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Review

Anaesthaesia for Category-1 urgency Ceasarean section

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Abstract

Caesarean section is the most performed surgical intervention worldwide. A proportion of these caesarean deliveries will necessitate emergency care for maternal and fetal compromise. Anaes-thetic management in these situations can be challenging and a short decision to delivery interval is burning. Current evidence suggests that multidisciplinary communication is essential to support anaesthetic management and optimise team performance. Communication should be supported by using a standardised classification of urgency tool. The four-grade classification scale has increasingly been adopted internationally. While neuraxial techniques are favoured for caesarean sections, gen-eral anaesthesia has an essential role in category 1 caesarean section (defined as a caesarean sec-tion in which there is an immediate threat to life for the mother or fetus). The risks and benefits of general and neuraxial anaesthesia for the woman and her baby must be carefully weighed on an individual base. Beyond the delivery of anaesthesia, other practical strategies, such as multidiscipli-nary team training, can contribute to improved maternal and neonatal outcomes.

Keywords: **Caesarean section, anaesthesia, category 1, decision-to-delivery interval, emergency caesarean section.**

Introduction

Caesarean section (CS) is the most performed surgical intervention worldwide. Recent data shows that 21% of women give birth by caesarean section worldwide, but there is significant regional variation with rates ranging from 5% in sub-Saharan Africa to 43% in Latin America[1]. A proportion of CS will be undertaken for maternal and fetal compromise necessitating emergency care. Anaesthetic management in these situations can be highly demanding. In this narrative review, current evidence is considered and a practical approach for safe anaesthetic care to optimise maternal and fetal outcomes in category 1 CS is discussed.

Classification of urgency of caesarean section

Traditionally the urgency of CS was classified as planned/elective or unplanned/emergency. This binary classification is inadequate because it fails to recognise the different degrees of urgency that may be included in the 'emergency' category. This can undermine communication in the multidisciplinary labour ward team and ultimately affect maternal and neonatal outcomes. Clear communication among all involved disciplines (obstetricians, anaesthesiologists, midwives and paediatricians) is crucial and will improve outcomes for a woman and her child. To optimise multidisciplinary communication, Lucas et al. introduced a four-grade classification scale (Table I)[2]. This scale, endorsed initially for use by the Royal College of Obstetricians and Gynaecologists in the UK and subsequently by the National Institute for Health and Care Excellence, has increasingly been adopted internationally[3]. A category 1 CS is necessitated when there is an immediate threat to life for the mother or fetus.

In large parts of Europe, non-elective CS are classified using a three-colour coding system: code-red corresponds to an emergency CS due to immediate

Table I. — Classification of urgency of CS developed by Lucas et al.[2]

Category	Definition
(1) Emergency	Immediate threat to life of the woman or fetus
(2) Urgent	Maternal or fetal compromise which is not immediately life threatening
(3) Scheduled	Needing early delivery but no maternal or fetal compromise
(4) Elective	At a time to suit the woman and maternity team

life-threatening maternal or fetal situations and is equivalent to category 1; code-orange describes an urgent CS related to maternal or fetal compromise which is not immediately life-threatening (equivalent to a category 2 CS), and code-green corresponds to a non-urgent CS (equivalent to category 3 or 4)[4].

The decision to delivery interval

When a CS is indicated for fetal compromise, the primary goal is to minimise the decision to delivery interval to minimise the risk of hypoxic ischaemic encephalopathy and improve neonatal outcomes. Hypoxic ischaemic encephalopathy occurs when the fetal brain is deprived of oxygen and can be associated with severe long-term neonatal morbidity and mortality. It can arise because of antepartum intra-uterine pathology (infection, congenital abnormalities), acute peripartum events (placental abruption, cord prolapse), and post-partum complications (intraventricular haemorrhage, sepsis)[5]. While medical error is an infrequent cause, the potentially catastrophic consequences of hypoxic ischaemic encephalopathy behoves anaesthesiologists to develop strategies to minimise the decision to delivery interval when fetal compromise becomes evident. A review of 21 years of medical litigation for anaesthetic negligence identified several contributory factors to hypoxic ischaemic encephalopathy for which anaesthesia may have had a role, including inadequate management of hypotension associated with spinal anaesthesia, failed intubation and delayed delivery of a second twin[6]. The same review additionally highlighted common themes including anaesthetic delay and poor communication between teams.

The appropriate time interval for the decision to delivery interval in the presence of fetal comprise has been widely discussed and is most frequently cited as 30 minutes. The origins of this figure are unclear and variously attributed to animal experiments from the 1960s or as a pragmatic time frame for an obstetrician to travel from home to a delivery unit and perform a CS[7,8]. This standard is used by many countries, including the UK and USA, although in some European countries, a 20-minute standard is used[9].

Despite the ubiquitous use of the 30 minute standard, studies have failed to demonstrate a correlation between worse outcomes and increasing decision to delivery intervals[10]. A systematic review of more than 30 observational studies examined the proportion of CS deliveries accomplished within 30 minutes and differences in neonatal outcomes in deliveries accomplished within 30 minutes compared to those beyond 30 minutes[11]. The authors found that there was a higher risk of an overall 5-minute Apgar score of less than 7 (odds ratio [OR] 3.10; 95% CI 1.93-4.96) and umbilical artery pH level less than 7.10 (OR 3.40; 95% CI 2.38-4.87) in cases involving shorter delivery intervals. However, analyses limited to category 1 deliveries did not show a statistically greater risk of Apgar score less than 7 (OR 0.69; 95% CI 0.11-4.51) or umbilical artery pH level less than 7.10 (OR 1.10; 95% CI 0.28-4.40) with shorter delivery intervals. The interpretation of these findings is limited by the considerable heterogeneity in the clinical indications that necessitate emergency CS, e.g., the inclusion of cases of cord prolapse with cases of labour delay. It would be potentially more helpful to examine the impact of decision to delivery interval time by focusing on one irreversible indication for emergency delivery, e.g., uterine rupture. In one small study examining the relationship between the decision to delivery interval and neonatal outcome in uterine rupture, poor neonatal outcomes were found with decision to delivery intervals of greater than 18 minutes[12].

Preparation for category 1 CS

Time constraints often limit a complete and detailed discussion, particularly before emergency general anaesthesia. Whatever the time constraints, it is important to explain as much as possible to the patient. A brief description of spinal or general anaesthesia, including risks and side effects, is important. Consent for a category 1 section is difficult to achieve, and despite all efforts, there is often an element of treating the patient in their best interest. A summary of considerations about preparation for category 1 is show in Box 1.

Box 1: Preparation and assessment for category 1 CS.

Discuss and explain the options for anaesthesia and seek consent

- For neuraxial anaesthesia, discuss the planned level of block and how it will be tested, the sensations that should be expected with an effective block, the possibility of pain, and the potential ways of treating it, including general anaesthesia.
- For planned general anaesthesia discuss the common risks of sore throat, poorer pain control afterwards (and potentially the use of abdominal wall blocks and patient controlled analgesia), postoperative nausea and vomiting, and the very rare risks of awareness and aspiration pneumonia.

Assess

- Past medical history - pre-pregnancy and current medical issues.
- Drug history & allergies.
- Previous anaesthetic history.
- The airway - Mallampati class, neck mobility, thyromental distance and dentition.

Check

- The patency of intravenous access.
- That monitoring is in place as soon as the epidural top-up is commenced. If the top-up is commenced in the labour room use portable monitoring and expedite transfer to the operating room.

Choice of anaesthesia for category 1 CS

The priority for category 1 CS is to balance minimising the decision to delivery interval with providing safe anaesthesia for the mother. This can represent a significant challenge to the anaesthesiologist. Neuraxial techniques are the preferred mode of anaesthesia for CS because of their optimal safety profile compared to general anaesthesia[13]. There are also social and emotional benefits, e.g., a birth partner is usually encouraged to be present in the theatre, and skin-to-skin contact can be established soon after delivery. However, general anaesthesia is usually considered to be faster and most likely to reduce the decision to delivery intervals and has an important role in category 1 CS. General anaesthesia may also be favoured in patients with haemodynamic instability due to massive haemorrhage or in women with sepsis. The choice of anaesthetic technique must assess and balance the risks for the individual patient.

Neuraxial techniques - spinal anaesthesia

Single-shot spinal anaesthesia is a widely used technique that provides fast and reliable surgical anaesthesia for CS[14]. Typically, spinal anaesthesia includes a local anaesthetic such as bupivacaine with an opioid. The recommended dose of 0.5% bupivacaine is between 10 and 15 mg[15,16]. Lower doses of local anaesthetic have been advocated to reduce spinal hypotension[17] and this has been assessed in systematic review comparing outcomes between low-dose hyperbaric bupivacaine (≤ 8mg) with high-dose (≥ 8mg) for elective CS[18]. In the low-dose group, the authors found a significant reduction in intraoperative hypotension (RR=0.78) and nausea and vomiting (RR=0.71). However, there was an increased need for supplemental analgesia and conversion to general anaesthesia seen with lower doses; therefore when using low dose spinal anaesthesia, a combined spinal-epidural technique should be used[17]. Combined spinal-epidural is less practical for category 1 CS because of the additional time taken to site the block.

The addition of an opioid can contribute to intraoperative anaesthetic quality and improve postoperative analgesia and is recommended in international guidance[19–21]. Hydrophilic opioids, such as morphine, have a slower onset (30–60 min) but a more sustained duration of action[22]. In contrast, lipophilic opioids, e.g., fentanyl or sufentanil have a more rapid onset and can contribute to intraoperative quality of the block but cannot contribute to postoperative analgesia.

Therefore, a spinal injectate should ideally include a combination of fentanyl (or sufentanil) with morphine plus local anaesthetic. The fentanyl (or sufentanil) dose would supplement the local anaesthetic and analgesia during a CS, while morphine would provide longer-duration postoperative analgesia. However, the potential benefit of drug combinations for spinal anaesthesia for category 1 CS must be balanced against the increased preparation time required.

A less frequently considered aspect of neuraxial anaesthesia is patient positioning during block placement. Most anaesthetists prefer the sitting position for siting spinal anaesthesia because it is easier to define the midline, particularly in obese patients. Suggested advantages of the lateral position are that it is a more comfortable position for a woman to maintain during siting of a spinal and may be easier and quicker for transferring a woman from the bed onto the operating table[23]. There are some situations, particularly relevant to category 1 CS, e.g., cord prolapse, where it may not be possible for a woman to sit during a spinal and also some evidence that uteroplacental perfusion is better in the lateral position compared to sitting[24]. The relative benefits and disadvantages of lateral versus sitting positions remain controversial. Ultimately, in these urgent situations, the prime consideration is which patient position the anaesthesiologist is most likely to succeed in siting the spinal, and this will be affected by personal preference and experience.

Studies suggest that a spinal block sufficient for surgery may be ready within 6 minutes of the injection time. However, this can be unpredictable and additionally, the time required to site the block will add to the overall time taken to provide anaesthesia. A modification to the standard technique of spinal anaesthesia that can be used in an emergency is the 'rapid sequence spinal'[25]. Rapid sequence spinal describes an approach to administering spinal anaesthesia in an emergency to minimise the anaesthesia time. The elements of rapid sequence spinal include:

- Deploying other staff to obtain intravenous access and establish monitoring – do not start the spinal injection until a cannula is secured.
- Using a 'no touch' technique – gloves only, with the glove packet as a sterile surface for equipment and skin preparation with a single wipe of 0.5% chlorhexidine solution.
- Consider using an increased dose of hyperbaric bupivacaine 0.5% (up to 3ml) if no opioid is used. Add opioid if procuring it does not produce an unacceptable delay.
- Skin infiltration with local anaesthetic is not mandatory.
- Attempt spinal anaesthesia only once, unless an obvious correction (e.g., to patient position) would support a second attempt.
- If necessary, start surgery when block height ≥T10 and ascending. Be prepared to convert to general anaesthesia if the block height fails to ascend sufficiently rapidly

The rapid sequence spinal was first described by Kinsella et al., who presented a series of 25 rapid sequence spinal anaesthetics for category 1 CS with a mean decision to delivery interval of 23 minutes. Since the first description there have been supporters and challengers of the role of rapid sequence spinal in emergency obstetric anaesthesia. Proponents suggest that in balancing risks, avoiding general anaesthesia outweighs the theoretical risks attributed to rapid sequence spinal, including the risk of infection. Good communication between the multidisciplinary team is an essential component of the rapid sequence spinal. It should not be undertaken by the inexperienced practitioner and should only be introduced after appropriate team training.

Top-up of labour epidural analgesia

If a category 1 CS is needed in a woman with an existing labour epidural, it may be possible to 'top-up' the epidural to convert labour analgesia to surgical anaesthesia. Key considerations around ensuring rapid, effective, and safe management of epidural extension are which epidurals to top-up, what drug to use and where to initiate the top-up. In a systematic review that assessed risk factors for failure of conversion of labour analgesia for CS, factors that were associated with an increased risk of failed conversion included an increasing number of clinician-administered boluses during labour (OR=3.2, 95% CI 1.8-5.5) and greater urgency for CS (OR=40.4, 95% CI 8.8-186)[26]. These factors underline the role of the anaesthesiologist as part of the labour ward multidisciplinary team and the value of active anaesthetic care for women on the labour ward, e.g., after a labour epidural has been sited it should routinely be reviewed to ensure it is effective should conversion to anaesthesia for CS be required. Poorly performing epidurals should be re-sited. Alongside this, maintaining ongoing communication with the obstetric team is essential to identify those women most likely to require a CS.

The optimal local anaesthetic to top-up labour analgesia for CS has been widely discussed. In a network meta-analysis Reschke et al. assessed the speed of onset of six local anaesthetics commonly used to extend labour epidural analgesia for CS[27]. The speeds of onset of surgical anaesthesia, from fastest to slowest, were lidocaine 2% with

bicarbonate; 2-chloroprocaine 3%; lidocaine 2%; ropivacaine 0.75%; l-bupivacaine 0.5%; bupivacaine 0.5%. The rate of intra-operative supplementation of analgesia was least after ropivacaine and highest after 2-chloroprocaine, 3%. However, the interpretation of this analysis is limited by the heterogeneous nature of contributory studies, e.g., different regimens used during labour before the top-up and different methods of block assessment. Additionally, the differences observed in the analysis were small. Another aspect of the speed of a drug's onset to extend labour epidural anaesthesia is the potential impact of preparation times for local anaesthetic solutions and the safety of this practice[28]. Solutions are usually made up immediately before use because of concerns about the instability of previously mixed preparations of local anaesthetic and additives such as epinephrine and bicarbonate; there is, therefore, the potential for a delay while such solutions are prepared. The more complex the mixture, the greater the potential for preparation errors, especially during the emergency setting of a category 1 CS. Other hazards of mixing solutions include the possibility of bacterial contamination and drug incompatibility; for example, adding bicarbonate 2 ml to 0.5% bupivacaine 20 ml causes instant precipitation[29]. It is our view that the balance of speed of onset, requirement for intraoperative supplementation and safety is best met by drugs that do not require preparation before use, e.g., ropivacaine 0.75% or 2-chloroprocaine, 3%.

The role of opioids in extending labour epidural analgesia for category 1 CS remains unclear. A meta-analysis of trials investigating the most effective agent to extend labour analgesia found that adding 50–75 μg epidural fentanyl to local anaesthetic decreased the onset time of surgical blockade by a mean difference of more than 2 min[30]. However, it did not reduce the need for intraoperative supplementation and may increase intraoperative nausea and vomiting. Despite a lack of compelling evidence, a pragmatic approach may be to use epidural fentanyl or sufentanil as part of the top-up solution (although commencing the local anaesthetic top-up should not be delayed while opioids are obtained from controlled drug storage).

The location of the administration of epidural top-up to convert epidural analgesia to anaesthesia for CS remains controversial. Topping-up in the delivery room before transferring the woman to the operating room can minimise the decision to delivery interval but topping-up the epidural in the operating room may be safer. Evidence from practice surveys suggest that anaesthesiologists are developing a more cautious approach. In a UK survey of practice the proportion of anaesthesiologists who gave the full top-up in the delivery room declined from 68% in 2008 to 14% in 2014[31]. A strategy that balances safety and speed may be for the anaesthetist to support the labour ward team in expediting patient transfer to the theatre rather than topping up in the delivery room. If the top-up is administered or started in the delivery room, the anaesthetist should ensure that they have both monitoring and vasopressor drugs immediately available[32]. A checklist to support the management of an epidural top-up for CS is shown in Box 2.

Management of hypotension associated with neuraxial anaesthesia

Hypotension following spinal anaesthesia is common and can cause maternal and fetal/neonatal adverse effects. It may also arise with extension of labour epidural analgesia. It is paramount that prophylactic measures are used and there is international guidance on this topic33. These are summarised in Box 3.

Box 2: Epidural top-up checklist.

Is there evidence of effective analgesia?	*Check effectiveness of labour analgesia with patient and midwife.* *Check epidural record – frequency of top-ups/ bolus doses/drugs used.*
Is there evidence of a symmetrical block	*Are both feet warm?*
Is the epidural still in situ?	*Check for catheter dislodgement or leakage.*
What is the existing block height /characteristics?	*Check block height to cold.* *Check the presence and extent of motor block.*

Box 3: Prophylaxis of hypotension associated with spinal anaesthesia based on international recommendations[33]

- Maintain systolic arterial pressure at ≥ 90% of an accurate baseline obtained before spinal anaesthesia and avoid a decrease to < 80% baseline.
- α-agonist drugs are the most appropriate agents to treat or prevent hypotension following spinal anaesthesia. Phenylephrine is currently recommended.
- Use a variable rate prophylactic infusion, e.g., with a syringe driver, of phenylephrine. The initial infusion rate should be 25–50 $\mu g.min^{-1}$ started immediately after the intrathecal local anaesthetic injection and titrated to blood pressure and pulse rate.
- Fluid co-loading should be used in addition to vasopressors.
- Aortocaval compression should be avoided with left lateral uterine displacement.

Prevention and management of pain during CS under neuraxial anaesthesia

Although neuraxial anaesthesia is generally reliable, failure can be associated with intraoperative pain. A woman who experiences pain during CS under neuraxial anaesthesia is at risk of adverse psychological sequelae[34]. To minimise the risk of failure of neuraxial anaesthesia, alongside using a recognised technique with adequate doses of local anaesthetic and opioids, it is essential that an assessment of the block is undertaken before starting surgery. However, objective assessment of neuraxial anaesthesia can be challenging and surveys of practice in this area reveal significant variation[35–37]. The urgent need for guidelines to support best practice and offer a standardised approach to practice in this area has been recognised by the publication of national guidelines in the UK and France[38,39]. Both guidelines focus on three thematic areas: patient consent, assessment of the neuraxial block and management of intraoperative pain. Regarding the latter, if a woman experiences pain during CS under neuraxial anaesthesia, management may include converting to general anaesthesia. If a clinician disregards a woman's experience intraoperatively, it may worsen her distress, and contribute to the development of psychological trauma[40]. Finally, the guidelines emphasise the crucial role of follow-up for women who experience pain and distress during CS under neuraxial anaesthesia.

General anaesthesia

The use of general anaesthesia for CS has declined over the last forty years but it still has a valuable role in anaesthesia for category 1 CS. The anaesthetic focus during general anaesthesia for CS is on minimising the specific risks of hypoxia, aspiration, awareness and failed intubation. Pregnant women have a higher risk of difficult or failed intubation, the development of hypoxaemia during induction and intubation, and pulmonary aspiration. Studies suggest that the incidence of failed tracheal intubation in obstetric patients is higher than in the non-obstetric population[41,42] . In 2015, the Obstetric Anaesthetists' Association and Difficult Airway Society (OAA/DAS) published guidelines for managing difficult and failed tracheal intubation in obstetrics[43]. These guidelines provide algorithms for the safe management of general anaesthesia in obstetrics, failed tracheal intubation, and a 'can't intubate, can't oxygenate' situation (Fig. 1,2,3). They also describe factors to assist decision-making around whether to wake a woman or proceed following failed tracheal intubation (Table II). The question of whether to proceed or wake the mother up is difficult, (particularly for the solo trainee working out-of-hours) and may be associated with considerable pressure from the obstetricians[44]. While the focus on safety during general anaesthesia for CS is on the mother's life, there may be situations where it is appropriate to proceed. The final decision will depend on the anaesthesiologist's clinical judgement and will be based on a combination of their personal experience, the clinical indication for CS, and the apparent effectiveness/stability of the airway control.

Hypoxaemia during induction of obstetrics general anaesthesia is common, with recent studies suggesting an incidence of 9.4%[42]. Effective preoxygenation before induction and intubation is essential to extend 'the safe apnoea time'. A wide variety of strategies for preoxygenation in obstetrics have been described [45]. There is currently significant interest in the role of high-flow nasal oxygen as a pre-oxygenation tool. However, volunteer studies have failed to establish a benefit of high-flow nasal oxygen over standard techniques (as assessed by the ability to achieve optimal preoxygenation, i.e., end-tidal oxygen >90%)[46,47]. Zhou et al. evaluated the efficacy of high-flow nasal oxygen compared with the conventional facemask for oxygenation during rapid sequence induction for CS under general

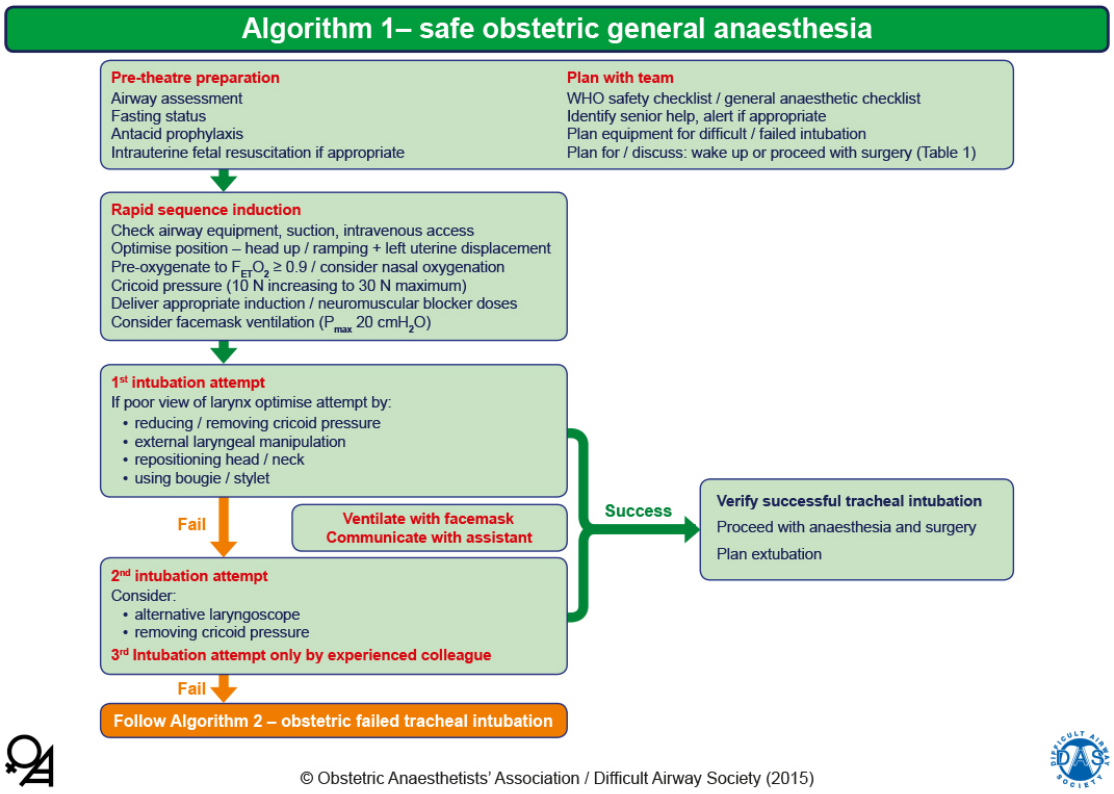

Fig. 1 — Safe obstetric general anaesthesia.

anaesthesia[48]. They found that PaO2 in the high-flow nasal oxygen group was significantly higher than in the standard face mask group. There was no difference in lowest saturation, intubation times, duration of apnoea, pH value or fetal outcomes. It is noteworthy that this study was small, with only 34 parturients who all had a normal body mass index and was conducted in the setting of elective surgery. While high-flow nasal oxygen shows promise as an adjuvant tool to support pre-oxygenation, there are also increased costs and training issues to consider before its routine use could be recommended.

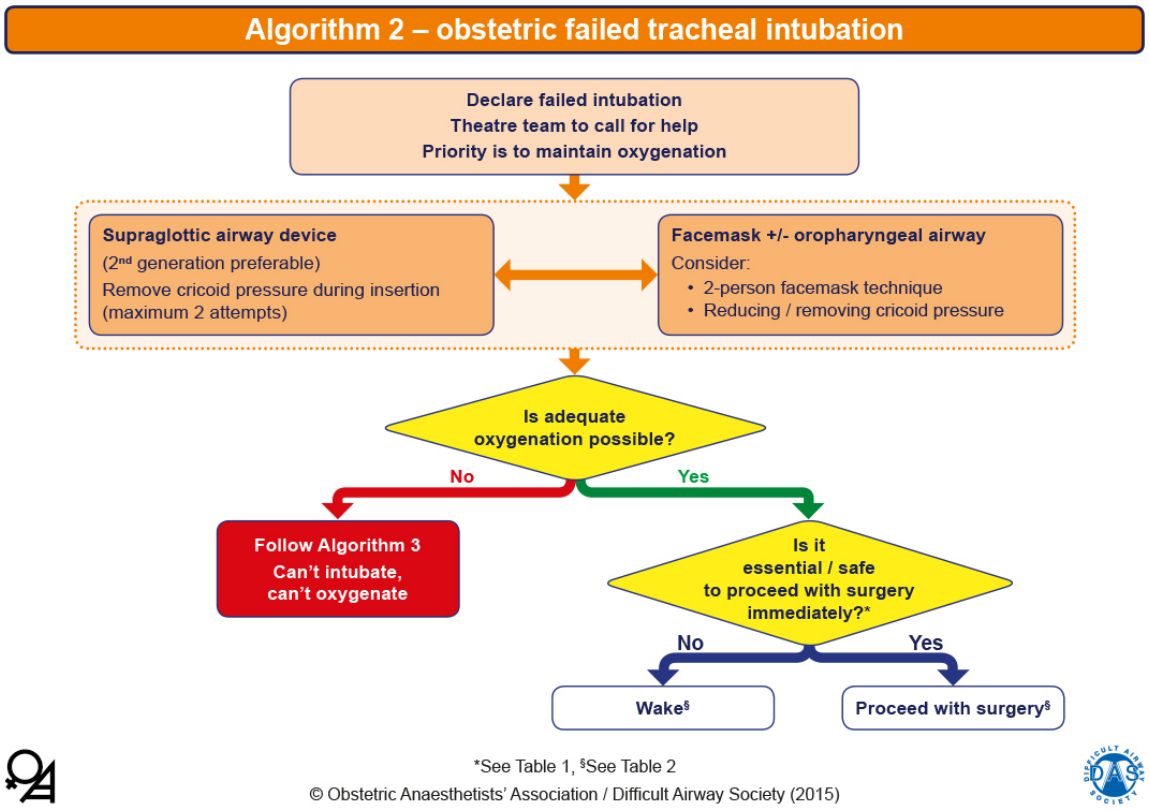

Fig. 2 — Obstetric failed tracheal intubation.

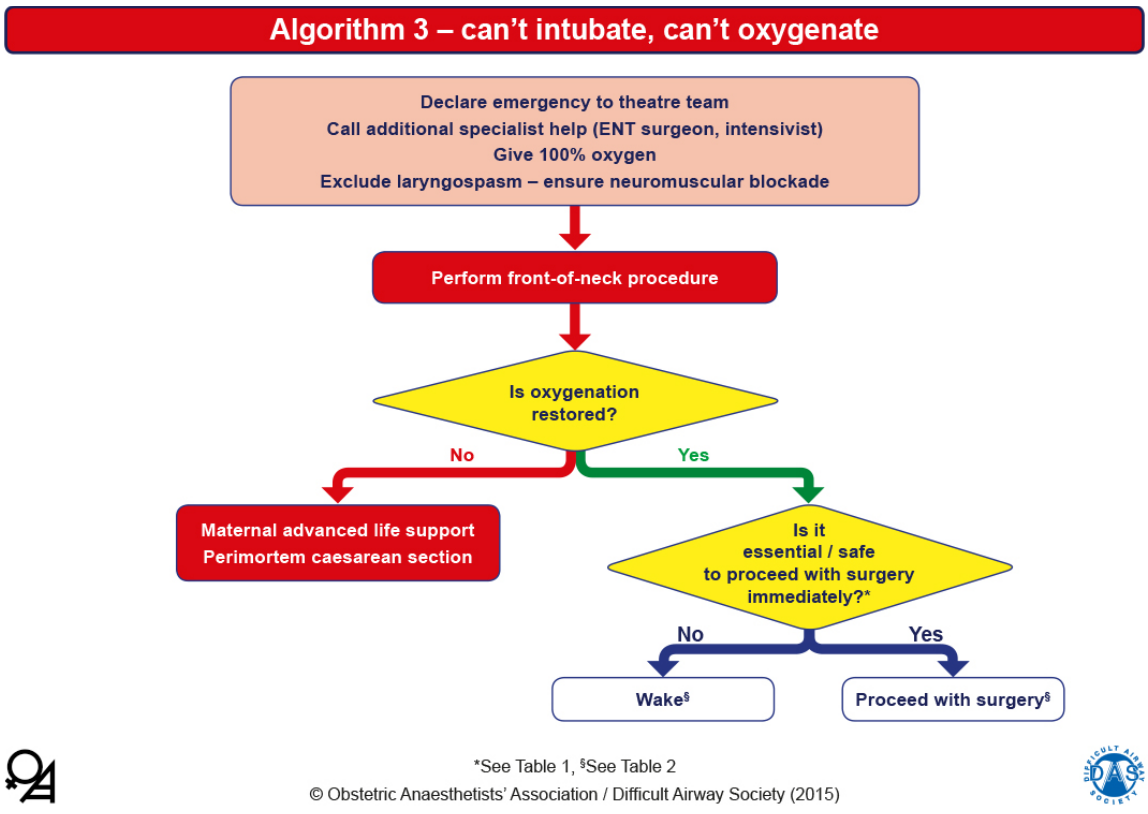

Fig. 3 — Management of a 'can't intubate, can't oxygenate' situation.

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

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.

Reproduced from Mushambi MC , Kinsella SM, Popat M, Swales H, Ramaswamy KK, Winton AL, Quinn AC. Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics.
Anaesthesia 2015; 70: 1286 – 1306, with permission from Obstetric Anaesthetists' Association / Difficult Airway Society.

Effective pre-oxygenation is a vital strategy to reduce the incidence of hypoxaemia, but the valuable role of apnoeic oxygenation is now recognised, i.e., maintaining oxygen flow in a patent airway through the glottis during apnoea. The OAA/DAS guidelines state that in obstetric general anaesthesia, the anaesthesiologist should consider attaching nasal cannulate with 5 l/min oxygen before starting pre-oxygenation to maintain the bulk flow of oxygen during intubation attempts. Although this may provide some benefit in delaying maternal desaturation, the use of high-flow nasal oxygenation offers a far more effective way of delivering a high fractional inspired oxygen at the glottis during the apnoeic period, and future work should focus on this area.

Videolaryngoscopy has a valuable role in reducing the incidence of difficult or failed intubation[49]. Recently published international guidance about preventing unrecognised oesophageal intubation suggests that videolaryngoscopes should be used whenever feasible[50]. The evidence supporting videolaryngscopy in obstetrics is limited. A systematic review comparing videolaryngscopy, and direct laryngoscopy for tracheal intubation identified only four randomised trials, nine observational studies, and 35 case reports/series with a total of only 528 participants[51]. The authors found that in obstetric patients without predictors of difficult intubation, video laryngoscopy compared with direct laryngoscopy, did not affect the first-pass success rate of tracheal intubation with no difference in the time to tracheal intubation. Another study used decision tree analysis to examine the most effective anaesthetic strategy for category 1 caesarean section in women with anticipated difficult tracheal intubation[52]. The authors assessed the time taken to achieve successful anaesthesia for three modes: spinal anaesthesia, awake tracheal intubation and general anaesthesia supported by video laryngoscopy. All three techniques achieved similar success rates, but the fastest was general anaesthesia with video laryngoscopy. The limitation of the decision tree analysis methodology, based on multiple systematic reviews rather than clinical evaluation, does not necessarily endorse general anaesthesia with video laryngoscopy. However, it suggests that it is an acceptable technique to choose. In several recent studies of obstetric general anaesthesia, videolaryngscopy was infrequently used, and broader adoption in obstetric anaesthesia is an important area for quality improvement[41,53,54].

Recovery from anaesthesia after category 1 CS

After category 1 CS and regardless of the anaesthetic technique, obstetric patients must receive recovery care to the same standard as all surgical patients, with adequate staff and appropriate equipment, i.e., blood pressure, ECG, and oxygen saturation[55]. Patients should receive one-one care until they have regained control of their airway (following general anaesthesia), are awake and able to communicate and stable from a cardiorespiratory perspective. Straight-leg raising should be used as a screening method to assess motor block in a patient who has received neuraxial anaesthesia[56]. If the woman cannot straight-leg raise at 4 hours from the last dose of epidural/spinal local anaesthetic, the anaesthesiologist should be called to assess whether the woman's care should be escalated to investigate the possibility of reversible causes of neurological injury.

Category 1 CS are often necessitated because of severe maternal and fetal compromise and can be a distressing experience for a woman and her partner. A traumatic birth experience can be associated with developing significant psychological sequelae, including post-traumatic stress disorder[57]. Appropriate follow-up, and debriefing may mitigate the impact of traumatic delivery and prevent the reduce the likelihood of psychological sequelae.

Beyond anaesthesia - team training and strategies to improve outcomes in category 1 CS

Poor teamwork can result in a delayed response to medical emergencies and be associated with adverse outcomes. Multidisciplinary simulation-based team training has been demonstrated to improve team performance in time-critical situations such as category 1 CS[58]. Several studies have demonstrated a reduction in decision to delivery intervals after simulation-based training[58,59].

Other strategies that may be employed to reduce the decision to delivery interval in category 1 CS include using centralised emergency call systems to simultaneously summon all team members in the event (rather than sequentially). A large maternity unit in Singapore described the use of a public announcement system to mobilise the anaesthetic and theatre team when an emergency CS is required[60]. All team members receive the urgent message simultaneously, ensuring the rapid assembly of all the necessary staff in the theatre. In 113 consecutive emergency caesarean sections over one year, the mean decision to delivery interval was 14.9 minutes, with 30 minutes achieved in 112/113 cases. Crimmins et al. examined the effect of digital and mobile technology on team performance in emergency CS[61]. This technology used preprogramed messages to alert predetermined team members simultaneously. They demonstrated improved team performance in emergency CS, a 7.4-minute

reduction in time from decision to delivery (26 pre-vs 18.6 minutes postimplementation, p = 0.001) and the delivery within 30 minutes improved by 15.2% (p = 0.018). Additional strategies to reduce the decision to delivery interval and optimise outcomes in category 1 CS are show in Box 4.

Summary

Provision of anaesthesia for category 1 CS can be challenging. Good multidisciplinary communication is essential to support anaesthetic management and optimise team performance to reduce the decision to delivery interval while optimising safety. Communication can be supported by using a standardised classification of urgency tool. While neuraxial techniques are favoured for CS, general anaesthesia has an essential role in category 1 CS. It is vital that, in every case, the risks and benefits of general and neuraxial anaesthesia for the woman and her baby are carefully weighed. Beyond the delivery of anaesthesia, other practical strategies, such as multidisciplinary team training, can contribute to improved maternal and neonatal outcomes.

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Box 4: Strategies to reduce the decision to delivery interval and optimise outcomes in category 1.

- Prioritise transferring a woman to the operating room: transfer delays have been associated with longer decision to delivery intervals [62]
- Ensure a woman is transferred to the operating room in the left lateral position. If a woman is transferred in the supine this can lead to aortocaval compression that can exacerbate pre-existing fetal compromise.
- On arrival in theatre, reassess the cardiotocograph. It is not uncommon for the fetal bradycardia or other cause for concern to have recovered when the patient is assessed in theatre, and this will reduce the pressure from the obstetric team to administer a general anaesthetic.
- Develop a strategy to ensure that the WHO surgical safety checklist does not cause unnecessary delay [63]

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