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Guidelines

Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics*

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Summary

The Obstetric Anaesthetists' Association and Difficult Airway Society have developed the first national obstetric guidelines for the safe management of difficult and failed tracheal intubation during general anaesthesia. They comprise four algorithms and two tables. A master algorithm provides an overview. Algorithm 1 gives a framework on how to optimise a safe general anaesthetic technique in the obstetric patient, and emphasises: planning and multidisciplinary communication; how to prevent the rapid oxygen desaturation seen in pregnant women by advocating nasal oxygenation and mask ventilation immediately after induction; limiting intubation attempts to two; and consideration of early release of cricoid pressure if difficulties are encountered. Algorithm 2 summarises the management after declaring failed tracheal intubation with clear decision points, and encourages early insertion of a (preferably second-generation) supraglottic airway device if appropriate. Algorithm 3 covers the management of the 'can't intubate, can't oxygenate' situation and emergency front-of-neck airway access, including the necessity for timely perimortem caesarean section if maternal oxygenation cannot be achieved. Table 1 gives a structure for assessing the individual factors relevant in the decision to awaken or proceed should intubation fail, which include: urgency related to maternal or fetal factors; seniority of the anaesthetist; obesity of the patient; surgical complexity; aspiration risk; potential difficulty with provision of alternative anaesthesia; and post-induction airway device and airway patency. This decision should be considered by the team in advance of performing a general anaesthetic to make a provisional plan should failed intubation occur. The table is also intended to be used as a teaching tool to facilitate discussion and learning regarding the complex nature of decision-making when faced with a failed intubation. Table 2 gives practical considerations of how to awaken or proceed with surgery. The background paper covers recommendations on drugs, new equipment, teaching and training.

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- *What other guidelines are available on this topic?*
  The Difficult Airway Society UK (DAS) and American Society of Anesthesiologists (ASA) Task Force guidelines for the management of the difficult airway exclude obstetric patients [1, 2]. The ASA Task Force's *Practice Guidelines for Obstetric Anesthesia* deal with equipment for the management of airway emergencies [3]. Recent national failed intubation guidelines from Canada [4, 5] and Italy [6] have small sections on the obstetric patient. In the UK, many hospitals have developed their own obstetric failed intubation guidelines, often based on the DAS algorithm for use during rapid sequence induction of anaesthesia [7].
- *Why were these guidelines developed?*
  There are no national guidelines on the management of difficult airway in obstetrics in the UK. Non-obstetric guidelines do not address the problem that surgery is often being performed with extreme urgency to ensure the wellbeing of a different individual to the patient. These guidelines was developed to include specific measures accounting for the physiological and physical changes relating to the presence of a fetus that affect oxygenation and airway management, as well as to provide a structure for advance planning should failed intubation arise. There is a need for standardisation of the approach to obstetric failed intubation because there are declining numbers of general anaesthetics with consequent reduction in experience, especially among trainee anaesthetists [8].
- *How do these guidelines differ from existing ones?*
  These are the first national obstetric-specific failed intubation guidelines in the UK. The algorithms contain a minimal number of decision points. They include attention to advance planning, teamwork, and non-technical as well as technical skills and, in conjunction with a table, clarify the potentially conflicting priorities of the mother and the fetus. With careful attention to optimising general anaesthetic technique, it is hoped that airway difficulties can be minimised and advance plans be made in case of difficulties, accepting that these may need to be modified as events unfold.
- *Why do these guidelines differ from existing ones?*
  There is growing support for modernising the administration of general anaesthesia at caesarean section, and making it more consistent with non-obstetric practice. These guidelines acknowledge and conform with that trend.

Introduction

The rate of failed tracheal intubation in obstetrics has remained unchanged over the past four decades [9]. The first obstetric failed intubation guideline was published by Tunstall in 1976 [10]. Since then, there have been many local modifications to the original guideline as a result of developments in anaesthetic practice and changing patient population. Since the introduction of national guidelines for failed intubation in non-obstetric patients [1], a need for an equivalent for the obstetric patient has been identified [11]. This paper presents the resultant guidelines developed by the working group commissioned by

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the Obstetric Anaesthetists' Association (OAA) and the DAS.

Methods

The OAA/DAS Obstetric Anaesthetic Difficult Airway Guidelines Group was formed in May 2012 with representatives from both organisations. We initially performed a comprehensive review of the literature on failed tracheal intubation following rapid sequence induction of obstetric general anaesthesia [9]. Further workstreams included a national OAA survey of lead obstetric anaesthetists to clarify aspects of management of difficult and failed intubation [12], and a secondary analysis of neonatal outcomes from the UK Obstetric Surveillance System (UKOSS) obstetric failed tracheal intubation database [9]. The draft algorithms and tables were presented at annual scientific meetings of both societies and were made available online for comments by members. Other stakeholders (Association of Anaesthetists of Great Britain and Ireland (AAGBI), Royal College of Anaesthetists, British Association of Perinatal Medicine, Royal College of Obstetricians and Gynaecologists, Royal College of Midwives) were also consulted.

Identification of evidence

A preliminary search of international guidelines and published literature was carried out. We performed a structured literature search of available scientific publications from 1950 to 2014 using databases (Medline, Embase, Pubmed, National Guidelines Clearinghouse), search engines (Google Scholar, Scirus), Cochrane database and officially recognised websites (DAS, OAA, Clinical Trials (see www.clinicaltrials.gov)). There were no language restrictions.

Abstracts were searched using keywords and filters. The words and phrases used were: intubation; difficult airway; obstetric; pregnancy; pregnant; pregnant woman; airway problem; cricothyroidotomy; laryngeal mask; LMA; supraglottic airway device; Pro-Seal LMA; LMA Supreme; i-gel; videolaryngoscope; Airtraq; Glidescope; MacGrath; C-Mac; Pentax airway scope; McCoy laryngoscope; airway assessment; Mallampati; thyromental distance; physiology of airway in pregnancy; failed intubation; cricoid pressure; cricothyroid; rapid sequence induction; general anaesthesia; pre-oxygenation; thiopentone; propofol; etomidate; suxamethonium; rocuronium; sugammadex; awake intubation; awake fibreoptic intubation; awake laryngoscopy; conscious laryngoscopy; and tracheostomy. The search was repeated monthly until June 2015. In total, 7153 abstracts were checked for relevance, following which 693 full papers were examined.

Classification of evidence

All scientific evidence was reviewed according to the Oxford Centre for Evidence-Based Medicine 2011 levels of evidence criteria [13]. Apart from a handful of studies, the published literature comprised either case reports or series, observational studies, opinion pieces or reviews. There is a larger amount of non-obstetric literature on airway management, some of which can be extrapolated to the obstetric situation. In view of this, the Guidelines Group decided that it was necessary to produce guidelines based on expert consensus rather than high-level evidence.

Why is airway management more difficult in the obstetric patient?

Maternal, fetal, surgical and situational factors contribute to the increased incidence of failed intubation.

The mucosa of the upper respiratory tract becomes more vascular and oedematous, leading to increased risk of airway bleeding and swelling. These changes result in increasing Mallampati score as pregnancy progresses, and also during labour and delivery [14–18]. Swelling may be exacerbated by pre-eclampsia [19, 20], oxytocin infusion, intravenous fluids and Valsalva manoeuvres during labour and delivery [15, 16, 21]. Decreased functional residual capacity and increased oxygen requirements accelerate the onset of desaturation during apnoea, and these are exacerbated in the obese parturient. Progesterone reduces lower oesophageal sphincter tone, resulting in gastric reflux, and a delay in gastric emptying occurs during painful labour and after opioid administration. Enlarged breasts may make the insertion of the laryngoscope difficult.

The majority of obstetric difficult and failed intubations occur during emergencies and out of hours

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[22, 23]. Concerns for rapid delivery of the fetus often lead to time pressure, which may result in poor preparation, planning, communication and performance of technical tasks.

There has been a decline in the number of obstetric general anaesthetics performed in the developed world over the past three decades as regional anaesthesia has become more popular [23–26], resulting in reduced training opportunities [8, 27]. Specific airway skills, including bag and mask ventilation and tracheal intubation, have declined with the increased use of supraglottic airway devices (SADs) [28]. Trainees may start obstetric on-call without having performed or observed a general anaesthetic in the obstetric patient [12]. Moreover, many obstetric units are remote from the main hospital site, delaying access to senior help and specialist equipment. Human factors play a significant role in decision-making, task management and communication during critical situations [29, 30]. Fixation error has been highlighted as a specific concern during airway emergencies [31].

These guidelines mainly concern general anaesthesia for caesarean section. However, the physiological changes of pregnancy will also affect anaesthesia carried out for other procedures during pregnancy and the postpartum period, and therefore many principles are also relevant in such cases.

The OAA/DAS obstetric difficult and failed intubation guidelines

The guidelines comprise:

- Master algorithm – obstetric general anaesthesia and failed tracheal intubation (Fig. 1)
- Algorithm 1 – safe obstetric general anaesthesia (Fig. 2)
- Table 1 – wake or proceed to surgery? (Fig. 3)
- Algorithm 2 – obstetric failed tracheal intubation (Fig. 4)
- Algorithm 3 – can't intubate, can't oxygenate (Fig. 5)
- Table 2 – management after failed tracheal intubation (Fig. 6)

Master algorithm – obstetric general anaesthesia and failed tracheal intubation (Fig. 1)

This is a composite of the three specific algorithms.

Algorithm 1 – safe obstetric general anaesthesia (Fig. 2)

This emphasises the importance of planning and preparation, and describes best practice for rapid sequence induction and laryngoscopy. By understanding the physiological differences during pregnancy and employing best practice technique, it is hoped that airway problems can be anticipated and minimised.

Pre-theatre preparation

Airway assessment: Every woman undergoing obstetric surgery should have an airway assessment to predict possible difficulty not only with tracheal intubation but also with mask ventilation or SAD insertion and front-of-neck access. There are a number of common factors that are associated with difficulty in performing all of these airway management tasks (Appendix 1). The assessment should be documented clearly [22, 32]. Oral piercings should be removed before any form of anaesthesia as they may cause trauma and bleeding during intubation as well as carrying the added risk of aspiration if pieces detach [33].

Women predicted to have significant airway difficulties, such that rapid sequence induction would not be suitable, should be referred antenatally for formulation of a specific anaesthetic and obstetric management plan.

Fasting status and antacid prophylaxis: Gastric clearance in the pregnant woman who is not in labour is the same as in the non-pregnant patient [34]. Labour and opioid analgesia delay gastric emptying, especially of food [35], but it returns to normal by 18 h post-delivery [36].

Current guidance for elective non-obstetric surgery suggests that food should be withheld for 6 h, whereas clear fluids may be given up to 2 h pre-operatively [37]. The commonest regimen for stomach preparation before elective caesarean section [38] is a combination of a H_2-receptor antagonist the night before and two hours before anaesthesia, with or without a prokinetic drug. If general anaesthesia is being used, sodium citrate is also administered immediately before induction [38, 39].

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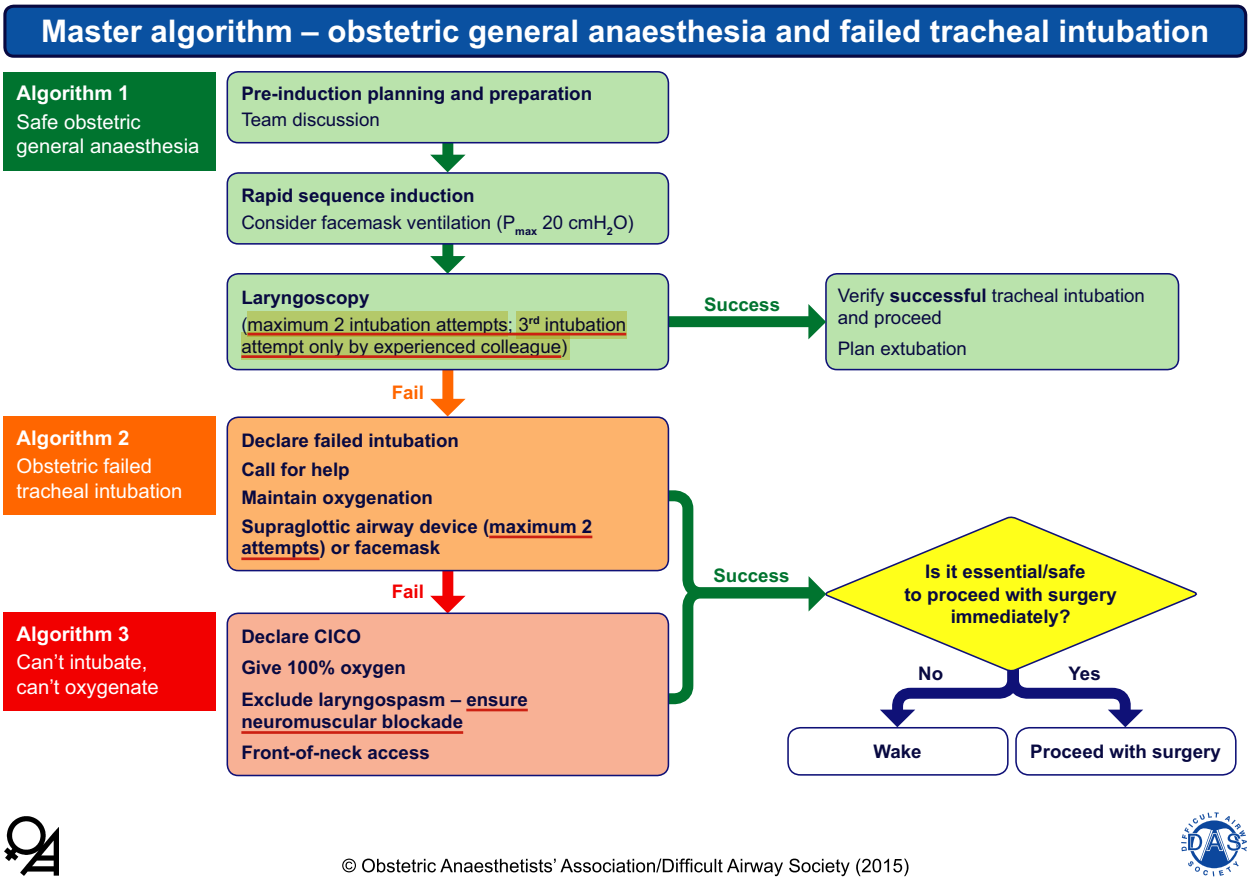

Figure 1 Master algorithm – obstetric general anaesthesia and failed intubation. The yellow diamond represents a decision-making step. P_{max}, maximal inflation pressure; CICO, 'can't intubate, can't oxygenate'. The algorithms and tables are reproduced with permission from the OAA and DAS and are available online in pdf and PowerPoint formats.

During labour, gastric emptying is slowed unpredictably and eating in labour increases residual gastric volume [35]. The recommended approach in the UK during labour is to stratify women into low- or high-risk for requiring general anaesthesia [40]. Low-risk women are allowed a light diet. High-risk women should not eat but may have clear oral fluids, preferably isotonic drinks, together with oral administration of H_2-receptor antagonists every 6 h [40, 41]. If anaesthesia is required for delivery, an H_2-receptor antagonist should be given intravenously if not already administered, with the aim of reducing the risk of aspiration at extubation. Sodium citrate should be given as for elective cases [38, 39].

Intrauterine fetal resuscitation: Intrauterine fetal resuscitation should be employed as appropriate before emergency operative delivery, and the urgency of surgery should be re-evaluated after transfer to the operating theatre [42].

Plan with team

The World Health Organization surgical checklist should be used before each theatre procedure [43]. This is often modified locally for caesarean section/operative vaginal delivery; in some units a specific anaesthetic checklist is used in addition [44]. The anaesthetist should be informed by the obstetrician about the clinical details of the case and the current urgency category. There should be a clear procedure for how to contact a second anaesthetist if required; if appropriate, induction of anaesthesia should be delayed while awaiting his/her attendance. Standardisation of airway equipment within the hospital is highly recommended [45]. The anaesthetic team should be familiar with the content of the airway trolleys and these should be regularly checked.

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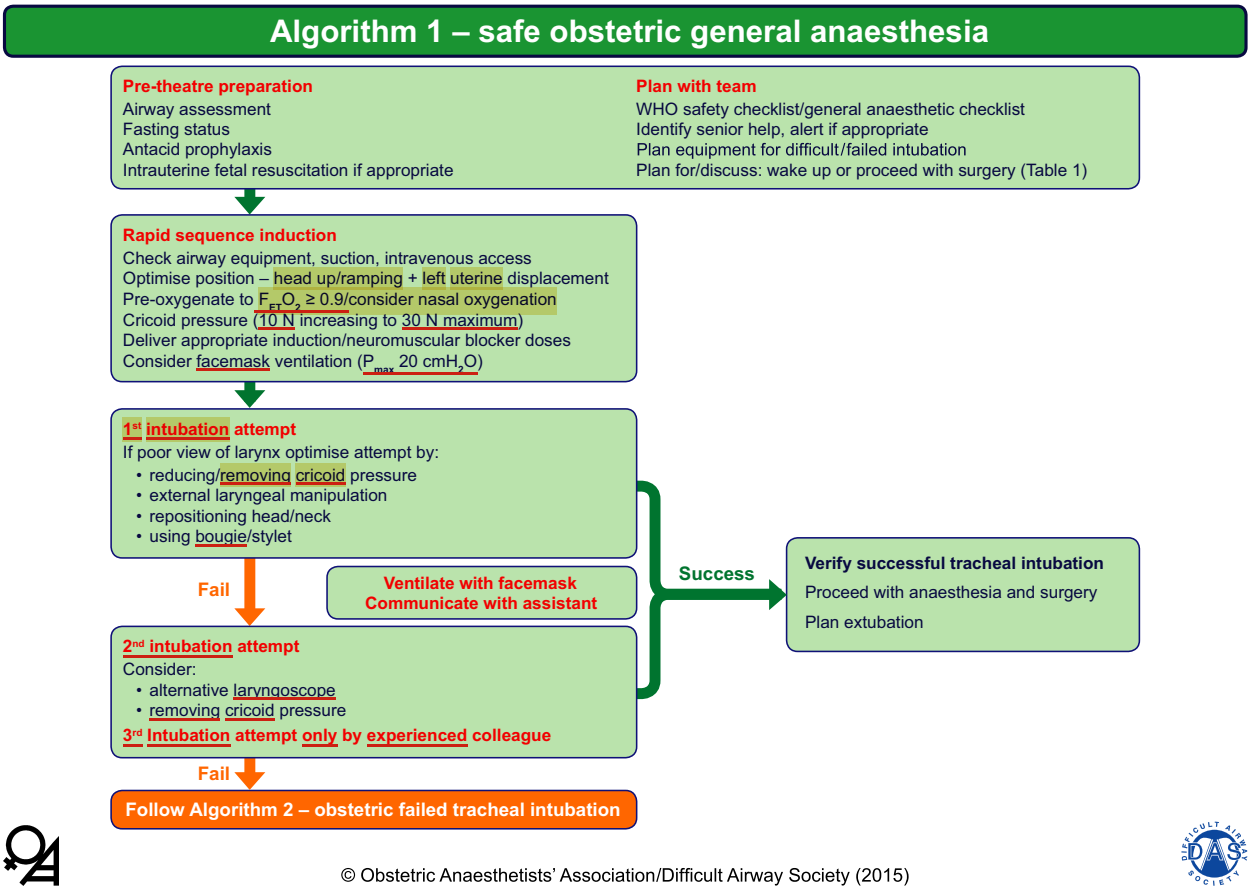

Figure 2 Algorithm 1 – safe obstetric general anaesthesia. WHO, World Health Organization; $F_{ET}O_2$, end-tidal fraction of oxygen; P_{max}, maximal inflation pressure. The algorithms and tables are reproduced with permission from the OAA and DAS and are available online in pdf and PowerPoint formats.

Table 1 – wake or proceed with surgery? (Fig. 3): Before induction of anaesthesia, the anaesthetist should discuss with the obstetric team whether to wake the woman or continue anaesthesia in the event of failed tracheal intubation. This decision is influenced by factors relating to the woman, fetus, staff and clinical situation, most of which are present pre-operatively (Table 1). The table highlights the many factors that need to be considered; the exact combination may be unique in each individual case. It is a useful exercise for the anaesthetist to consider at this stage whether (s)he would be prepared to provide anaesthesia for the duration of surgery with a SAD as the airway device.

Fetal compromise is a more common indication for urgent caesarean section than maternal compromise [46]. Although maternal safety is a greater priority for the anaesthetist than fetal, women willingly accept some risk to themselves to ensure a good neonatal outcome [46]. Fetal condition is likely to be maintained during a delay in the majority of cases [9]; at caesarean section for fetal bradycardia in one study, there was a significant decline in neonatal pH with increasing bradycardia-delivery interval only in cases with an irreversible cause for the bradycardia, in contrast to those with a potentially reversible or unascertained cause [47]. Irreversible causes include major placental abruption [48], fetal haemorrhage (e.g. from ruptured vasa praevia) [49], ruptured uterine scar with placental/fetal extrusion [50], umbilical cord prolapse with sustained bradycardia [51, 52] and failed instrumental delivery [47]. Such specific causes for fetal distress may only become evident after delivery, and therefore a high index of suspicion is necessary. Potentially reversible causes include uterine hyperstimulation, hypotension after epidural anaesthesia/analgesia, and aortocaval compression [47].

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Table 1 – proceed with surgery?

	Factors to consider	WAKE ←		→	PROCEED
Before induction	**Maternal condition**	• No compromise	• Mild acute compromise	• Haemorrhage responsive to resuscitation	• Hypovolaemia requiring corrective surgery • Critical cardiac or respiratory compromise, cardiac arrest
	Fetal condition	• No compromise	• Compromise corrected with intrauterine resuscitation, pH < 7.2 but > 7.15	• Continuing fetal heart rate abnormality despite intrauterine resuscitation, pH < 7.15	• Sustained bradycardia • Fetal haemorrhage • Suspected uterine rupture
	Anaesthetist	• Novice	• Junior trainee	• Senior trainee	• Consultant/specialist
	Obesity	• Supermorbid	• Morbid	• Obese	• Normal
	Surgical factors	• Complex surgery or major haemorrhage anticipated	• Multiple uterine scars • Some surgical difficulties expected	• Single uterine scar	• No risk factors
	Aspiration risk	• Recent food	• No recent food • In labour • Opioids given • Antacids not given	• No recent food • In labour • Opioids not given • Antacids given	• Fasted • Not in labour • Antacids given
	Alternative anaesthesia • **regional** • **securing airway awake**	• No anticipated difficulty	• Predicted difficulty	• Relatively contraindicated	• Absolutely contraindicated or has failed • Surgery started
After failed intubation	**Airway device/ ventilation**	• Difficult facemask ventilation • Front-of-neck	• Adequate facemask ventilation	• First generation supraglottic airway device	• Second generation supraglottic airway device
	Airway hazards	• Laryngeal oedema • Stridor	• Bleeding • Trauma	• Secretions	• None evident

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Figure 3 Table 1 – wake or proceed with surgery? Criteria to be used in the decision to wake or proceed following failed tracheal intubation. In any individual patient, some factors may suggest waking and others proceeding. The final decision will depend on the anaesthetist's clinical judgement. The algorithms and tables are reproduced with permission from the OAA and DAS and are available online in pdf and PowerPoint formats.

The overriding indications to proceed with general anaesthesia are maternal compromise not responsive to resuscitation, and acute fetal compromise secondary to an irreversible cause as above (especially when an alternative of rapid spinal anaesthesia or awake intubation is not feasible). The firm indications to wake the mother up are periglottic airway swelling and continuing airway obstruction in the presence of optimised SAD or facemask management.

General anaesthesia is continued after failed intubation in most cases of elective as well as emergency caesarean section in current UK practice [9, 12, 22].

Rapid sequence induction

The theatre team should keep noise to a minimum during preparation and induction of anaesthesia to reduce distraction and to ensure that all staff remain aware of the developing situation.

Optimise patient position: Optimal positioning is essential before the first intubation attempt. In addition to lateral uterine displacement as indicated, the head-up position should be considered. A 20–30° head-up position increases functional residual capacity in pregnant women [53] and safe apnoea time in non-pregnant obese and non-obese patients [54–57]. It also decreases difficulty with insertion of the laryngoscope caused by large breasts, improves the view at laryngoscopy [58] and may reduce gastro-oesophageal reflux [59]. In the morbidly obese patient, the 'ramped' position, aligning the external auditory meatus with the supra-sternal notch, has been shown to be superior to the standard 'sniffing position' for direct laryngoscopy

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[60]. Certain hairstyles can affect neck extension and lead to difficulty with intubation. Elaborate hair braids may require removal before anaesthesia [61–65].

Pre-oxygenation: Pre-oxygenation increases the oxygen reserve in the lungs during apnoea. End-tidal oxygen fraction ($F_{ET}O_2$) is the best marker of lung denitrogenation [66, 67]; an $F_{ET}O_2 \geq 0.9$ is recommended [67, 68]. Breath-by-breath oxygen monitoring can be used to monitor the process; this should be corroborated with a capnogram as erroneous values of $F_{ET}O_2$ may be displayed because of apparatus deadspace and dilution from high fresh gas flows. A fresh gas flow rate of ≥ 10 l.min^{-1} is required for effective denitrogenation, and a tight mask-to-face seal is essential to reduce air entrainment [67]. Most anaesthetists pre-oxygenate for ≥ 3 min even during category-1 caesarean section [69]; however, previous clinical research and recent computer modelling shows that a 2-min period of pre-oxygenation is adequate for the term pregnant woman at term [66, 70].

If the patient is apnoeic and the airway is not being instrumented, continued administration of 100% oxygen with a tightly fitting facemask and maintenance of a patent airway allows continued oxygenation by bulk flow to the alveoli (apnoeic oxygenation) [71]. In elective non-obstetric surgery, insufflation of oxygen via a nasopharyngeal catheter during laryngoscopy increases the time to desaturation in both normal and obese patients [72, 73]. The anaesthetist should consider attaching nasal cannulae with 5 l.min^{-1} oxygen flow before starting pre-oxygenation, to maintain bulk flow of oxygen during intubation attempts [74, 75]. New systems for nasal oxygenation that deliver humidified oxygen at high flow, such as the Optiflow™ system (Fisher and Paykel Healthcare Ltd, Panmure, Auckland, New Zealand), are being developed but these have only been assessed in non-pregnant patients [76].

Cricoid pressure: Cricoid pressure during rapid sequence induction has long been debated [77]. Cricoid pressure is used almost universally in the UK during general anaesthesia for caesarean section [78], although practice varies in other countries [79]. Current evidence supports applying 10 N force initially and then increasing to 30 N after loss of consciousness [80], as too much force (e.g. 44 N) is associated with airway obstruction [81, 82]. If the head-up position is used for induction, this force can be reduced to 20 N [59]. Taylor et al. recently described a cricoid cartilage compression device that might improve standardisation of cricoid pressure [83].

The direction that cricoid pressure is applied should account for any lateral tilt of the operating table. Videolaryngoscopes provide a display on a screen from a camera at the tip of the blade; this allows the assistant to adjust cricoid pressure and improve the view of the glottis [84].

Incorrectly applied cricoid pressure can lead not only to a poor view at laryngoscopy but also to difficulties with insertion of the tracheal tube or SAD, mask ventilation and advancement of the tracheal tube over an introducer [82, 85–88]. Because of these concerns, there should be a low threshold to reduce or remove cricoid pressure should intubation or mask ventilation prove difficult; it should be removed for insertion of a SAD. If cricoid pressure is reduced or removed, there is a possibility that regurgitation may occur; the anaesthetist and assistant should be ready to reapply cricoid pressure, administer oropharyngeal suction, introduce head-down tilt or a combination thereof.

Deliver appropriate doses of induction agent/neuromuscular blocking drug: Thiopental remains the most commonly used drug in UK for induction during rapid sequence induction in obstetrics [89–91]. However, the case for its continued use has greatly diminished; there are strong recommendations to use propofol instead for reasons that include familiarity, supply, ease of drawing up and fewer drug errors [90, 92, 93]. Propofol also suppresses airway reflexes more effectively than thiopental [94], which may be an advantage should intubation fail. The Fifth National Audit Project of the Royal College of Anaesthetists and the AAGBI (NAP5) found a high incidence of awareness in obstetrics, and highlighted inappropriately low doses of thiopental (< 4 mg.kg^{-1}) as one of the factors [95]. Hence, it is important to ensure that an adequate dose of induction agent is administered initially, and that further doses are available should difficulty with intubation be encountered.

Suxamethonium has been the standard neuromuscular blocking drug for rapid sequence induction as it

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had a faster onset and shorter duration than the alternatives. Although there is a presumption that its action will wear off to allow spontaneous ventilation in the event of failure to intubate, it has been shown that hypoxia occurs before recovery of neuromuscular activity [96, 97]. A unique disadvantage is that suxamethonium increases oxygen consumption through its depolarising action, and hence may cause earlier desaturation than rocuronium [98].

The use of high-dose rocuronium (1.0–1.2 $mg.kg^{-1}$) with sugammadex backup is a suitable alternative to suxamethonium, as rocuronium can be fully reversed by sugammadex (16 $mg.kg^{-1}$) within 3 min compared with 9 min for the spontaneous offset of suxamethonium [99–103]. However, because of the time taken to prepare sugammadex, its use must be anticipated and the dose pre-calculated, and it should be immediately available for an assistant to draw up and administer [100]. The use of the rocuronium/sugammadex combination is currently limited because of the cost of sugammadex.

Consider facemask ventilation: Mask ventilation before laryngoscopy has generally been avoided during rapid sequence induction for fear of gastric insufflation and increasing the risk of regurgitation [104], but this should not occur with correctly applied cricoid pressure and using low peak ventilatory pressures [105, 106]. Currently, gentle bag/facemask ventilation (maximal inflation pressure < 20 cmH_2O) is recommended after administration of induction drugs during rapid sequence induction as it can reduce oxygen desaturation [104], and may allow an estimation of the likelihood of successful bag–facemask ventilation should it be required during prolonged or failed intubation attempts.

First intubation attempt

Anaesthetists must be familiar with the performance benefits and limitations of the laryngoscopes available on their airway trolley. A short-handled Macintosh laryngoscope has been the device of choice in the UK for tracheal intubation in pregnant patients. McCoy blades and obtuse angle devices (e.g. polio blade) are commonly stocked, although the latter are rarely used [12].

Videolaryngoscopes usually provide a better view of the glottis than direct laryngoscopes. There is extensive experience with their use in non-obstetric patients, including those with predicted difficult airways and following failed tracheal intubation [107–114], and it has been suggested that a videolaryngoscope should be the first-line device for all tracheal intubations [115].

A videolaryngoscope should be immediately available for all obstetric general anaesthetics. Currently, they are stocked in 90% of obstetric units in the UK [12]. In obstetric practice, videolaryngoscopes have been used at elective caesarean section, in morbidly obese patients and during failed intubation [116–125]. However, currently there are no comparative studies of the best videolaryngoscope for the obstetric population [126]. Despite a good glottic view, subsequent insertion of the tracheal tube may not be straightforward [127], and trauma has been described, particularly when using devices that require a stylet [128–131].

If a poor view of the larynx is obtained at the first laryngoscopy, attempts should be made to improve the view by reducing or removing cricoid pressure, external laryngeal manipulation and repositioning the head and neck [132, 133]. Insertion of the tracheal tube can be facilitated with the use of a tracheal tube introducer (bougie) or a stylet. However, repeated attempts or blind passage of a bougie or tracheal tube carries a risk of airway trauma [45, 134–136]. Small tracheal tubes (e.g. size 7.0) should be used routinely to improve the success rate and minimise trauma.

Second intubation attempt

If the first attempt at intubation fails, the second attempt should be by the most experienced anaesthetist present, using alternative equipment as appropriate. If delay is anticipated, we recommend that mask ventilation is recommenced during preparation. Cricoid pressure should be released as it may be the cause of the poor view; however, the view of the larynx may be improved by external laryngeal manipulation guided by the anaesthetist [133, 137]. If there is a grade-3b or -4 view at laryngoscopy, the success rate of blind insertion of a bougie or tracheal tube is low and the risk of airway trauma is high, especially with multiple attempts; early abandonment of attempts at intubation is strongly recommended to avoid causing trauma and loss of control of the airway. A third attempt at intubation should

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only be by an experienced anaesthetist. Administration of a further dose of intravenous anaesthetic should be considered to prevent awareness [95].

Verify tracheal intubation

Deaths from oesophageal intubation still occur in the UK [45, 138]. A sustained capnographic trace is the most reliable method of confirming tracheal intubation. Severe bronchospasm or a blocked tracheal tube may rarely cause absent ventilation with a flat capnograph trace in spite of a correctly placed tracheal tube [31, 45, 139]. However, if a flat trace is seen after intubation, the presumption must be that the tracheal tube is located in the oesophagus until proven otherwise.

Secondary methods of assessing correct tracheal tube position include seeing the tube positioned between the vocal cords using a direct laryngoscope or videolaryngoscope, auscultation in the axillae and over the epigastrium, the oesophageal detector device [140] and fibreoptic inspection to see the tracheal rings and carina [45]. New methods such as ultrasonic localisation are promising, but require further studies [141].

Algorithm 2 – obstetric failed tracheal intubation (Fig. 4)

If the second intubation attempt is unsuccessful, a failed intubation must be declared to the theatre team who should call for further help from an experienced anaesthetist. Once a failed intubation has been declared, the focus is to maintain oxygenation via either a facemask or a SAD, and prevent aspiration and awareness. An oropharyngeal airway, a four-handed (two-person) technique and release of cricoid pressure should be used if facemask ventilation is difficult [142].

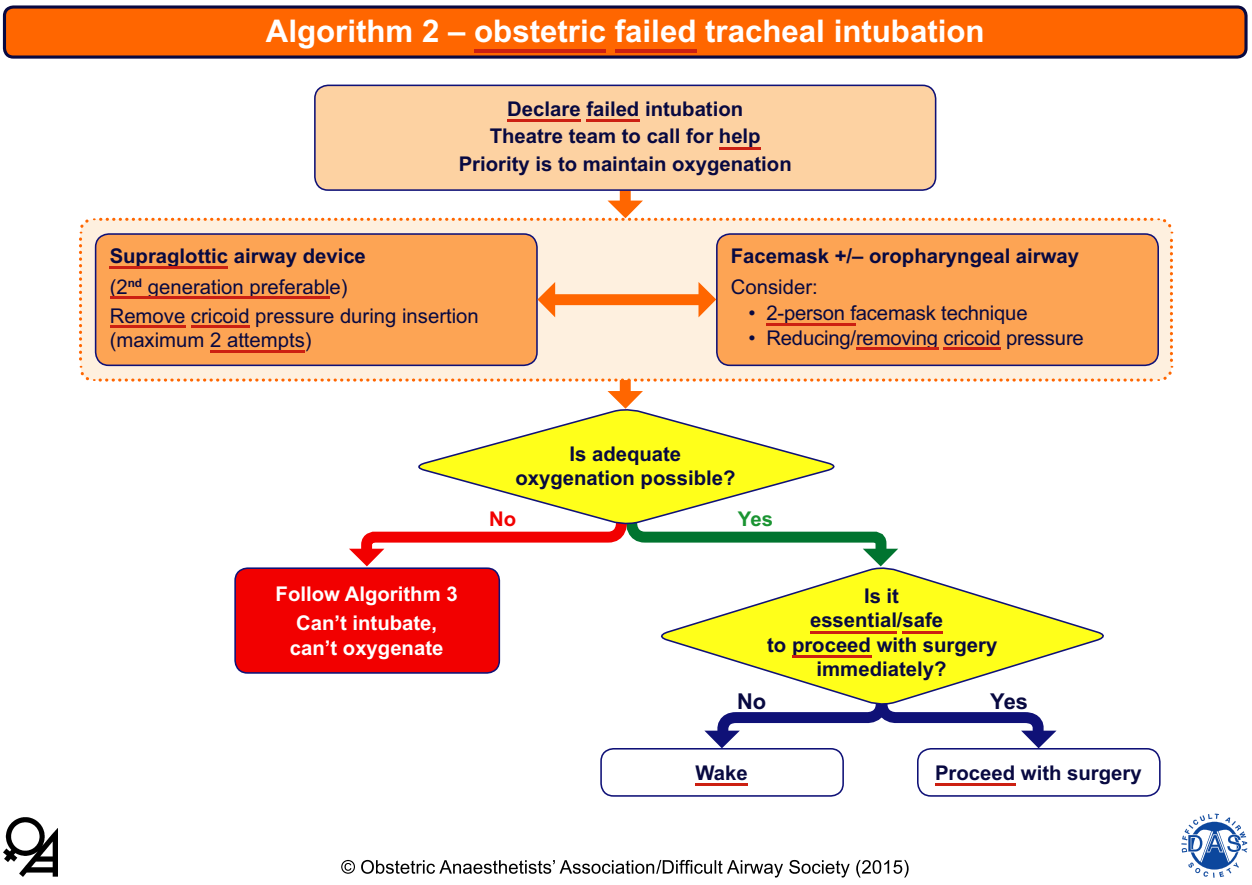

Figure 4 Algorithm 2 – obstetric failed tracheal intubation. The yellow diamonds represent decision-making steps; the lower right decision step links to Table 1 (Fig. 3). The boxes at the bottom link to Table 2 (Fig 6). The algorithms and tables are reproduced with permission from the OAA and DAS and are available online in pdf and PowerPoint formats.

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If facemask ventilation has been attempted and found to be difficult, or the pre-induction decision was to proceed with surgery (Table 1; Fig. 3), immediate insertion of a SAD is the preferred choice before the induction agent and suxamethonium wear off. Use of a laryngoscope may aid SAD placement [143, 144]. Studies have shown that cricoid pressure applied with standard 30-N force using the single-handed technique impede laryngeal mask placement and adequate lung ventilation [87, 88]. This may be because cricoid pressure prevents the distal part of the laryngeal mask from occupying the hypopharynx [88]. We recommend that cricoid pressure should be released temporarily during insertion of a SAD.

A second-generation SAD with a gastric drain tube is recommended to allow the passage of a gastric tube and the ability to generate higher inflation pressures [45]. It is important that the device is positioned and fixed correctly to ensure that gastric contents are vented through the oesophageal port [145]. If the SAD has an inflatable cuff, this should be inflated to the minimal pressure required to achieve an airway seal, and never exceeding 60 cmH_2O [146]. If the first SAD does not provide an effective airway, an alternative size or device should be considered. As with tracheal intubation, multiple attempts at SAD placement increase the risk of trauma [147], and hence we recommend a maximum of only two insertion attempts.

Algorithm 3 – 'can't intubate, can't oxygenate' (Fig. 5)

A period of failed ventilation is not uncommonly reported after failed intubation, but is usually not

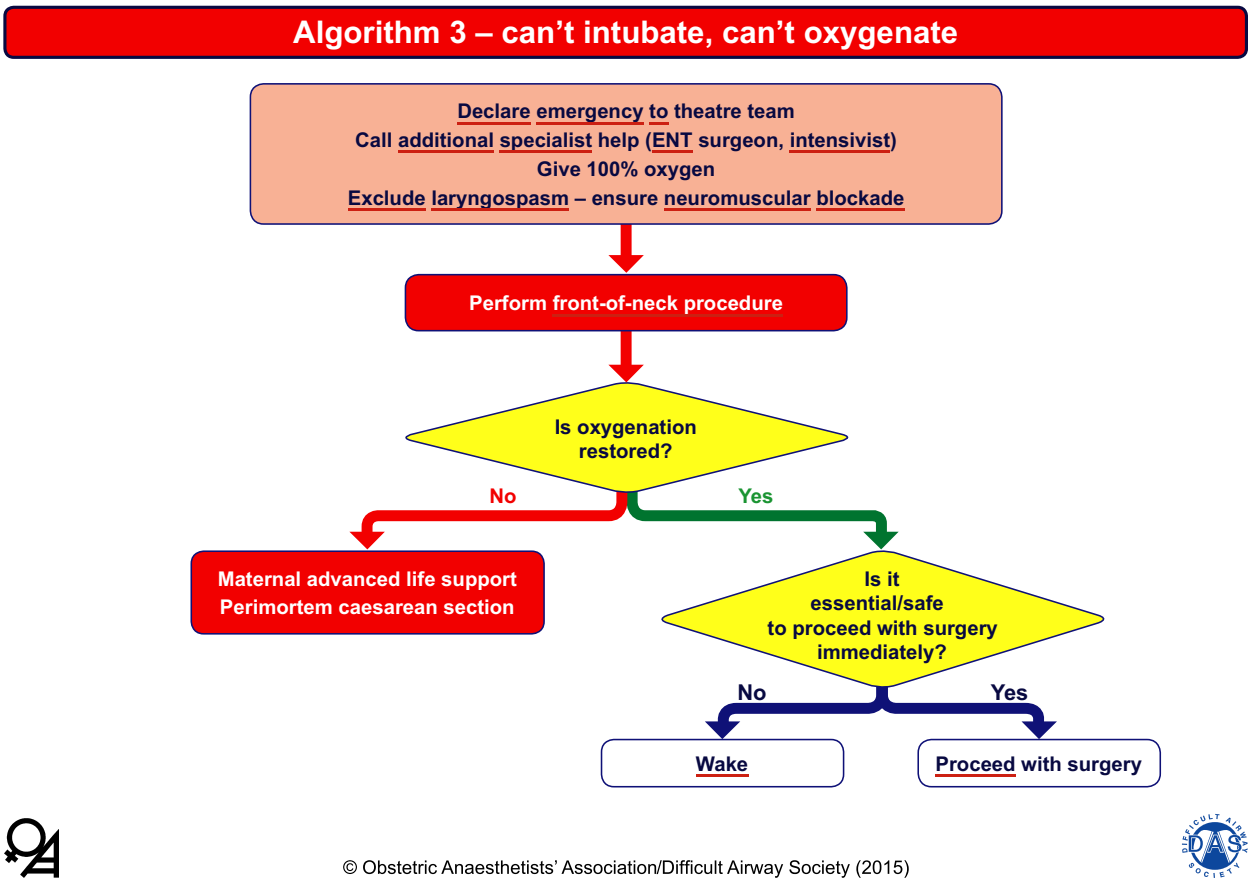

Figure 5 Algorithm 3 – 'can't intubate, can't oxygenate'. The yellow diamonds represent decision-making steps; the lower right decision step links to Table 1 (Fig. 3). The boxes at the bottom link to Table 2 (Fig. 6). ENT, ear, nose and throat. The algorithms and tables are reproduced with permission from the OAA and DAS and are available online in pdf and PowerPoint formats.

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sustained [9]. Persistent failure to ventilate despite optimal attempts using a SAD and/or facemask may be caused by intrinsic patient factors; however, laryngeal spasm and poor chest wall compliance are potentially modifiable and may be improved by ensuring full neuromuscular blockade. If suxamethonium was used at induction, then if available the rocuronium/sugammadex combination is preferred.

When a 'can't intubate, can't oxygenate' situation has been declared, specialist help such as ear, nose and throat surgeon and/or intensivist should be called.

Front-of-neck procedure

The recommendations for performing a front-of-neck procedure are changing continually with respect to equipment, technique and human factors. A small-bore cannula technique has a high failure rate, especially in obese patients [45]. A surgical airway provides a definitive airway and has a higher success rate [148]. Ultrasound of the neck may be a useful aid to locate the correct site for front-of-neck access, even as an emergency procedure [149]. We suggest that current DAS guidelines for emergency front-of-neck airway access in the non-obstetric patient are followed (see http://www.das.uk.com/guidelines/downloads.html).

If the front-of-neck procedure fails to restore oxygenation, a cardiac arrest protocol should be instituted, including caesarean delivery if there is an undelivered fetus of > 20 weeks' gestation [150].

Is it safe or essential to proceed with surgery immediately?

If adequate oxygenation is achieved by any method after failed intubation, the provisional decision to wake the patient or continue general anaesthesia and proceed with surgery should be reviewed, especially with regard to a possible change in severity of maternal or fetal compromise (Table 1; Fig. 3). The airway device and the presence of airway obstruction must be considered; suboptimal airway control, airway oedema, stridor and airway bleeding indicate a potentially unstable situation that may deteriorate during surgery if anaesthesia is continued and will lead towards a decision to wake up.

Table 2 – management after failed tracheal intubation (Fig. 6)

Wake

If the decision is made to wake the patient following a failed intubation, oxygenation needs to be maintained while avoiding regurgitation, vomiting or awareness. Early failed intubation guidelines called for the woman to be turned into the left lateral recumbent position with or without head-down tilt, whereas more recent guidelines usually suggest maintaining the supine position with lateral uterine displacement [7]. In the event of regurgitation or vomiting, the lateral head-down position ensures the least risk of aspiration. However, the left lateral head-down position presents problems such as difficulty with turning heavier women, poor facemask seal and unfamiliarity; therefore, the supine head-up position may be preferable if some of these factors apply. During awakening, there is a risk of laryngeal spasm and a 'cant intubate, can't oxygenate' situation; the anaesthetist should prepare for this with appropriate equipment, drugs and personnel. If there is persisting paralysis and the clinical situation allows it, administration of further anaesthetic agent to reduce the chance of awareness should be strongly considered. Rocuronium should be reversed with sugammadex if it is available.

Following waking, the urgency of delivery should be reviewed with the obstetrician. The preferred options are regional anaesthesia or securing the airway while awake followed by general anaesthesia. Further anaesthetic management will require the woman's cooperation, suggesting that this must wait until she is responsive to command [151]. The lateral position is usually preferable for siting regional anaesthesia, especially if the woman's conscious level is impaired. If regional anaesthesia is performed, a backup plan for high or failed block must be formulated.

Awake intubation will usually be via the oral route, as nasal intubation risks bleeding from the nose. After topical anaesthesia has been established, intubation can be performed with a fibrescope, videolaryngoscope [152, 153] or direct laryngoscope as appropriate. Any accompanying sedation should be minimised.

Tracheostomy may be the preferred option if the initial management has demonstrated features indicating extreme difficulty or danger with tracheal intubation via the upper airway.

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Table 2 – management after failed tracheal intubation

Wake

- Maintain oxygenation
- Maintain cricoid pressure if not impeding ventilation
- Either maintain head-up position or turn left lateral recumbent
- If rocuronium used, reverse with sugammadex
- Assess neuromuscular blockade and manage awareness if paralysis is prolonged
- Anticipate laryngospasm/can't intubate, can't oxygenate

After waking

- Review urgency of surgery with obstetric team
- Intrauterine fetal resuscitation as appropriate
- For repeat anaesthesia, manage with two anaesthetists
- Anaesthetic options:
  - Regional anaesthesia preferably inserted in lateral position
  - Secure airway awake before repeat general anaesthesia

Proceed with surgery

- Maintain anaesthesia
- Maintain ventilation - consider merits of:
  - controlled or spontaneous ventilation
  - paralysis with rocuronium if sugammadex available
- Anticipate laryngospasm/can't intubate, can't oxygenate
- Minimise aspiration risk:
  - maintain cricoid pressure until delivery (if not impeding ventilation)
  - after delivery maintain vigilance and reapply cricoid pressure if signs of regurgitation
  - empty stomach with gastric drain tube if using second-generation supraglottic airway device
  - minimise fundal pressure
  - administer H_2 receptor blocker i.v. if not already given
- Senior obstetrician to operate
- Inform neonatal team about failed intubation
- Consider total intravenous anaesthesia

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Figure 6 Table 2 – management after failed tracheal intubation. i.v., intravenous. The algorithms and tables are reproduced with permission from the OAA and DAS and are available online in pdf and PowerPoint formats.

If the anaesthetic was being provided for operative delivery, the neonatologist should be informed about the failed intubation, as this is an independent predictor of neonatal intensive care unit admission [9].

Proceed with surgery

When the decision has been made to continue with general anaesthesia and surgery, key issues to consider are: choice of airway device and ventilation strategy; maintenance of anaesthesia; use of cricoid pressure; drainage of gastric contents; and plans to perform delayed tracheal intubation if required.

Hypoxaemia may occur from causes other than hypoventilation, and its presence is not an absolute indication to change the airway device if pulmonary ventilation is adequate. Furthermore, ventilation/perfusion mismatch and pulmonary compliance may improve after delivery at caesarean section, and urgency may therefore dictate temporarily accepting suboptimal conditions until delivery.

A decision to use spontaneous or controlled ventilation should be made on a case-by-case basis; controlled ventilation was used after failed intubation in two-thirds of cases in a UK survey [12]. Positive pressure ventilation may be achieved with or without using a neuromuscular blocking drug. Using a neuromuscular blocking drug has several advantages including prevention of laryngospasm, reduction in peak airway pressures and gastric insufflation, and facilitation of surgery by reducing abdominal muscular tone; its use must be monitored with a peripheral nerve stimulator. The surgery should be performed by the most experienced surgeon available, and only minimal fundal pressure should be used to assist delivery. The neonatal team should be informed about the failed intubation.

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Effective cricoid pressure is unlikely to be sustained beyond 2–4 min [154]. However, cricoid pressure should ideally be maintained until after delivery, following which it may be cautiously released; a high vigilance for regurgitation should be maintained throughout surgery.

If a second-generation SAD with a drain tube has been used, the stomach contents should be suctioned at the proximal end of the drain tube if regurgitation is occurring, or via a gastric tube inserted through the drain tube at an appropriate time during the case.

After failed intubation, anaesthesia should initially be maintained with a volatile agent. A non-irritant agent such as sevoflurane is advisable. Total intravenous anaesthesia with propofol should be considered if there is any concern about poor uterine contraction after delivery, as it does not produce a decrease in uterine muscle tone.

Constant evaluation of airway patency, ventilation and oxygenation is required during the case. If delayed tracheal intubation or front-of-neck access is required, this must not be attempted without additional senior anaesthetic assistance. Intubation via a SAD must only be attempted using a technique familiar to the anaesthetist. This should involve placement under direct vision with a fibrescope to avoid airway trauma and oesophageal intubation [155]. If a definitive airway is required and tracheal intubation cannot be performed safely, a tracheostomy will be required.

Extubation of the trachea

Problems at the end of anaesthesia and postoperatively may relate to pulmonary aspiration secondary to regurgitation or vomiting, airway obstruction or hypoventilation [31, 45, 138, 156, 157]. The Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society (NAP4) [45] showed that almost 30% of all adverse events associated with anaesthesia occurred at the end of anaesthesia or during recovery. In a series of 1095 women having general anaesthesia for caesarean section, McDonnell et al. recorded regurgitation in four cases at intubation and five at extubation (one of these at both intubation and extubation) [157]. The key issues in safe extubation are planning and preparation; the options for re-intubation should be considered, including the immediate availability of appropriate staff, equipment and drugs [158]. In obstetric practice, tracheal extubation is usually only performed when the woman is awake, responsive to commands, maintaining oxygen saturation and generating a satisfactory tidal volume. In the past, patients who had a rapid sequence induction underwent extubation in the left lateral/head-down position. More recently, there has been a trend towards extubation in the head-up position, which is likely to aid airway patency, respiratory function and access to the airway, especially in the obese parturient [159].

If re-intubation might be difficult (e.g. laryngeal or tracheal oedema in patients with pre-eclampsia or after traumatic intubation) or there is a concern with oxygenation, supplementary airway evaluation by direct laryngoscopy, fibreoptic examination or confirmation of an audible leak around a tracheal tube with the cuff deflated may be required. Transfer to the intensive care unit for controlled ventilation and delayed extubation may be appropriate [20, 158, 160, 161].

Debriefing and follow-up

Following an anticipated or unanticipated difficult airway, task debriefing is an important opportunity for the individual and team to reflect on their performance. Successful debriefing is achieved by identifying aspects of good performance, areas of improvement and suggestions of what could be done differently in the future [45, 162, 163].

It is good practice to perform a follow-up visit for all obstetric patients who have undergone general anaesthesia, but this is particularly important after a difficult or failed tracheal intubation. Minor injuries are common. Serious but rare morbidity includes trauma or perforation to the larynx, pharynx or oesophagus. Perforation, presenting with pyrexia, retrosternal pain and surgical emphysema, is associated with a high mortality; if suspected, urgent review by an ear, nose and throat specialist is recommended [164]. Awareness during anaesthesia is more frequent if intubation has been difficult, and direct enquiry should be made about this during the follow-up visit [95, 165].

In cases where management of the patient's airway has been difficult, full documentation should be made about the ease of mask ventilation, grade of laryngoscopy, airway equipment or adjuncts used,

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complications and other information that may assist with decision-making during future anaesthetics. A proforma is often used (DAS alert form) [166] for a letter to the patient and her general practitioner; if failed intubation has occurred, the READ code[1] SP2y3 should be included [167, 168]. For complex cases, it is good practice to offer the patient a follow-up outpatient appointment with an anaesthetist.

Teaching

The majority of failed intubations in obstetrics occur out of hours and in the hands of trainee anaesthetists [12, 22, 23], and there is hence a need to maximise training opportunities. The Royal College of Anaesthetists recommends that all general anaesthetics for elective caesarean section in training institutions should be used for teaching [169]. Components of airway control may also be taught in other clinical (bariatric, rapid sequence induction) and non-clinical (manikin, wetlab [170], low-/high-fidelity simulation) environments. Boet et al. suggested that high-fidelity simulation training, along with practice and feedback, can be used to maintain complex procedural skills for at least one year [171].

There is a growing range of specialised airway devices, and expertise in their use may take a significant caseload to develop [172, 173]. Anaesthetists should develop competence in the use of any advanced airway equipment that is stocked in their hospital. Training on airway equipment and management of failed intubation should include other professionals who assist the anaesthetist and recover patients [174].

Front-of-neck airway access is needed in only 1 in 60 failed intubations [9], but when done effectively and without delay, may be life-saving. Providing training in these techniques, especially surgical cricothyroidotomy, is difficult; the wetlab is more realistic than manikins for these skills. A large proportion of the management of such an extreme situation involves non-technical skills. These include leadership, decision-making, communication, teamworking and situational awareness. Clinical information from critical incidents may be used as a basis for multidisciplinary simulation teaching [175]. Table 1 may be used in simulations as well as case-based discussion to explore the interaction of factors involved in the decisions about continuing anaesthesia and airway control, or waking after failed intubation.

The use of checklists and cognitive aids can improve standardisation, teamwork and overall performance in operating theatres and during crisis situations [43, 176–181], and several have been described for use in general [45, 182] and obstetric anaesthesia [44, 183, 184].

Future directions and research

Anaesthetic departments should review all cases of obstetric failed tracheal intubation, in a multidisciplinary setting when relevant. There should be a mechanism for practitioners to report cases of failed intubation to a central national register, to share information on new equipment and techniques used during management. There is a wide and ever-increasing range of specialised airway equipment, with little evidence on comparative merits; selection should be based on 'ADEPT' guidance [185]. The use of rocuronium with sugammadex at induction of anaesthesia requires greater familiarity: further research into the recovery profile and return of airway patency with use of this combination during the management of failed intubation is desirable.

Conclusions

These guidelines cover the essential elements and steps for safe management of obstetric general anaesthesia, with the intention of minimising the incidence of failed tracheal intubation while ensuring optimal management should it occur. The algorithms use simple flow pathways with minimal decision points. Algorithm 1 incorporates items to check during the preparation, planning and delivering of anaesthesia, to supplement the World Health Organization checklists. Table 1 allows a more structured evaluation of the multiple pre- and post-induction factors salient to the decision whether to wake or proceed after failed intubation (Algorithm 2) or a front-of-neck procedure (Algorithm 3); the examples in the rows are illustrative and will assume different importance both for individual practice as well as unit-based approaches, and

[1] Standardised clinical terminology code for UK general practitioners.

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therefore an individual case might be managed differently by different anaesthetists. Besides a clinical tool, the table can act as a focus for case-based teaching. Table 2 formulates detailed management for both awakening and proceeding with surgery after failed intubation, an area that has not been described in detail previously. We hope that the publication of national guidelines will improve consistency of clinical practice, reduce adverse events and provide a structure for teaching and training in failed tracheal intubation in obstetrics.

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The authors have taken care to confirm the accuracy of information; however, medical knowledge changes rapidly. It is not intended that these guidelines represent a minimal standard of care during management of the difficult airway or failed intubation, nor should they substitute for good clinical judgement. The application of this information remains the responsibility and professional judgement of the anaesthetist.

The algorithms and tables are available in pdf and PowerPoint formats on the websites of the OAA (http://www.oaa-anaes.ac.uk/ui/content/content.aspx?id=179) and DAS (http://www.das.uk.com/guidelines/downloads.html) for download and use by readers subject to permission.

Competing interests

The OAA and DAS provided financial support during the development of these guidelines. MK is an Editor of *Anaesthesia* and this manuscript has undergone an additional external review as a result.

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Appendix 1 Factors that predict problems with tracheal intubation, mask ventilation, insertion of a supraglottic airway device and front-of-neck airway access.

	Tracheal intubation [186–191]	Facemask ventilation [188, 192]	SAD insertion [193]	Front-of-neck airway access [45]
Body mass index > 35 kg.m^{-2}	X	X	X	X
Neck circumference > 50 cm	X	X	X	X
Thyromental distance < 6 cm	X	X	X	
Cricoid pressure [81, 82, 87, 88]	X	X	X	
Mallampati grade 3–4	X	X		
Fixed cervical spine flexion deformity	X			X
Dentition problems (poor dentition, buck teeth)	X		X	
Miscellaneous factors (obstructive sleep apnoea, reduced lower jaw protrusion, airway oedema)	X	X		
Mouth opening < 4 cm	X			

SAD, supraglottic airway device.

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Editorial

Obstetric difficult airway guidelines – decision-making in critical situations

"***It's always difficult to make black and white out of the usual grey we get presented with***"

—Survey respondent [1]

Medicine is a risky business and anaesthetists are familiar with having to make difficult decisions when complex clinical emergencies arise. There are perhaps few more challenging anaesthetic situations than failed tracheal intubation and when this arises in the obstetric setting, the burden on the anaesthetist and the consequences of his/her actions may be considerable [2, 3]. The marked decline in general anaesthesia for caesarean section in many parts of the world in recent decades has reduced the likelihood of anaesthetists' encountering such a situation, but increased the pressure on them when they do: not only is caesarean section under general anaesthesia a relatively rare event for many anaesthetists, it tends to be reserved for women requiring the most urgent delivery [4, 5]. Conditions at these times are often adverse, the time pressure extreme and the 'stakes' may reasonably be described as high.

Algorithms to guide anaesthetists who encounter this emergency have been described [6, 7], but despite publication of a universal difficult airway guideline for non-obstetric, non-paediatric patients in 2004 [8], it is only now that national obstetric-specific difficult airway guidelines have been developed in the UK. These guidelines, jointly developed by the Obstetric Anaesthetists' Association (OAA) and Difficult Airway Society, are published in this edition of *Anaesthesia* [9], and we commend the authors for their careful and thorough work. We are certain that these guidelines will be a major tool for improving safety in obstetric anaesthesia.

It is no surprise that obstetric-specific difficult airway guidelines have been long in the making, given the myriad of settings in which the airway crisis may occur and the limited available evidence base [10]. These new guidelines aim to provide a consistent framework for providing safe obstetric general anaesthesia and the management of unanticipated difficult tracheal intubation, failed tracheal intubation and the dreaded 'can't intubate, can't oxygenate' (CICO). Discussion of management after failed intubation covers the different actions to be taken should the anaesthetist decide to wake the patient or proceed with general anaesthesia. The difficulty in making this decision is acknowledged by including criteria that aim to aid selection of the most appropriate option in the light of the differing circumstances of each particular case.

The guidelines' authors emphasise the value of greater simplicity in decision-making and the importance and influence of human factors, something lacking from many previous guidelines but increasingly recognised as crucially important, especially in a clinical crisis that may be unstable, complex and time-critical [11–13]. One aspect of this is how decisions are made, and despite the most prescriptive clinical guidelines, decision-making – or more specifically, making 'correct' decisions – is likely to pay a big part in influencing outcome. Here, we focus on some of the factors involved in this process, basing our discussion around points raised (and comments made by respondents) in a survey we conducted in 2012 [1] in which we presented UK OAA members with a hypothetical case, summarised in Box 1, and asked how they would proceed (and why), using an inductive approach to data analysis [14].

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Box 1 Summary of hypothetical case presented to obstetric anaesthetists [1].[1]
A healthy, 80-kg nulliparous woman in labour at 38 weeks, requiring category-1 caesarean section for sudden, severe, prolonged fetal bradycardia at night, 4 h after food. Normal airway/neck movement. No anaesthetist available to help for at least 20 min. Ranitidine/sodium citrate given. After pre-oxygenation, thiopental 400 mg + suxamethonium 100 mg given; grade-4 view on laryngoscopy; failed intubation despite re-positioning and two further attempts. Facemask ventilation fails despite Guedel airway; SpO_2 falls to 65%. Bag-ventilation effective but not perfect (inspiratory/expiratory noise around the device) with a standard laryngeal mask. SpO_2 96% on 100% oxygen. Cricoid pressure maintained throughout.

"We do need to recognise that these decisions are complex, made in the moment, and informed by very particular sets of circumstances"

—Survey respondent [1]

Making decisions – defined as 'choices among alternatives' – is an essential human behaviour that has been extensively studied in cognitive psychology but less so in the medical specialties [15]. It is not uncommon (e.g. in conversations in the workplace, presentations at meetings, and case reports published in the literature) to discuss clinical management of challenging cases (such as that in Box 1) in terms of *what* was done, rather than *why* the decisions were made that led to the actions taken. In our view, failure to explore the reasoning behind the decision-making and to discuss alternatives, and the circumstances under which they might be better, or worse, represents a failure of debriefing, from both a risk-management and an educational point of view. In such discussions, one also must recognise that there are many factors that may lead clinicians not to make consistent choices when faced with the same or similar critical event, and these too should be explored.

"We are always wiser in hindsight"

—Survey respondent [1]

Whether analysing an actual case or a survey/scenario, it is tempting to compare the decisions made with the 'model' solution, to attempt to determine whether the clinicians or a group of respondents made the 'correct' decision. One way of doing this might be to compare the actual decisions against published guidelines – something that is often done (in excruciating detail) in the Courts. However, such 'cold' analysis can easily overlook the human factors already mentioned, and makes the assumption that the guidelines are themselves logical and based on evidence – let alone the risk that a number of guidelines may conflict regarding 'best' management [16]. Similarly, the views of 'experts' may be diametrically opposed to one another [17]. Techniques that aim to apply a more logical analysis of treatment options have been described but they may suffer from a lack of evidence to inform both the likelihood of certain outcomes in such specific situations and the degree of 'preference' for one outcome over another [18]. Thus there are many unknowns: whether the airway will deteriorate during the case; whether the fetus's condition will worsen if the mother is woken; whether the mother would be best left supine with lateral tilt or turned fully lateral; whether ventilation should remain spontaneous or positive pressure ventilation applied, and whether neuromuscular blocking drugs should be given; whether a tracheal tube should be passed through the laryngeal mask (and if so, how), or whether that would risk making things worse. These considerations do not even take account of the vast array of airway equipment we may, or may not, have at our disposal [19].

"This case raises lots of ifs, buts and maybes, which would alter the decision process"

—Survey respondent [1]

The case presented in Box 1 excludes the subtleties that influence 'real-life' decision-making, and perhaps that is why such a disparity of results were obtained. Missing data that might be gathered as part of the general situational awareness of the anaesthetist actually present would include: the mother's past history; her social set-up; the equipment available and the anaesthetist's expertise using it; the

[1]Of the 928 responses (response rate 51%), 73% were consultants, suggesting a high level of obstetric anaesthetic experience and expertise; interestingly, they were divided in the actions they would take: 52% responded that they would maintain anaesthesia following failed intubation; while 47% chose to abandon surgery and wake the mother.

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skill and expertise of the surgeon(s), anaesthetic assistant and other staff; and the 'feel' of the airway during ventilation and whether it felt stable and the oxygen saturations were well maintained. Thus an experienced anaesthetist, used to managing difficult cases without tracheal intubation, with an experienced assistant who is confident at being able to maintain cricoid pressure, and an experienced and fast surgeon for a small baby with no other complicating factors, would be expected to decide differently from an inexperienced anaesthetist under the opposite circumstances. Experienced anaesthetists may even do one thing but advise another – this dichotomous behaviour was described by 2% of the anaesthetists who said they would continue anaesthesia; thus: "*I am experienced and would continue to save the fetus. I would advise a junior trainee always to wake the mother up and call for help*". It is difficult to legislate for such complexity in any set of guidelines.

"*I will call for help but foremost I must be confident in myself and keep calm*"

—Survey respondent [1]

So far we have considered mainly external factors (the circumstances of the case) but it is also important to realise that there are internal factors – and not just those relating to experience – also at play. These include the practitioner's underlying attitudes to risk and a host of cognitive biases that may hinder the application of his/her knowledge and skills and potentially compromise effective decision-making, as well as his/her current emotional state and ability to cope under stress [20]. Cognitive errors are less obvious than procedural errors and do not solely afflict the inexperienced. In the situation presented, an overriding fear of a dead baby or mother ("*The decision would haunt me, but I believe it is the right one*"), and a fear of criticism by colleagues and of breaching presumed medicolegal standards ("*The decision to carry on in these circumstances would be difficult to defend*"), may play heavily on some anaesthetists' minds.

"*I would like to think I would behave as I have indicated but in real life I may not*"

—Survey respondent [1]

Surveys of practice may suggest how respondents might behave but do not represent the real thing and cannot provide all the subtle factors that influence decision-making. When it comes to what anaesthetists actually *do* do when confronted with a similar situation to the one we presented, there is a distinct lack of detailed evidence. A recent, two-year, UK case-control study of failed obstetric intubation provides some clues [21]. The study focused more on risk factors and outcomes, and less on decision-making, but of 52 failed intubations at caesarean section, at least 30 cases proceeded under general anaesthesia with a supraglottic airway (A. Quinn, personal communication). Interestingly, of the four women who were woken, two were reported to be 'urgency grade 1' and of those women who were not woken, eight were for non-urgent indications. The authors remark: "*it is noteworthy that the clinicians chose to continue and not awaken the patients as per conventional teaching*", although no reference or detail of this teaching is provided. Whatever conventional teaching advises – and we are not certain exactly what that is – this is clearly a controversial and debatable area and has been so for over 20 years [22, 23].

It might appear that a significant majority of anaesthetists, at least those captured by Quinn et al.'s study, choose to continue anaesthesia rather than wake the patient when obstetric intubation fails in real-life. However, in the absence of specific details of the cases and accounts of why they decided to do what they did, little more can be concluded. Importantly, we cannot conclude that continuing anaesthesia is the *correct* decision, only this was what was done more frequently. Such data are nonetheless important, since they provide valuable information on rare outcomes, although we need to consider also how to gather data on the behavioural aspects of decision-making from real-life events, difficult though that is.

"*While we all agree that our priority is to the mother, it is extremely difficult to let a baby potentially die*"

—Survey respondent [1]

Of the anaesthetists who indicated they would wake the mother, the most often quoted reasons for doing so were the risks posed to her by an inadequate and unprotected airway (73%), and the primary duty of care to the mother (40%). Conversely, the commonest reasons quoted by those indicating they would continue were

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the risk to the fetus if delivery was delayed (64%) against a feeling that the airway, while not ideal, was adequate for the task at hand (75%). This illustrates how, when presented with the same information, people view and interpret it differently – though in real-life there would be more clues regarding adequacy of the airway and ventilation. These findings also demonstrate how people attach different priorities to the mother ("*My obligation is to put the mother's life as a priority over fetal demise*") and the fetus ("*There is an obvious fetal distress and the baby needs to be born*").

People (including anaesthetists) have different attitudes to risk [24], and the 'glass half-full/half-empty' views of the airway in our survey may illustrate this. Furthermore, those who said they would wake the mother were more likely to mention medicolegal factors or the possibility of facing criticism for risk-taking (see above), and 'teaching' or local policy that directed a specific action in this situation ("*Current guidelines used in my place of work are to wake the patient up unless the mother's life is in immediate danger*"). Accommodating clinicians' incongruent beliefs and risk perception within guidelines is difficult, but recognising that they exist is nonetheless important.

"*Guidelines are to guide. Clinical judgments are made according to experience and may well not fit a guideline in these situations*"

—Survey respondent [1]

Decision-making in this and other critical situations is complex, influenced by external *and* internal factors and compounded by ethical and medicolegal uncertainties and a limited evidence base – accounting for these variables in guidelines is difficult. However, good decision-making can enhance guidelines and we believe that people can learn how to make better decisions, but this demands attention on several fronts. The individual needs to understand the complexity of decision-making and his/her personal perception (and misperception) of risk that may lead to poor judgments. The trainer needs to recognise and utilise opportunities in the workplace to explore the reasons *why* decisions were made during the management of challenging clinical cases – trainees should be reassured that reflection, even when things don't turn out so well, can be a positive experience [11]. Finally, the research community that already recognises the important contribution of human factors, and the value of qualitative data collection in this area, should be commended and encouraged to continue and develop their good work.

It is reassuring that the authors of the new obstetric difficult airway guidelines emphasise the contribution of non-technical factors and the importance of decision-making in this setting [9]. We hope that greater focus on this interesting area can improve outcomes and lighten the load on anaesthetists managing these challenging and unpredictable cases.

"*The surgeon will already have started the operation, in my experience*"

—Survey respondent [1]

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Editorial

Point-of-care haemoglobin measurement – state of the art or a bleeding nuisance?

Intra-operatively, patients may experience major blood loss, which is independently associated with peri-operative mortality [1]. In this scenario, the anaesthetist must decide when a blood transfusion is required, and although plasma haemoglobin concentration (Hb) is the most commonly used transfusion trigger, there remains controversy regarding what level of Hb is appropriate as a definitive trigger [2]. To stand any chance of avoiding unnecessary blood transfusion, it is important to reliably and accurately measure Hb, and traditionally this has involved drawing blood for analysis, which is then processed at a location remote from the operating theatre. Apart from being invasive, this is time consuming and the Hb value may no longer be clinically relevant once obtained. In addition, the National Blood Transfusion Committee in the UK published 'Patient Blood Management' in June 2014, which recommended

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