood pressure and capnography should be available
- Pre-oxygenation with 100% oxygen
- Adequate depth of anaesthesia, analgesia and neuromuscular blockade is essential for successful and smooth laryngoscopy and help in obtaining the best view during laryngoscopy[11]
- Nasal oxygen to be administered with nasal prongs/catheter during attempts at laryngoscopy and intubation for apnoea ventilation.

## Laryngoscope type and laryngoscopic techniques

For direct laryngoscopy, a Miller or Macintosh type blade can be used for the first attempt. With the Miller type straight blade, the epiglottis is lifted directly. The Macintosh blade is preferred in older children. Alternately, a videolaryngoscope can be used if equipment and expertise are available.

### *Positioning*

The head, especially the occiput, is relatively large, and this is more pronounced in younger children. Optimal position is obtained when the neck is in a neutral position or slightly extended. In neonates and infants, a roll under the shoulders helps to avoid flexion of the neck during laryngoscopy.[3,6]

### *External laryngeal manipulation*

Because of the long epiglottis and the cephalad location of larynx, it is always necessary to apply external pressure on the neck to obtain a good view of the laryngeal inlet. External laryngeal manipulation (ELM) in children can be applied by the anaesthesiologist doing the laryngoscopy using the little finger or little and ring fingers of the hand holding the laryngoscope.[3]

### *Technique of intubation*

When the vocal cords are visualised, the endotracheal tube (ETT) is gently inserted between them and moved down through the cricoid cartilage up to mid-trachea. In infants, the vocal cords are angled more anteriorly, and if the tip of the tube is caught in the anterior commissure, a slightly rotating movement of the tube will often solve the problem. As soon as the ETT is in place, the centimetre marking near the gingiva or teeth is noticed. This makes it possible to re-establish the position of the tube, if it is accidentally moved during fixation.

## Videolaryngoscopes

Videolaryngoscopy has been described in paediatric patients with channelled (Airtraq®) and non-channelled (C-MAC®, Glidescope® and Truview®) videolaryngoscopes.[12,13]

With videolaryngoscopy, four steps are recommended: (1) insert the video laryngoscope under direct vision looking at the mouth, (2) position it properly looking at the monitor, (3) pass the ETT looking directly into the mouth and (4) pass the ETT into the trachea looking at the monitor.

### *Bimanual laryngoscopy*

In some children, external manipulation with the fingers of hand performing laryngoscopy can be inefficient to provide optimal ELM. In such situations, the other hand can be used to manipulate the larynx with external pressure while a second anaesthesiologist passes the ETT. Despite these techniques, if epiglottis is the only visible structure, then bougie, fibre-optic intubation or videolaryngoscopes may be considered.[3]

## Use of intubation aids

Intubation aids can be malleable stylets and soft tip introducers with or without a hollow passage. For example, Gum Elastic Bougie®, Aintree Intubation Catheter® and Frova Introducer® (5Fr 50 cm bougie for neonates and infants, 8 Fr bougie/Frova for children up to 5–6 years of age (ETT size 5 mm ID) and 11 Fr bougie for children over 6 years of age (ETT size 5.5 mm ID).[14] Intubation aids should never be blindly introduced into the trachea as such practices could result in severe airway trauma.[6,15]

## Number of attempts

A maximum of two attempts at laryngoscopy should be allowed in children (this recommendation is based on consensus). The rationale of limiting the attempts is to avoid trauma and hypoxia. Intermittent face mask ventilation with 100% oxygen should be performed between attempts to maintain oxygenation. Nasal oxygen insufflation during apnoea should be continued. Call for help, following the failed first attempt at laryngoscopy. The second attempt should

be attempted only after additional help is available and oxygen saturation is 95% or higher. A third and final attempt at laryngoscopy should only be done by an anaesthesiologist with paediatric experience. This should be exploratory to understand the anatomy and plan a strategy. For second and subsequent attempt, a change in operator, equipment or position or a combination of these must be considered. All attempts should be performed with adequate oxygenation and depth of anaesthesia, optimal equipment, optimal positioning, ELM and help.

### Role of nasal apnoeic oxygenation during intubation

Continuing apnoeic oxygenation with passive oxygen flow using nasal prongs/catheter during attempts at laryngoscopy and intubation is strongly recommended. This may require another oxygen source with a flow meter. The flow rate of oxygen should be adjusted targeting oxygen saturation more than 95%.

### Confirmation of successful intubation

Successful tracheal intubation is confirmed by the presence of six consistent capnograph traces without any decline in detected levels of carbon dioxide. Other methods such as 5-point auscultation and bilateral chest expansion, condensation of vapour in the ETT during exhalation though less specific, may also be used to rule out oesophageal intubation.[16]

## ROLE OF SUPRAGLOTTIC AIRWAY DEVICE AS A RESCUE DEVICE DURING A DIFFICULT AIRWAY

Supraglottic airway devices (SADs) with a gastric drainage tube (second generation SAD) are preferred.[17] They fit the airway contour better, have a higher seal pressure and a gastric drain tube. Number of attempts at SAD insertion should be limited to two. Mask ventilation should be resumed between two attempts. If the first attempt to insert SAD fails, consider changing the size and type of SAD before proceeding to second attempt.[6]

If SAD is successfully placed,

- It is to be decided if it is safe and essential to proceed with the procedure, with the SAD as the primary ventilation device
- If endotracheal intubation is required to proceed with surgery, one should consider passing ETT through the SAD using a flexible fibre-optic bronchoscope, only if equipment and expertise are available
- If it is unsafe to proceed with a SAD in place or endotracheal intubation through SAD is not possible and it is a non-emergency surgery, option of waking up the child should be considered
- A tracheostomy may be considered only in case of emergency surgical procedure.

If two attempts to use SAD are not successful, rescue mask ventilation should be resumed.

## EMERGENCY SURGICAL AIRWAY ACCESS

The incidence of cannot intubate, cannot oxygenate or complete ventilation failure situation in children is extremely rare. Little evidence exists in children for the selection of optimal rescue technique. The unique anatomy and cephalad position of the infant's larynx, the small size of the cricothyroid membrane, adipose tissue in the neck and the technical difficulty of locating the correct anatomical structures make most of the emergency surgical airway access techniques impractical and dangerous in small children.[18]

We recommend to proceed for emergency surgical airway access whenever there is complete ventilation failure, and this is best done while oxygenation is best maintained and one should not wait for a fall in saturation. The decision to perform an emergency surgical airway access should not be delayed until the child begins to desaturate.

The cricothyroid membrane has a mean vertical dimension of 2.6 mm (standard deviation [SD], 0.7) and width of 3 mm (SD, 0.6) in neonatal cadavers (mean height of 44.9 cm and a mean weight of 2 kg) as compared to adults where the dimensions vary from 8 to 19 mm (mean 13.7 mm) in the vertical dimension and from 9 to 19 mm (mean 12.4 mm) in the transverse dimension.[19,20] These anatomical variations lead to difficulty in location and demarcation of cricothyroid membrane. The cricothyroid membrane is angulated in newborn up to 60°–70° to tracheal axis as compared to adults where it is almost parallel.[21] Probably, it reaches the adult structure around the age of 5 or 6 years. Hence, when punctured with a needle, the tip might be directed towards the laryngeal inlet and hypopharynx in children.[21]

The options for emergency surgical airway access with available evidence in children include:

## For children <8 years of age

### *Tracheostomy*

In children below 8 years of age, surgical tracheostomy is the procedure of choice when skilled surgical help is available. Johansen *et al*. and Stacey *et al*. have mentioned that cricothyroidotomy can be dangerous in children and a surgical tracheostomy is the method of choice.[22-24] During tracheostomy, attempt should be made to maintain oxygenation by keeping the upper airway patent and continuously administering 100% oxygen.

However, if trained surgical help for a surgical tracheostomy is not available, then it is recommended to proceed with a transtracheal needle puncture/needle cricothyroidotomy (with a needle <4 mm diameter) and jet ventilation with a pressure regulated jet ventilation device.[18]

### *Transtracheal needle puncture/needle cricothyroidotomy*

The best strategy for emergency transtracheal needle puncture/cricothyroidotomy and oxygenation in children under 12 years of age remains unclear. In young children, especially infants and neonates, the cricothyroid membrane is small and difficult to localise, often lying immediately under the mandible, making it a less than ideal site for emergency surgical airway access.[25] Transtracheal needle puncture is, therefore, commonly proposed in this age group as opposed to needle cricothyroidotomy.[18] In children of 5–7 years, a needle cricothyroidotomy may be attempted. Overall, needle cricothyroidotomy showed a better success rate than scalpel bougie cricothyroidotomy.[26] Scalpel cricothyroidotomy is not recommended below the age of 12 years. A 16 or 18 G IV cannula is usually used for cricothyroidotomy in children as the external diameter is <4 mm, thereby reducing the chances of injury to the cricothyroid membrane or the trachea.[14] The details on technique of a needle cricothyroidotomy are discussed in the respective section in All India Difficult Airway Association 2016 Guidelines for the Management of Unanticipated Difficult Tracheal Intubation in Adults.[5]

#### Pressure regulated jet ventilation devices

Once the needle is in the trachea, it is advisable to begin with the lowest pressure (0.5 bar) and gradually increase the pressure till a visible chest rise and improvement in oxygenation is obtained.[6]

Maintaining upper airway patency to aid expiration while using a jet ventilation device is mandatory; otherwise, it can lead to barotrauma and pneumothorax. The diameter of the small bore cannula may not be enough for adequate expiration to occur. Oxygen must be continued through the upper airway.

#### Adequate time for expiration

The I: E ratio should be maintained at 1:4, so there is enough time for expiration to take place, thereby preventing barotrauma.

#### Other methods of oxygenation

Other methods of oxygenation such as Enk Oxygen Flow Modulator®, Ventrain® and Rapid $O_2$® are recommended for adults; however, its availability is limited for paediatric patients. The use of a three-way technique for oxygenation (with intermittent finger occlusion of the three-way port) is strictly not recommended in children anymore.[14]

Cricothyroidotomy cannula kinking and dislodgement should be avoided as it can lead to subcutaneous emphysema.[6]

### *Wide bore cannula cricothyroidotomy*

Most of the cannula cricothyroidotomy sets used in adults are contraindicated in children as the diameters of these devices are more than 4 mm. If used, these can cause irreversible damage to the child's airway. The APA guidelines recommend that cannulae with a diameter of more than 4 mm should not be used in children <8 years.[6]

### *Surgical cricothyroidotomy*

The dimensions of the cricothyroid membrane are too small for passing a tracheal tube.[4] The dimensions of the tube exceed that of the cricothyroid membrane, and this could fracture the cartilages of the larynx. The performance of a surgical cricothyroidotomy and passing of a tracheal tube through it is, therefore, strongly discouraged in children <12 years.

## For children older than 8 years and up to 12 years

For older children between 8 and 12 years of age, a needle cricothyroidotomy is relatively safer compared to neonates or smaller children.[27] In children older than 8 years of age, the vertical span of the cricothyroid space enlarges sufficiently to accommodate several commercially available cricothyroidotomy products. However, some of these devices have been associated with tracheal damage in animal models and therefore should be cautiously used in children.[4]

Cricothyroidotomy should be performed only for emergency oxygenation and a definitive airway, for example, a tracheostomy should be performed or secured as soon as possible. A definitive tracheostomy should be done in <40 min or else dangerous plasma levels of $CO_2$ may build up.[28]

## STEPWISE APPROACH TO MANAGEMENT OF THE UNANTICIPATED DIFFICULT INTUBATION IN CHILDREN (1–12 YEARS) REFER FIGURE. 1

It is important to remember that while following any step in the algorithm, if the oxygen saturation is not maintained or starts falling rapidly or there is bradycardia, one can bypass any step and even consider emergency surgical airway. The below-mentioned algorithm [Figure 1] is recommended to be used for children between 1 and 12 years of age. Neonates and infants have special considerations and are recommended to be managed by persons with expertise in a special setup equipped to manage them.

### Calling for help

Help should be sought at the earliest when the first difficulty in airway management is encountered. While any additional help will be useful during a difficult airway, one should try to get expert help if available. The AIDAA recommends calling for additional help when the final attempt at rescue mask ventilation fails and emergency surgical airway access is planned.

### Step 1: Mask ventilation and tracheal intubation

Maximum two attempts at intubation should be performed provided the $SpO_2$ levels are ≥95%. Final attempt should be performed by an anaesthesiologist with paediatric experience. (If unavailable, do not attempt another laryngoscopy, proceed to Step 2). Continue nasal oxygenation during apnoea and maintain depth of anaesthesia throughout. If intubation is difficult, one should change the plan in between attempts to improve the chance of success rather than repeatedly doing the same procedure. This may involve changing the position, different technique, intubating device like using a videolaryngoscope, ELM, using additional tools such as bougie or stylet or additional manoeuvres (bimanual laryngoscopy). If a Cormack–Lehane grade of 3 or above is encountered, one should abandon intubation attempts and continue mask ventilation until a definite airway management plan is made and experienced help is available. If attempts at intubation fail, resume mask ventilation using 100% oxygen.

### Step 2: Maintaining oxygenation using a supraglottic airway device

When intubation fails, insert a second generation SAD to maintain oxygenation. Maximum two attempts at SAD insertion with mask ventilation using 100% oxygen in between. Consider using an alternate type of SAD, continue nasal oxygenation and maintain the depth of anaesthesia till SAD is in place. Once SAD has been successfully inserted, effective ventilation and oxygenation will be maintained. This will provide sufficient time to think about a further airway management plan. The safest option will be to wake up the child if it is a non-emergency surgery. If it is an emergency procedure and continuation of the procedure is safe using SAD, one may proceed keeping in mind that this is a high-risk option. One must remember that this patient had a failed intubation and any trauma during attempts may produce airway oedema which may worsen during the course of the surgery. If the procedure is unsafe to be continued using an SAD and the procedure is an emergency major surgery, one should consider intubation through the SAD using a flexible fibre-optic bronchoscope if the expertise is available. In very rare situations, a tracheostomy may be necessary despite successful ventilation using the SAD.

### Step 3: One last attempt at mask ventilation

When SAD insertion fails, one final attempt at mask ventilation should be tried after ensuring neuromuscular blockade using the optimal technique for mask ventilation and an oropharyngeal/nasopharyngeal airway if required. Ensure that the mouth is open and soft tissue is not being pushed by the finger while mask holding. Upper airway should be kept patent with chin lift and jaw thrust. Ensure complete neuromuscular blockade during the final attempt at mask ventilation before proceeding to emergency surgical airway access. Insert an orogastric or nasogastric tube to decompress the stomach and prevent the splinting of diaphragm. If face mask ventilation is successful, the patient should be woken up after reversal of the neuromuscular blockade. Continue nasal oxygenation. When there is complete ventilation failure, call for additional help and proceed to perform emergency surgical airway access before the patient desaturates.

### Step 4: Emergency surgical airway access

Continue nasal oxygen and efforts at rescue face mask ventilation.

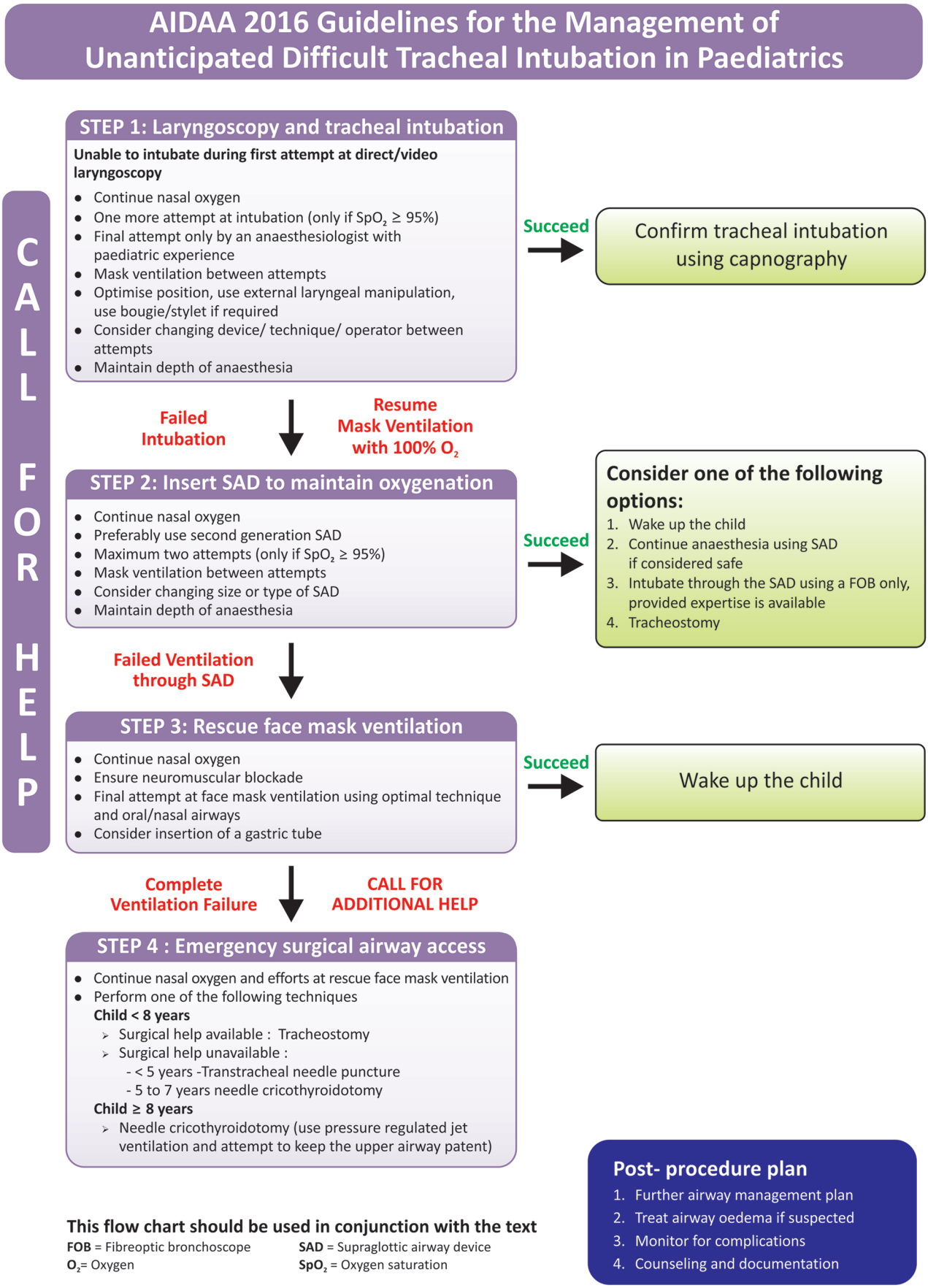


**Figure 1:** All India Difficult Airway Association 2016 algorithm for the Management of Unanticipated Difficult Tracheal Intubation in Paediatrics

For children <8 years of age, a surgical tracheostomy is the first choice if skilled surgical help is available. If skilled help is not available then a transtracheal needle puncture for children <5 years or a needle cricothyroidotomy for children between 5 and 7 years may be performed. To maintain oxygenation through these devices, pressure-regulated jet ventilation is needed. A prerequisite to use jet ventilation is maintenance of patency of upper airway.

For children between 8 and 12 years, perform emergency surgical airway access using needle cricothyroidotomy. Maintain oxygenation using pressure-regulated jet ventilation with upper airway patency and adequate time for expiration.

A tracheostomy should be performed as soon as feasible (preferably in <40 min).

### Post-procedure care

Verbal communication and counselling of the parents and documentation of the airway difficulty and its management in the case record are mandatory. In addition, an airway alert form should be filled by the attending physician to complete the documentation and to have a standard reporting of a difficult airway. Complications are monitored and airway oedema if it occurs should be treated.

## SUMMARY

The guidelines are meant to be used for children between 1 and 12 years of age. The guidelines recommend the optimum technique for face mask ventilation, nasal insufflation of oxygen during apnoea in all patients and calling for help if the initial attempt at intubation is unsuccessful. The maximum number of attempts at intubation should be limited to two. When intubation fails, a SAD, preferably a second-generation SAD, should be inserted, with a maximum of two attempts at SAD insertion. If SAD insertion fails, one final attempt at mask ventilation should be tried after ensuring neuromuscular blockade using the optimal technique for mask ventilation, and decompression of the stomach, if distended. If mask ventilation is successful, the patient should be woken up. If ventilation is still not possible, complete ventilation failure is declared, and after call for additional help, perform emergency surgical airway access. The choice of technique for emergency surgical airway technique would depend on the age of the child. Parent and/or patient counselling, documentation of the airway difficulty and filling of an airway alert must be done.

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### Conflicts of interest

There are no conflicts of interest.

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