

Managing the newborn infant with a difficult airway

Airway management is a core skill in neonatology and proficiency in managing the difficult airway may be life-saving in an acute emergency. In the following article the authors outline a three-step intervention which aims to improve neonatal airway management within the Southern West Midlands Newborn Network. It encompasses a structured skills training programme in airway management combined with simple guidelines, to enable rapid decisions to be made at times of crises. Frequent reinforcement of such training should lead to skill retention, improved knowledge, a boosting of confidence and may improve patient outcomes.

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Key points

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1. A structured training programme in airway management is needed for trainees to achieve competency in essential procedural skills.
2. The presented guideline for difficult airway management in the newborn enables rapid decisions to be made in times of crises.
3. Indirect laryngoscopy is the gold standard for managing difficult endotracheal intubation.
4. Video laryngoscopy enhances intubation training by facilitating visualisation of airway anatomy.

At birth, 5-10% of all infants will require assisted ventilation¹. The rapid provision of effective positive pressure ventilation is the single most important predictor of successful neonatal resuscitation². Ineffective ventilatory support leads to hypoxia and may result in increased morbidity and mortality.

Endotracheal intubation of newborn infants is a skilled procedure performed most often by advanced neonatal nurse practitioners, paediatric trainees and other non-career grade practitioners. Although competency in the intubation of newborn infants, including extremely premature babies and those with congenital malformation, is a requisite for completion of the RCPCH curriculum in neonatal medicine, training in airway management tends to be opportunistic and the individual experience of paediatric trainees is often variable. Furthermore, during the last decade the requirements of Modernising Medical Careers³ and the European Working Time Directive⁴ have combined to reduce both the time postgraduate trainees spend in their training programmes and their working hours and subsequently substantially reduced their opportunities for experiential learning and training. In medicine there is a large body of evidence showing a correlation between expertise and experience^{5,6} and not surprisingly, today's trainees are less experienced than trainees from earlier generations with some reports indicating that third year paediatric trainees failed in their attempts to intubate infants within two attempts in up to 40% of cases⁷.

If the infant has a craniofacial abnormality, management of the airway may become even more difficult and challenging (see **TABLE 1**). It is most important therefore that as trainees' opportunities for training are reduced, structured training programmes to teach essential and potentially life-saving procedural skills such as intubation are provided as part of the core training in neonatal medicine.

- Achondroplasia
- Beckwith Wiedemann syndrome
- Cleft palate
- Craniofacial dysostosis: Apert, Crouzon and Pfeiffer's syndromes
- Cystic hygroma
- Down's syndrome
- Fibrodysplasia ossificans progressiva
- Freeman-Sheldon syndrome
- Goldenhar syndrome
- Hemi facial microsomia
- Klippel-Feil anomaly
- Laryngeal cysts
- Mandibulofacial dysostosis
- Mucopolysaccharidoses
- Pierre Robin sequence
- Rubenstein-Taybe syndrome
- Treacher-Collins syndrome
- Vascular malformations: haemangioma/ arteriovenous malformations involving the face or airway
- Venous lymphatic malformation

TABLE 1 Craniofacial anomalies that may compromise the airway in the newborn period^{8,9}.

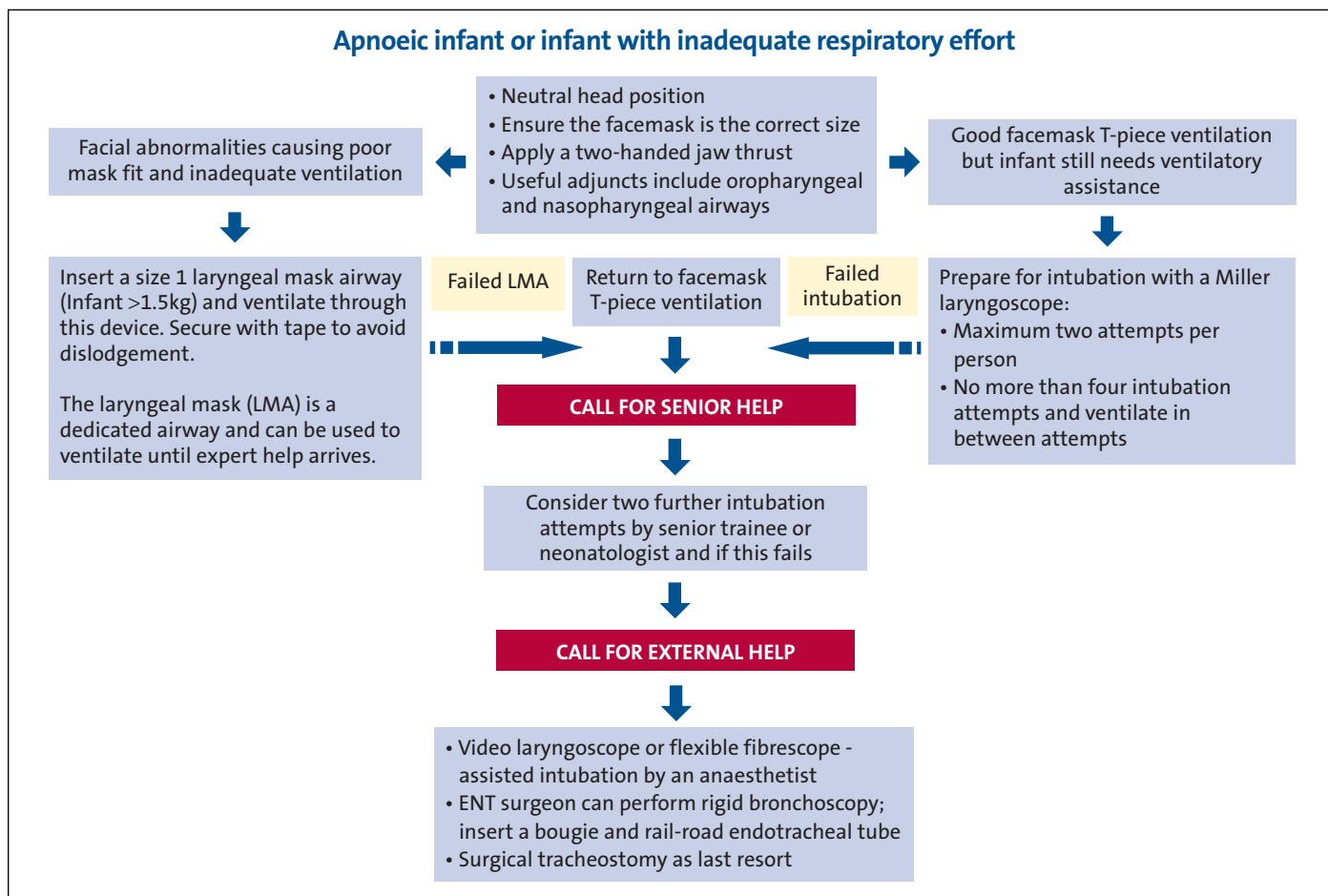


FIGURE 1 Difficult airway management in the newborn.

Currently there is no standard UK protocol for the management of a difficult neonatal airway and many neonatal units do not stock the equipment required for advanced airway techniques. In addition, none of the hospitals that deliver babies in the Southern West Midlands Newborn Network have a dedicated paediatric anaesthetist on site at all times to offer expert support if an emergency arises. The authors feel strongly that these issues need to be addressed as, although rare, the 'can't ventilate adequately, can't intubate' scenario is life threatening. Morbidity and mortality is associated with repeated intubation attempts when airway oedema can result in a 'can't ventilate, can't intubate' scenario. Therefore in the following article a programme to improve neonatal airway management within the Southern West Midlands Newborn Network is proposed.

Step 1: Establishing a difficult airway management algorithm for newborn infants

The proposed Difficult Airway Management Algorithm for Newborn Infants is illustrated in **FIGURE 1**.

Can't ventilate adequately, can't intubate

If on initial assessment the infant is apnoeic or has inadequate respiratory effort then the resuscitator must attempt to deliver positive pressure ventilation. The infant's head should be placed into the neutral position. A correctly sized face mask should be positioned, encircling the infant's mouth and nose and inflation breaths should be delivered using the T-piece. If there is difficulty creating a tight seal on the face-mask a two-handed jaw thrust should be applied with the help of a second healthcare professional.

If facemask T-piece ventilation remains inadequate an airway adjunct should be used. The oropharyngeal airway (Guedel airway) is available in a variety of sizes for infants and can help maintain a patent airway channel between the tongue and the posterior pharyngeal wall, by displacing the tongue anteriorly. It is important to size the oropharyngeal airway correctly: too small an airway is ineffective and may worsen airway obstruction and too large an airway may cause laryngospasm. If the airway is the correct size the tip should reach the angle of the jaw when the flange is aligned with the centre of the lips¹⁰. This

airway adjunct may be particularly useful in the management of infants with Down's syndrome in whom hypotonia may cause posterior tongue displacement. A nasopharyngeal airway may be used to relieve upper airway obstruction in infants with Pierre-Robin sequence, craniofacial anomalies and micrognathia. As neonatal nasopharyngeal airways are not commercially available, a shortened endotracheal tube (ETT) may be used. The required nasopharyngeal airway length can be estimated from the distance between the nasal tip and the tragus of the ear. The airway should be lubricated and passed through the nostril, posteriorly along the floor of the nose into the pharynx. A correctly sized nasopharyngeal airway will fit snugly in the nostril without causing blanching of the alae nasi¹⁰.

If the resuscitator is still unable to oxygenate the infant, as seen by poor chest movement, cyanosis or bradycardia they must call for senior help. At this stage, a supraglottic airway may be used for airway rescue if bag and mask ventilation has failed¹¹. It is an effective modality for ventilation and studies have shown laryngeal mask airways (LMAs) to be quick

and easy to insert¹². Gandini's prospective observational study reported successful resuscitation and ventilation of 103 newborn infants using an LMA and of these newborns 29 were low birthweight, with six weighing between 1000 and 1499 grams¹³. However, although several infant LMA devices are now available their usefulness remains limited in extreme premature infants due to their size. If LMA insertion is successful the infant should be ventilated through the LMA and transferred to the neonatal unit for intubation by a senior neonatologist.

If LMA insertion is unsuccessful the resuscitation team should prepare for intubation. The infant should be appropriately positioned. A roll under the shoulders may be helpful but over-extension of the neck should be avoided. A straight bladed Miller laryngoscope is preferred in infants as its narrow tip can help lift the epiglottis to expose the vocal cords¹⁴. Gentle external cricoid pressure may further help to drop the vocal cords into view. Once a clear view of the vocal cords is obtained the ETT should be inserted from a lateral approach. An introducer may be helpful if there are difficulties in guiding the ETT through the cords.

If direct laryngoscopy proves difficult it is important to limit the number of attempts made in order to reduce the risk of upper airway trauma, oedema and bleeding. Therefore it is suggested that each person should have a maximum of two attempts at intubation and no more than four attempts should be made in total. This guidance is in line with the Difficult Airway Society's adult algorithms^{15,16}. If intubation is successful the infant should be transferred to the neonatal unit for further stabilisation.

Where direct laryngoscopy has failed, the assistance of the most experienced neonatologist should be sought. A neonatologist or anaesthetist experienced in the use of videolaryngoscopy may make



FIGURE 2 The Storz DCI video laryngoscope.

additional attempts to intubate the infant using a video laryngoscope. Indirect laryngoscopy is the gold standard for managing difficult endotracheal intubation, especially in the case of craniofacial abnormalities. Studies have shown that video laryngoscopy improves the glottic view in children when compared to direct laryngoscopy^{17,18}. There are currently four devices that can be used in children under the age of two; the Airtraq disposable optical laryngoscope, the Glidescope video laryngoscope, Truview PCD Infant and the Storz DCI video laryngoscope (SVL)¹⁹ (**FIGURE 2**). The SVL has the shortest blade and therefore can be used in small preterm infants with limited mouth opening; as demonstrated by Vanderhal et al who reported 48 successful intubations in infants ranging from 530 to 6795g²⁰.

If indirect laryngoscopy is unsuccessful immediate expert help should be sought. Notably the cricothyroid space is too small to cannulate in neonates and so a surgical cricothyrotomy is not a suitable procedure in this age group. A paediatric ENT surgeon may perform rigid bronchoscopy and may use an introducer placed in the trachea to facilitate intubation by rail-roading an ETT, if video laryngoscopy has failed. An ENT surgeon may perform a life-saving surgical tracheostomy if all the above measures have failed.

Can ventilate, can't intubate

If on initial assessment facemask T-piece ventilation is effective, as demonstrated by good chest expansion and a rising heart rate, but the infant still needs assistance then the resuscitator should prepare for intubation.

Each intubation attempt should be limited to 30 seconds to minimise the risk of hypoxia. If the intubation attempt is unsuccessful then the resuscitator should return to facemask T-piece ventilation to optimise oxygenation. Each person should have a maximum of two attempts at intubation, with no more than four attempts being made in total. This limits trauma to the airway which could convert a 'can ventilate, can't intubate scenario' into the life threatening 'can't ventilate, can't intubate' scenario. If intubation is unsuccessful consider inserting an LMA as a rescue device and ventilating through the device.

If both direct laryngoscopy and LMA insertion fail, indirect laryngoscopy should be used to attempt intubation. However, if

- Infant oropharyngeal airways
- Infant nasopharyngeal airways
- Infant laryngeal mask airways
- Introducers
- Endotracheal tubes ranging from size 2-4.5
- Endotracheal tube fixation equipment
- Miller laryngoscope and blades
- Storz C-Mac video laryngoscope
- Miller 0 and Miller 1 blades for the C-Mac Storz video laryngoscope

FIGURE 3 Difficult neonatal airway equipment set.

this technique is also unsuccessful then expert help from an ENT surgeon or paediatric anaesthetist should be sought, to enable a life-saving surgical tracheostomy or rigid bronchoscopy to be performed.

Step 2: Preparing a difficult airway equipment set

An easy to access, well-maintained difficult airway trolley is integral to the successful delivery of expert neonatal airway management. The trolley should be kept in a specially allocated area to ensure rapid retrieval when it is required. Drawers should be arranged with increasing invasiveness from top to bottom. An equipment checklist should be attached to the trolley, and a staff member should be designated to check and restock the trolley on a daily basis. Sterility, cleaning and maintenance instructions should be stored with the equipment and these should be closely adhered to, to ensure longevity and maximal performance of the equipment. Suggested equipment for a difficult airway set is displayed in **FIGURE 3**.

Step 3: Improving training in intubation and difficult airway management

Standard teaching of direct laryngoscopy can be problematic. It is difficult to give a practical demonstration of the neonatal airway anatomy and the intubation process to a learner, while carrying out the procedure, and standing to one side to allow the trainee a hasty view of the vocal cords is not ideal. Furthermore providing supervision and assistance to the inexperienced trainee can be challenging because one is wholly reliant on the trainee's ability to give feedback on what they can see through the laryngoscope, and providing an accurate description can be difficult for trainees with limited experience.

Recent studies have shown that video laryngoscopy enhances intubation training by facilitating visualisation of airway anatomy; this subsequently improves performance and promotes increased trainee confidence levels^{21,22}. The design of the SVL allows for improved training in both direct and indirect videolaryngoscopy. It can be used as a conventional Miller laryngoscope; with its 14 x 25cm monitor screen enabling colleagues to see the operator's view of the glottis¹⁹. This can advance trainees' understanding of upper airway anatomy prior to them attempting the procedure themselves. Moreover the supervisor can provide trainees with better guidance during the intubation, and can see for themselves the effectiveness of a change in position or the application of cricoid pressure.

An audio-video teaching package is currently under development in the Heart of England Foundation Trust, to support the video laryngoscopy training programme. The aim is to aid senior paediatric trainees and consultants in the development of indirect laryngoscopy skills and increase their ability to manage the difficult neonatal airway.

Research has demonstrated that gaining experience in what has been learnt is an integral step in the acquisition of knowledge²³. Furthermore for the successful incorporation of a new technique into clinical practice the practitioners must become familiar with the equipment and comfortable with the method of its use²⁴; and these factors are only derived from practice. The authors plan to incorporate the use of the SVL into daily practice and will encourage operators to record an image of the glottic view at the point of intubation. This image will then become part of the infant's medical record as well as serving as evidence of the operator's experience and competency.

To assess and measure the impact of the training programme an audit project comparing the rates of successful intubations with and without the use of a SVL by trainees at different levels of seniority will be conducted. As the provision of such a service will be unique in the UK, studies to examine the learning curve of using the SVL and whether the skills so acquired are retained will be carried out. The aim is to first establish an in-house training programme for unit trainees and senior neonatal members of staff. Once this is firmly established the

training programme will be offered to other neonatal trainees within the region as part of their formal training in neonatal medicine. At a later stage, the programme will be available to other healthcare staff, including non-career grade paediatricians, physician assistants and advanced neonatal nurse practitioners.

Hopefully these studies will contribute to the growing evidence on the utility of both direct and indirect video laryngoscopy in training neonatal specialists to manage the airways of infants requiring respiratory support, leading to this scheme being adopted nationally.

Conclusion

Neonatal trainees need to acquire several procedural skills during their training. Airway management is one such core skill and proficiency in managing the difficult airway may be life-saving in an acute emergency. The recent introduction of shorter training periods for UK postgraduate medical and surgical trainees along with the reduction in working hours due to the Working Time Regulations, makes a strong case for the provision of a structured programme in airway management in order for trainees to achieve proficiency in essential procedural skills. Skills training in airway management with simple guidelines enable rapid decisions to be made at times of crises and the frequent reinforcement of such training leads to skill retention, improved knowledge, a boosting of confidence and may improve patient outcomes.

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