Managing the Difficult Airway in the Neonate -
A Framework for Practice

For Consultation

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1 Recommendations

a. This framework document should be used to ensure that in any centre in which neonates are looked after there is an agreed approach to the difficult neonatal airway, including clear identification of resources available to be used and which teams in the hospital are responsible for providing help within the agreed approach.

b. The equipment required to execute the agreed approach should be readily available and the team who may be involved in actioning the plan should be familiar with its use.

c. Regular simulation (in situ if possible) should be done inclusive of all teams who need to be involved, to practice response to the situation of a difficult neonatal airway. This must include debriefing and dissemination of learning, with a focus on both technical and non-technical aspects (human factors).

d. Any centre where babies are delivered should have a designated neonatal airway lead whose responsibilities include:

   i. Putting a specific plan in place for management of the unexpectedly difficult neonatal airway, including provision of equipment appropriate to the centre for managing a difficult airway, or access to these if present elsewhere in the hospital.

   ii. Liaising with the wider hospital medical team (anaesthesia, ED, ENT, respiratory) to ensure there are plans in place for advanced help to be accessed in the situation of a difficult airway arising.

   iii. Ensuring regular simulation and skills practice are completed.

   iv. Ensuring that when the difficult airways process is used there is a case review and debriefing, from which relevant learning is shared.

   v. Being the key contact to receive/communicate plans for management at birth after specialist antenatal review, in case of unexpected delivery (see below).

e. Antenatal MDT liaison should occur where likely airway problems are diagnosed on antenatal scans and delivery planned for in a specialist centre. Written information should be provided to the family of the plans for delivery and written correspondence sent to other centres where delivery may occur to allow them to plan for unplanned delivery outside the specialist centre.
2 Introduction

Care of the neonate occurs in a wide variety of clinical, and non-clinical settings. Each setting will present its own logistic challenges and uniquely available resources when it comes to managing both expectedly, and unexpectedly, difficult clinical situations. The situation of managing an unexpectedly difficult airway at any age is one which is, by definition, time critical.

Neonatal care in the first ten minutes of life is focussed around aeration of the lung\textsuperscript{1-3} so any problem in effectively opening and maintaining the airway is immediately problematic. Likewise, the mode of arrest in the older neonate is usually respiratory and so in the operating theatre, emergency department, or post-natal ward, managing the airway remains key. The occurrence of a true difficult airway may be rare across the neonatal population, but faced with a difficult airway in person it becomes, quite literally, a time-limited matter of life or death. In any centre looking after neonates there has to be a clear, defined, in-house approach to this emergency as there will be little or no chance of help arriving in time from outside the centre in time to preserve life.

There is no doubt that the wider experience from anaesthesia is that an approach to the difficult airway, plans in place and routinely practiced, gives the best opportunity for a team to be fluid in response to the technical and non-technical stresses of a difficult airway situation.

Acknowledging the different resources available in different settings, this Framework for Practice provides a template designed to be adapted locally for use in responding to the difficult neonatal airway in a stepwise fashion, tailored to the resources available locally in any given setting in which neonatal care is provided. The plan generated can then be used in drills and simulation to allow the clinical team on the ground to practice their response to a difficult airway, should they encounter it in practice.
3 Process and scope of framework

This Framework for Practice has been compiled by a multidisciplinary working group drawn from a variety of specialities with interest in the neonatal airway, and representing a variety of Societies with expertise and interest in managing the difficult airway.

This Framework for Practice primarily provides an approach to the unanticipated difficult airway in neonates with a post-conceptional age of no greater than 44 weeks, though many of the principles will be unchanged in older infants than this.

It is acknowledged that for a neonate, there may be antenatal diagnosis or high levels of suspicion of the likelihood of a difficult airway at birth. On these occasions there should be multidisciplinary planning, clearly outlining the need for presence of ENT/respiratory teams at delivery, and consideration of use of specialist peripartum techniques such as an ExIT procedure. There is neither intention for this Framework for Practice to replace the process of antenatal planning, nor suggestion that expert peripartum airway management teams should change what works for them in their own place of work in the case of an antenatally suspected difficult airway. It would, though, be perfectly acceptable for such teams to adapt the action plan in this Framework for Practice to their needs if they wished.

Some information about antenatal diagnosis is included in this Framework for Practice both for interest and because it is possible for babies planned for delivery in a specialist ‘airway’ centre to be delivered unexpectedly in other centres.

Similarly, this Framework for Practice, which describes an escalation process in the difficult airway situation, is not intended to be used in routine intubations. It is expected that clinicians practicing in their own centres will have their own intubation checklist and approach to follow for the majority of intubations. ‘Routine’ intubation may evolve into an unexpectedly difficult airway situation and there a locally agreed threshold for when a difficult airway situation should be declared.
4  Background

There are at present, no set national guidelines for the management of the difficult airway in neonates, though guidelines do exist for management of the difficult airway in paediatric and adult age-groups through the Difficult Airways Society. The ‘difficult’ airway situation arises most frequently in older age groups at intubation for surgical procedures, thus is (for the most part) in a controlled and well-resourced environment, with an airway expert present. In the neonate (especially at time of birth) need for intubation may be unexpected, and birth tends to happen in more diverse environments than surgery.

Each year approximately 700,000 neonates are born in England and Wales, of which nearly 105,000 (1 in 7) will be admitted to the neonatal intensive care unit. This may be due to prematurity, medical condition or due to complications at birth. Not all infants admitted to a neonatal unit will require respiratory support, and of those that do, not all will require invasive support by placement of an endotracheal tube. Increasingly, non-invasive respiratory support with less invasive surfactant administration is being used to circumvent the need for intubation in the group of babies who can be most technically challenging to intubate by virtue of their small size.

4.1  Anatomical Differences Between the Neonate and Older Children

The respiratory tract shares a common embryological origin with the foregut, branching from the endoderm to form the respiratory bud around 5-7 weeks gestation. The ‘airway’ relevant to management of the difficult airway (from lips and nostrils to carina) is recognisably formed by these gestations.

The key differences between neonatal airways and older children/adults are:

- Neonates are preferential nasal breathers but can breathe through the mouth, though not effectively enough to sustain respiration with concurrent nasal occlusion.
- The tongue is relatively larger. Congenital macroglossia and/or micrognathia, and clefting of the palate may all allow the tongue to obstruct both oro- and/or nasopharynx simultaneously.
Figure 1: Anatomical comparison of the adult and infant airway

- The epiglottis is proportionally longer, narrower, larger, and less flexible; often described as omega-shaped. This shape combined with short aryepiglottic folds may lead to inspiratory collapse of the upper airway to the point of obstruction (laryngomalacia).

- The larynx lies higher relative to the cervical vertebrae (descending to lie in the ‘adult’ position by around 6 years of age)

- The intrinsic laryngeal shape differs, being ‘cone-shaped’, and narrowest point at the level of the cricoid cartilage (rather than at the glottis opening as in older patients).

- A lack of encircling tracheal cartilage posteriorly (where the trachealis muscle lies unsupported) may be a source of collapse and obstruction of the airway during inspiration (tracheomalacia).

The laryngeal position and tracheal flexibility explain the importance of aiming for a ‘neutral’ head position when positioning the neonate for mask ventilation, and why not doing so risks inducing airway obstruction.

Development of subglottic stenosis due to the trauma of long-term ventilation is one of the commoner reasons for unexpectedly challenging reintubation of an ex-preterm neonate requiring a smaller-sized endotracheal tube than anticipated.
Understanding neonatal airway anatomy is important to anyone looking after neonates so pharyngeal obstruction can be managed, views of the larynx/grade of intubation accurately assessed, and an appreciation of possible causes of obstruction which may occur below laryngeal level.

### 4.2 The difficult airway

A ‘difficult airway’ may be defined as “…a clinical situation in which a trained Practitioner experiences difficulty with face mask ventilation, difficulty with tracheal intubation, or both”.

Difficulty with airway management at induction of anaesthesia may cause cardiac arrest, brain injury, and death in children. Intrauterine preparation for birth (at full term) is the only occasion in any human life where significant physiological adaptation to sustained hypoxia occurs, offering potential for some resilience in the circumstance of a difficult airway problem, depending on the nature of the preceding delivery. Around 1-2 per 1000 liveborn babies will require some assistance in breathing to transition successfully, and of these between 2-10% may not respond to mask ventilation leading to an attempt at intubation.

Unwell babies at delivery, in NICU, or in theatre may lack physiological reserve predisposing to rapid compromise in the circumstance of loss of respiratory support or induction of anaesthesia removing innate respiratory effort.

Skilled management of the neonatal airway is required even for anatomically normal neonatal airways. Airway adjuncts may be effective in assisting the practitioner to manage the neonatal airway including when tracheal intubation has not been possible. An airway adjunct is any medical device used to open or maintain open the airway. There are limitations of adjunct availability with respect to the neonate, especially the preterm infant, where none small enough may be available.

Other airway adjuncts aid endotracheal tube placement or provide alternative means to deliver gas to the lungs when conventional intubation is not possible. These include video laryngoscopes and supraglottic airway devices (SADs) such as the Laryngeal Mask Airway (LMA). Such adjuncts are emerging technologies in the neonate with evidence to support neonatal use increasing as companies manufacture equipment suitable for use at
term and earlier gestations\textsuperscript{22-24}. The cost/use of video laryngoscopes remains potentially prohibitive for smaller neonatal units in the NHS though increasing use in adult anaesthesia offers the opportunity for it to be available within a hospital if not immediately on the neonatal unit.

The endpoint of ineffective airway management, potentially leading to fatal consequences, is when a “can’t intubate can’t ventilate (CICV)” clinical scenario occurs. The Resuscitation Council’s Newborn Life Support (2016) guidance emphasises the importance of airway management as the fundamental component of neonatal stabilisation and/or resuscitation at birth. The Advanced Resuscitation of the Newborn Infant (ARNI) course develops this approach further to include the technical and non-technical skills required to manage the baby and the clinical team with a difficult airway scenario. There is an increasing awareness of the importance of human factors, including task fixation and systems optimisation, in successful preparation for and dealing with the difficult airway situation\textsuperscript{25}.

Practices in managing intubation of babies differ significantly, often dependent on the clinical setting in which care of the neonate is being delivered\textsuperscript{26}. A difficult airways approach or plan has been shown not to be present universally\textsuperscript{27} in UK paediatric and neonatal intensive care settings. Whitby et al\textsuperscript{28} estimated that only 2/3 of neonatal units had specific difficult airways equipment available on NICU and only 4 of 60 had a specific ‘can’t intubate, can’t ventilate policy’. Variation in practice is particularly apparent in approaches to number/quality/length of intubation attempts by one practitioner\textsuperscript{11,29}.

An important consideration in the management of the difficult airway is the escalation pathway if the most senior experienced neonatologist/paediatrician present is unable to stabilize the airway of an infant. Seeking expert help from the ear, nose, and throat (ENT) surgeons\textsuperscript{11} or Paediatric Respiratory Specialists with airway expertise is an ideal end-point of such escalation. Fundamentally not all neonatal units, delivery suites, theatres, or emergency departments have immediate access to paediatric ENT surgeons or paediatric anaesthetics on site. However, most hospitals have practitioners with generic ‘airway skills’ outside the arena of neonatal care who could be enlisted to help in emergencies. A ‘hub and spoke’ model for training local teams using the regional airway teams has been used successfully in the South of England to equip non-specialist centres with skills to manage the
difficult paediatric airway, built around regular updates and collaborative in-situ simulation with the multidisciplinary team identified for these emergencies\textsuperscript{30}.

By providing teams who look after neonates a means to allow formulation of a site-specific plan for when and how to escalate management of the difficult neonatal airway, this Framework for Practice aims to support those healthcare professionals looking after neonates in any clinical environment. Furthermore the document should help these clinicians to investigate, develop and cement links between skilled practitioners in airway management across their hospital, and their wider region, in such a way that the occurrence of a ‘difficult airway’ in a neonate will trigger a well-practiced response, mobilising staff and resources in a timely fashion, which has the potential to prevent a bad outcome.
5 Anticipating the difficult neonatal airway

There are broadly two instances where there is opportunity for a difficult airway to be anticipated in the neonate:

1. Antenatally diagnosed problems impacting the airway (anatomical and neuromuscular)
2. At time of planned airway intervention, especially extubation or planned intubation

In all other circumstances, it is likely that a difficult airway may not be anticipated, but may still occur.

Difficult airways may, in broad terms (in order of likelihood), be due to:

1) External airway compression from neck masses
2) Structural compromise to the airway
3) Craniofacial structural abnormalities including cleft palate, cranial dysostosis and syndromes affecting maxillofacial structures
4) Neuromuscular abnormalities

A ‘trigger list’ of diagnoses where difficulty with the airway during provision of respiratory support should be anticipated is provided in the resource materials document. In patients in whom these conditions are diagnosed or suspected, extra care should be taken to plan for management of the difficult airway if any airway management is needed.

5.1 Antenatal diagnosis and prediction of the difficult airway

In such cases when a difficult airway is anticipated before birth, Wyllie et al. emphasise the importance of an antenatal birth plan to be in place for delivery at an appropriate centre where they have appropriately skilled practitioners and equipment to deal with any difficulties with the airway. However, difficult airway patients may deliver away from the planned centre or a difficulty may only be recognized during the process of resuscitation and intubation, where internal anatomical changes gave previous clue to their presence.

Most often a detailed scan to assess to fetal anatomy at around 18-22 weeks will be done: this is when a fetal anomaly that may complicate the airway is most likely to be diagnosed. Occasionally, a scan performed later in pregnancy, for example to assess fetal growth or
wellbeing, or because of suspected polyhydramnios, may reveal a potential airway problem. While sometimes a genetic diagnosis will have been made, this may not make the implications for the fetal airway any more certain. Rarely, fetal interventions (such as placement of an endotracheal balloon in utero to attempt to treat fetal diaphragmatic hernia) may lead to a compromised airway at delivery.

Maternity units suspicious of a fetal anomaly will most often refer these women for review in a regional fetal medicine centre. Here multimodal, multi-disciplinary team assessment utilising three-dimensional ultrasound, and/or fetal MRI may be used to characterise the abnormality as precisely as possible and assess the implications for airway management at birth. It is essential that a multi-disciplinary, anticipatory plan of care is drawn up between relevant specialities including fetal medicine, obstetrics, neonatology and, for example, paediatric surgical, respiratory and anaesthetic specialities. It is recognised that not all perinatal centres will provide specialist care for babies diagnosed with likely airway problems and so within each region, there should exist clear regional referral pathways to optimise the likelihood that babies needing specialist airway intervention at, or soon after birth, receive it.

Aspects to be covered in this anticipatory plan must include:

- Planned place and mode of delivery
- Staff and equipment to be alerted and/or to be present at the time of birth
- Contingency plans in the event of an unplanned delivery due to unexpected complications
- Consideration of hospice/palliative care team involvement if appropriate
- Consideration of extended admission to the planned maternity unit (in advance of delivery) if - for example - significant polyhydramnios develops, increasing the risk of preterm delivery and/or membrane rupture

In some instances, a plan for delivery and stabilisation while the fetus/neonate is being oxygenated via the placental circulation will be considered - the “Ex-utero Intrapartum Treatment” or ExIT procedure. Regional perinatal centres should develop their own guidelines and protocols, linking into their local maternity network, for occasions when a
fetus that may be a candidate for this procedure is identified. In some instances, this may mean care being shared with another centre if staff experienced in such a procedure is limited. Centralisation of these procedures and designating a specific ‘ExIT team’ may help to concentrate expertise in performing these procedures. The team would be encouraged to perform ‘dry runs’ well in advance of any planned ExIT procedure to ensure that the procedure is conducted with as few complications as possible. For a summary of antenatal care including ExIT, see Ryan, Somme and Crombleholme.\(^2\)

![Flowchart for assessment on antenatally anomaly suspected to include a difficult airway](image)

**Figure 2: flowchart for assessment on antenatally anomaly suspected to include a difficult airway**

### 5.2 Anticipation difficult airway at time of planned extubation or intubation

Any planned intubation or extubation is an opportunity to anticipate and plan for a difficult airway. It is clear that a standardised approach to management of the airway (including the difficult airway and ‘can’t intubate/can’t ventilate’ situations) has, in adult medicine, reduced the number of critical incidents in which something goes awry during intubation.
However, the rate of incidents experienced at extubation has not reduced, so while less frequent, they now comprise a greater proportion of the number of incidents in airway management leading to harm. In the neonatal population, there are a number of babies at high risk of complications at re-intubation such as babies born extremely preterm intubated for long periods of time, those who have had surgery (e.g. PDA ligation) and those who have grown poorly. For this reason, we recommend that prior to extubation, there is a set local process for agreeing the timing of extubation and subsequent assessment of post-intubation progress including thresholds for intervention/reintubation set by the extubating team. This process should include consideration of what to do if the airway becomes difficult to manage and there is a good argument for an ‘extubation checklist’ approach to be considered as routinely as an ‘intubation checklist’. Likewise, for neonates who need to be intubated for planned procedures should be assessed in the context of whether they are at risk of having a difficult airway event based on their known neonatal course.

6 Equipment and Human Factors

This framework provides a template for any centre looking after neonates to put in place the processes, people and equipment to address the situation of a difficult neonatal airway. This implicitly recognises that in the event, managing the team in a time critical emergency situation requires the team to be well organised, well drilled, and familiar with the equipment they will be using. The human factors which impact the teamworking and team performance can be broadly considered under the headings of organisational factors and individual factors. These are discussed in more detail in the resource materials document. As outlined in section 10, simulation and education are key in modelling human factors for the specific occasion of a difficult neonatal airway. Repeated multidisciplinary simulation to test the systems, equipment and deployment of the team will identify areas where human factors need to be accounted for and process modified. Some of the specific human factors relevant to deploying the algorithm in the framework, such as when to declare the emergency, using ‘challenge and response’, identifying an airway lead, and organising the difficult airway equipment are covered in section 8.

The resource materials document also contains a detailed review of what equipment is available for management of the airway. As a minimum to establish a difficult airway box,
the following are recommended for consideration in addition to the basic equipment one might use for initiating airway management in a baby:

- Specific difficult airway plan (the Algorithm from this framework)
- Supraglottic Airway Devices
- Different Types of laryngoscope blade for direct laryngoscope
- Neonatal Bougies/Magills Forceps/small ET tubes (2.0mm ID)
- Indirect laryngoscope system
- Video laryngoscope system
- Access to medicines for intubation
- Equipment for ENT intubation and/or surgical airway

Though not all centres will be able to have immediate access to the complete set of equipment that might be desired, most hospitals will have this equipment within the building and the key is therefore ensuring processes exist to obtain it in a timely fashion in an emergency.

**Front of neck access (FONA)**

Neonatal airway anatomy, the shortness of the neonatal neck and the relative thickness of the anterior neck tissues mean that even under general anaesthetic a surgical airway (tracheostomy) is unlikely to be possible in babies less than <2kg or <36 weeks corrected gestation. In adults and older children, the anatomy of the neck makes needle cricothyroidotomy a potential rescue technique in a can’t intubate/can’t ventilate. In neonates, likewise, needle cricothyroidotomy is not likely to be successful. It is therefore not included in this framework as a suggested option, and if tracheostomy is an option in ‘Plan D’ it must only be attempted by appropriately trained surgical personnel. If centres choose to include needle cricothyroidotomy as a last resort option in neonates, then it should be agreed by whom and when to use it, as it has such a low probability of working.
7 Drugs and the difficult airway

7.1 The role of drugs in the difficult airway

It is not the purpose of this document to recommend a drug or combination of drugs for routine or emergency use for neonatal intubation. Individual units have established policies, and the circumstances of the intubation will vary in degree of urgency, the place where the baby is being managed and the experience and training of the clinician who is managing the airway. Drugs and drug combinations given by neonatologists for elective or semi urgent intubation on the NNU will differ from those used by anaesthetists in the operating theatre reflecting different circumstances, familiarity with certain drugs and access to inhalational agents.

If a difficult airway is anticipated, decisions and preparation of drugs will be made in advance. However, in some cases, difficulty will not have been predicted and only becomes apparent after sedation, anaesthesia and possibly muscle relaxants have already been given. Local centres should refer to their own protocols and pharmacopoeias when choosing which agents, if any, they will use in the context of the difficult airway. In principle, agents chosen will ideally be easily administered, quick acting and either relatively short-acting or reversible to achieve adequate sedation and paralysis as needed. As with all aspects of implementing a standardised approach to the difficult airways, local staff must ensure familiarity with and competence in using any medicine chosen.

Adequate doses of muscle relaxants will ensure paralysis and optimise intubating conditions with no movement or risk of laryngospasm. Mask ventilation is not difficult in the majority of neonates and may be made easier by the use of muscle relaxants, however if there is doubt about the ability to maintain mask ventilation after paralysis, muscle relaxants should not be used, and spontaneous ventilation maintained. These decisions will depend on individual circumstances, the assessment of the airway difficulty and the skills and experience of the clinician.

In the worst situation where intubation and all attempts at oxygenation have failed, and the neonate is hypoxic and bradycardic muscle relaxants should be given if not already used. Paralysis may make mask ventilation possible by resolving laryngospasm or reducing tone.
and allowing a better mask seal, and will also optimise intubating conditions and the chance of success for any attempt at front of neck access.

8 Framework Algorithm Template for managing the unanticipated difficult neonatal airway, guide for use and examples

8.1 Defining a ‘difficult airway situation’

There is no ‘absolute’ in when a difficult airway situation might or should be declared. Factors which influence this are the environment in which the situation occurs (for example delivery suite, ENT theatres, the emergency department), the staff present (for example junior doctor, midwife, consultant neonatologist, consultant anaesthetist), the inherent patient factors (such as gestation, aetiology or nature of the difficulty) and the equipment available to hand (or otherwise), which might help.

In the context of the unexpected difficult neonatal airway, it is likely that first responders will be trained in simple airway management (mask techniques, airway suction and possibly oropharyngeal airway use) as the principles of the Neonate Life Support algorithm (RCUK) are well known and adopted throughout the UK. More skilled help (such as proficient use of supraglottic devices or tracheal intubation) is likely to be the next layer of help arriving, for example someone who is a Neonatal Consultant or who has completed an advanced neonatal provider course such as ARNI (RCUK). The majority of babies with apparent airway issues will be well served by these.

After that, the remaining layer of help comes from those with specific airway expertise such as anaesthetists, respiratory paediatricians or ENT surgeons who are practiced in utilising highly specialised equipment to instrument the airway. This layer of help is that which is needed for the true difficult airway situation and therefore it is recommended that:

If an experienced clinician has had up to two intubation attempts, but failed to intubate declare “this is a difficult airway situation with failed intubation” and proceed to activate the difficult airway plan.
In most centres an ‘experienced’ clinician would be expected to be either a senior doctor in training (such as a neonatal GRID trainee at ST7/8 level) or a consultant with paediatric and neonatal airway skills, and experience of intubation appropriate to their seniority.

8.2 Resource differences between different clinical settings and centres
It has to be acknowledged that the breadth of different clinical environments in which a neonate may be born means that the ‘ideal’ mix of skills and resources to deal with a difficult airway will not be available to all clinicians, in all centres. The key to mitigating against this is to assess what options are available to the team in any given centre. This will involve looking at what expertise there is within the department, and then in the wider hospital, linking in with airway leads in other departments to assess what options might be deployed in a neonatal emergency. Likewise, there is good reason to consider in non-specialist centres whether local or regional transport teams should be approached to see whether they are in a position to form part of the response, though the timescales involved make this unlikely in the situation of a difficult airway.

Similarly highly specialised equipment may not be available in the neonatal unit in a small centre, but something available in adult theatres might be able to be brought to a delivery suite in an emergency to provide help. A good example of this might be a video or indirect laryngoscope system: these are often readily available in adult theatres, and while purchase of the whole system for sole use by a NNU might be impossible, the NNU team might be able to purchase a neonatal-sized blade and then jointly train in its use with the obstetric anaesthetists in preparation for an emergency. Similarly, adult intensive care units or emergency departments may contain untapped resources when considering an MDT approach.

Whatever the equipment available turns out to be, the key is then in preparation and planning for deployment and in the maintenance of skills in using both the equipment and process.

8.3 Using the Framework Algorithm Template
The Framework Algorithm Template is a two-page document which is intended to be used to both capture the locally agreed approach to the management of a difficult neonatal airway and allow the approach to be effectively deployed in that situation. It is written in
such a way as to give a sensible, stepwise structure to the process management of the difficult neonatal airway in the acute situation.

To use the document effectively, there are four steps to follow in order:

- **Assessing resources available**
- **Compiling equipment and algorithm**
- Simulation and training (see section 10)
- Review and learning (see section 10)

It is anticipated that a local Neonatal Airway lead will be nominated and take responsibility for ensuring these steps are followed in their centre.

### 8.4 Assessing resources

In each centre, the Neonatal Airway lead should be formally designated and then liaise with their colleagues to identify where resource in terms of equipment and personnel lies within their organization. This will likely include their neonatal or paediatric colleagues at consultant and senior practitioner level; any ENT, anaesthetic or respiratory teams in the locality who deal with paediatric cases; and the designated Airway Lead for the organisation (who will most likely be an anaesthetist). Obstetric anaesthetic teams are also often in close geographical proximity to neonatal services and emergency departments in smaller hospitals may benefit reciprocally from involvement in planning/responding to the difficult neonatal airway and have skills to contribute.

In resource-rich settings (such as hospitals with neonatal, paediatric and maternity services at regional or supraregional level) the key aspects of resource identification are likely to centre on how to get the expertise and equipment into the room when needed in an emergency. In less resource-rich settings (for example a NNU in a district general hospital) there will be need to consider what equipment might be available in the hospital and how to move it to the neonatal arena alongside which personnel in an emergency. Wherever possible, attention should be paid to using equipment common to different areas of practice as this widens the pool of people who may be able to use it. For example, if i-gels™ are used alongside Airtraq™ devices in adult theatres and intensive care areas in a local hospital, then it will be advantageous for the NNU planning for the neonatal difficult airway to use these too.
8.5 Compiling equipment and the Framework Algorithm

The difficult airway box

Whatever particular equipment is ultimately chosen to go into the difficult airway ‘box’, it is important that it is kept in a safe location with a method of ensuring that it is not used for other purposes such as routine intubation. Use of plastic anti-tamper seals with labels, such as are often used to seal resuscitation trolleys, can ensure that there is immediate evidence of interference with the equipment if the seal is broken, and there can be an immediately obvious visual confirmation of when the equipment was last checked and by whom.

The other important step that can be taken to aid fluent use of the equipment is to ensure that the equipment for each Plan (A to D) is labelled with the relevant plan letter. Drawers can be effective in laying out equipment in this fashion but are harder to reliably seal. Externally the equipment box must be clearly labelled as a ‘Neonatal Difficult Airway’ box/equipment. There must be an agreed frequency of checking the equipment to ensure it is working and agreement as to who is responsible for this check to allow it to be built into a working routine. It is also suggested that to aid retrieval of the equipment in the emergency situation where staff may be unfamiliar with what it looks like, a photo-reference chart such as that in the template may be used and kept inside the difficult airway box. As equipment, practice and staff change, the airway lead is responsible for updating the algorithm and photo-reference chart.

Two copies of the Framework Algorithm should be laminated and placed inside the Plan A compartment to ensure that if one copy is taken away to be used in contacting emergency help, the other can be used in the active process of managing the airway. It is recommended that further copies of the Framework Algorithm are kept in clinical areas such that there is further direction to the difficult airway box which is not reliant on having the box in hand.

The Framework Algorithm

The Framework algorithm covers two sides of A4 sized paper and requires only one piece of A4 paper to be printed on, double-sided, to then be laminated for use.

On the facing page, there is key information to help activate a response to the difficult airway situation including (if relevant):
• Location of the Difficult Airway box (if not kept with the algorithm)
• Key telephone numbers for expert help to be contacted together with agreed ‘trigger’ phraseology to guarantee a response
• Medications including doses which might be needed (sedation/paralysis/reversal)
• Details of any equipment to be brought from other areas in the hospital and how to obtain them (e.g. tracheostomy equipment, rigid bronchoscopes, indirect laryngoscopes)

Modifying the Framework Algorithm for a local centre

The Framework Algorithm has to be applicable to many different levels of resource setting and therefore some aspects can be modified at a local level for their specific use to fit the available resources. However, key aspects should not be changed (see below) in order to ensure that personnel moving between centres are familiar with the layout and use, even where the detail might change in individual steps.

The colour scheme used for the Algorithm template is similar to that used for the Difficult Airways Society (DAS) guidelines which will be familiar to anaesthetic colleagues, and should be easily copied in black and white if colour is not available.

Things that should not be altered at a local level without good reason are:

- The Plan A-D layout (the intrinsic structure of the algorithm)
- The challenge and response format (see below), highlighted by the text in bold. The challenge and response technique is integral to the use of the algorithm in practice and should not be changed.

Things that can be changed:

- In the coloured boxes, any text highlighted in yellow can be amended to reflect the locally available and chosen equipment
- In the ‘consider’ boxes, a piece of equipment may not be available (for example a bougie). This can be removed from the algorithm as to retain it but not be available will confuse people. Likewise, specific equipment maybe listed in these boxes reflecting local availability
- Specific relevant information can be included in the first page where indicated

Two examples versions of how the algorithm might be modified, and look in different clinical settings, are provided in the resource materials document.
Challenge and Response

The framework algorithm template is written specifically to make use of ‘challenge and response’ technique during a difficult airway situation. Conventional uses of ‘checklists’ in healthcare either rely on a pause to check that a process has been completed before starting a procedure (for example the WHO surgical checklist) or training beforehand which teams rely on to have recall of the process during the event (such as the NLS algorithm). For regularly encountered situations the latter can work well, and the former is good for ensuring coherent team working in a task to come, but neither approach works well in rare, high-stress situations outside usual practice.

The challenge and response paradigm relies on one team member speaking out loud (challenge) set text to the team (most often questions/statements) in a stepwise fashion moving through a defined series of clinical steps, which require confirmation (yes/no response) at each stage. This ensures that the team move forward through escalating levels of care in a coordinated way to a defined plan giving the best opportunity for a successful outcome. It moves the algorithm from a reference tool to an active intervention. Use of this technique is key to successful use of the framework algorithm.

In the algorithm the plans are designed to be worked through sequentially:

- Plan A is designed to ensure the basics are being done optimally and set in motion the process of getting help
- Plan B is designed to encourage thinking about alternative means to ventilate/deliver oxygen
- Plan C is designed to optimise oxygenation if ventilation is difficult and to prompt minimising airway trauma from repeated attempts while further help arrives
- Plan D is the final step and utilising expert help to secure the airway
BAPM Framework algorithm:

Unexpected Difficult Airway (Neonates)

Read all text in **BOLD** aloud to the team:
VERBALISE AS CHALLENGE AND RESPONSE.
Yes/No responses required from team leader

Immediate actions: **We have a difficult airway situation**

1) **Has someone called for expert help?** Send a specific team member to Call for help (numbers below):

Tell them to state: ‘We have a difficult airway situation in (state your location). Please attend immediately’

   - 1) ........................................
   - 2) ........................................
   - 3) ........................................

2) **Has the Difficult Airway box been located and retrieved?**

If Not: Retrieve and Open the Difficult Airway Box: Located at........................................

*NOW TURN OVER THIS SHEET AND READ FROM ‘PLAN A’*

Other information:

Medication for sedation/paralysis: **Type/dose**..............................

Medication for reversal of sedation/paralysis: **Type/ dose**..................

Location of specific equipment (e.g. ENT scopes, tracheostomy kit)

*(what).................................(where).................................

.................................................................

To be accessed by contacting ........................................ on ........................................
PLAN A

Priority: Mask ventilation and oxygenation
We need to optimise mask ventilation:
- Is the mask an appropriate size?
- Is head position correct (neutral position)?
- Is the T-Piece set to appropriate pressures?
- Is the 2 person technique effective?

Consider:
- Get the VL if available
- Smaller mask/use longer Ti
- Higher pressures (PIP and PEEP)
- Increase oxygen to 100%
- NG tube passage
- CO₂ detector in circuit
- Oropharyngeal airway

YES to all

Is the chest moving (and has the heart rate increased?)

PLAN B

Priority: Oxygenation and ventilation
We need to optimise oxygenation:
- Is the set oxygen 100%?
- Try a supraglottic device: Consider: LMA or iGEL or Nasopharyngeal airway.

Consider:
- Increase oxygen to 100%
- NG tube passage
- CO₂ detector in circuit
- IV access (UVC/IO)

Are we able to oxygenate and ventilate?

PLAN C

Priority: Oxygenation
We need to optimise oxygenation:
- Is the set oxygen 100%? Supplemental nasal cannula oxygen on Attempt secondary intubation with help arrived, no more than two attempts.

Consider:
- Bougie, smaller ETT
- Indirect laryngoscope (e.g. Airtraq)
- Videolaryngoscopy
- Sedation and paralysis (reversible agents available?)

Has a definitive airway been established?

PLAN D

Priority: Rescue methods
Continue to optimise oxygenation
Do we need to reverse paralysis?
Expert help to establish airway

EXPERIENCED PERSONNEL IN LIFE THREATENING SITUATIONS:
- Rigid bronchoscopy + railroaded ETT
- Flexible bronchoscopy + railroaded ETT
- Emergency tracheostomy (ENT only)
BAPM Difficult Airway Framework: **TEMPLATE**

**Equipment: visual inventory-Store with difficult airway box**

<table>
<thead>
<tr>
<th>PLAN A</th>
<th>Name and location of equipment</th>
<th>Add photos here</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLAN B</td>
<td>Name and location of equipment</td>
<td>Add photos here</td>
</tr>
<tr>
<td>PLAN C</td>
<td>Name and location of equipment</td>
<td>Add photos here</td>
</tr>
<tr>
<td>PLAN D</td>
<td>Name and location of equipment</td>
<td>Add photos here</td>
</tr>
</tbody>
</table>
9 Consideration of the Family

Family integrated/centred care is becoming central to the ethos of care in many Neonatal units around the country. Involving the family in the care delivered encourages bonding and confidence in families whose babies who are unwell, and may shorten time to discharge home. In situations where life is limited, it is key to ensuring that the families are able to optimise the quality of their time with their baby. With specific reference to management of the difficult airway, three opportunities for involving the wider family present themselves.

Antenatal detection: the family should be counselled honestly and openly and be aware of the full spectrum of appropriate options. This may include a palliative approach, expectant assessment with palliative option, or full intervention as far as is possible depending on the condition at hand. Parent’s wishes within these possible options can be included in delivering a holistic approach around delivery. In some circumstances, with the appropriate liaison with a local centre, it may be appropriate for a baby to deliver in a non-specialist centre where intensive care is either not wanted or not a feasible option.

Where an unexpected difficult airway is found: immediate management must be directed to the baby as per clinical need. During this process, if possible, a knowledgeable member of staff should keep parents informed and aware of progress periodically, if no member can be allocated to be with the family continuously. It is clear that many parents benefit from witnessing resuscitative attempts in later processing of grief where resuscitation was unsuccessful. In the circumstances of an ultimately unmanageable airway, the parents must be involved in the process of ceasing attempts at life-sustaining treatment in favour of ongoing comfort care.

When moving to intensive care setting for ongoing care: the attending clinical team should follow their unit’s standards of family integrated care delivery, but with sensible and consistently-applied modifications to ensure that the secured airway is retained and protected. For example, modifying the process/timing of skin-to-skin contact and parent delivered cares for their baby. The approach to be taken will need to be agreed by the clinical team at the time of admission, and communicated clearly with reasoning to the family. Agreed review points as the clinical course progresses should allow for further modification to the integrated care process based on ground of risk and safety at these times.
10 Simulation and Education

It is important that any person involved in managing a neonatal airway is aware of the local policies, process and environment. This includes knowledge of location of difficult airway management equipment and the difficult airway guidance.

The likely environments in which difficult airways may be encountered need to be familiar to personnel assigned to respond to the situation of a difficult airway: ENT teams may be required to attend and, if so, bulky kit might be brought into the area (i.e. equipment for fibre optic intubation). Space for this equipment will be required.

Each neonatal unit should have an allocated difficult airway lead that is responsible for setting up the equipment and ensuring team knowledge and training of the kit.

The difficult airway equipment should have a contents list of all available equipment, as well as phone/ bleep/ radio page numbers for staff who might be required, and the ‘challenge and response’ algorithm to be read out to the team during a declared difficult airway situation. This should be laminated and attached to/inside the difficult airway box.

In line with practice recommendations around debriefing from life support organisations such as the Resuscitation Council (UK), Advanced Life Support Group, and the Difficult Airways Society, any situation in which a difficult airway is declared/experienced should be debriefed appropriately and formally reviewed. This is to ensure that the process in place locally was followed, and any lessons from the process (both good and bad) are learned. The conduct of these and dissemination of learning falls under the remit of the Neonatal Airway lead in each centre.

There should be regular skills training with the equipment in order to familiarise all team members. In addition, simulation should be used, focussed at testing processes and infrastructure across clinical teams, in order to ensure there are no latent risks to the MDT response required in a difficult airway situation. Effective delivery from the MDT should be practiced and not presumed. It is well evidenced that neonatal airway skills and fluency decrease with increased length of time between rehearsals/exposure\(^{38,39}\) therefore it is recommended that there should be no more than a maximum of 6 months between simulated difficult airways drills, with appropriate debriefing and learning shared in the same fashion as for real clinical events. The responsibility for ensuring environment and equipment
changes are accounted for, and that skills teaching and regular simulation occurs in centres, lies with the neonatal airway lead.

11 References


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