INTRODUCTION

Over the past 30 years, the rate of delivery by cesarean section (CS) has steadily increased, in high-, middle-, and low-income countries. Many countries have exceeded the optimal cesarean delivery rate of 10% to 15% as proposed by the World Health Organization in 1985.\(^1\) Data from Africa show that although cesarean delivery is on the increase, it is still well less than the recommended 15%, and the World Health Organization global survey on maternal and perinatal health in Africa reports an operative delivery rate of only 8.8%. This is likely caused by a lack of access to appropriate surgical interventions, as evidenced by only 73% of facilities participating in the survey offered cesarean delivery.\(^2\) It is well established that maternal mortality is higher in areas where the overall rate of delivery by CS is lower than recommended standards.

KEY POINTS

- The management of maternal comorbidities and the compromised fetus at urgent cesarean section (CS) requires precise teamwork and communication, where the anesthesiologist has a central role.
- Urgency of CS is best described as a continuum of risk. The decision-to-delivery interval (DDI) is an important audit tool in safe maternal management and neonatal outcomes.
- Although general anesthesia (GA) shortens the DDI, the risk to the mother and fetus is higher.
- Regional anesthesia (RA) is safely performed in the emergency setting, provided no contraindications exist, without compromising neonatal outcomes.
- Anesthesia for urgent CS always requires an individualized approach, taking into consideration specific high-risk clinical scenarios.
In terms of perioperative maternal mortality, Gebhardt and colleagues reported that in South Africa specific areas of concern were hemorrhage during or after CS; hypertensive disorders of pregnancy; puerperal sepsis; and importantly, anesthesia-related deaths. This phenomenon is probably caused by a lack of skills, and inexperienced staff. This is also true in the overall African context, where obstetric hemorrhage and anesthesia expertise have recently been identified as major challenges.

Considering the multiple maternal comorbidities and often compromised fetal biophysical profile, particularly in limited-resource environments, it is of the utmost importance that the anesthesia practitioner is familiar with the management of urgent and emergency anesthesia. A knowledge of the classification of urgency of caesarean delivery, and the diagnosis and management of maternal comorbidities indicating urgent operative delivery, and fetal compromise, is not only the ambit of the obstetrician, but requires precise teamwork and communication. This narrative review discusses how anesthesiologist may influence maternal and neonatal outcome, by choosing the most appropriate method of anesthesia for maternal safety, and achieving timeous delivery to reduce fetal morbidity. Novel issues are addressed, related to anesthesia training for emergency delivery.

**URGENCY OF CESAREAN SECTION**

The most widely adopted classification system of urgency of CS is the four-point classification described by Lucas and colleagues in 2000. This was subsequently endorsed for use by the Royal College of Obstetricians and Gynecologists (RCOG) and the National Institute for Health and Care Excellence in 2004. Table 1 describes the categories of urgency in detail, which are best regarded as a continuum of risk. To date, no more comprehensive classification of the urgency of CS has been described.

**THE IMPORTANCE OF THE DECISION-TO-DELIVERY INTERVAL**

Considerable early literature suggests that much of the damage to the fetal brain that precipitates hypoxic ischemic encephalopathy and cerebral palsy is antepartum, and often beyond the control of the obstetrician and anesthesiologist. However, a landmark paper on MRI and post mortem in 351 infants with neonatal encephalopathy and/or early seizures, has shown evidence for acute injury in 80% of infants. This highlights the importance of timely responses to intrapartum hypoxia.

The decision-to-delivery interval (DDI) is the time taken from recognition of an abnormality on fetal heart tracing using cardiotocography and decision to proceed with operative delivery, to the time of delivery of the fetus. International guidelines from the American College of Obstetricians and Gynecologists and RCOG agree on maximum DDI of 30 minutes in urgent cases. The RCOG further expands on their guidelines, stating that category 1 patients should have a DDI no longer than 30 minutes, but delivery in category 2 and 3 CS is safely achieved within 75 minutes of decision-making. However, the National Institute for Health and Care Excellence Guidelines emphasize that these times are for audit standards only, and not a strict judgment of practice in individual cases. There may be conflicting concerns regarding the safe management of mother and baby; expediting delivery with a view to improve neonatal outcomes may compromise thoroughness and care in maternal management. The ideal DDI in clinical practice is unknown, with the suggested time intervals in the current literature all based on observational data. It is difficult to draw firm conclusions on neonatal outcome based on the DDI alone. Although some authors report improved outcomes if delivery is completed within 30 minutes, others have found no difference, until DDI exceeds 75 minutes, by which time a significantly lower 5-minute
Apgar score is noted, and the chance of maternal admission to a high-care setting is 50% higher.\textsuperscript{12}

Factors influencing the DDI vary greatly between obstetric units. A recent randomized trial in a middle-income country comparing vasopressors for spinal hypotension during category 1 to 3 CS in patients with preeclampsia and fetal compromise reported DDI as a secondary outcome. Patients with fetal bradycardia were excluded. DDI was 62 minutes and 70 minutes, respectively, in the two groups of patients.\textsuperscript{13} The long mean DDI in this study likely reflects a high-pressure, overburdened system in an underresourced environment.

Obesity has been found to contribute to a longer DDI in category 1 CS, probably because of the more challenging nature of the surgical procedure in this population group. In this study, the contribution of epidural top-up to the reduction of the DDI was also examined, compared with the administration of combined spinal-epidural (CSE) anesthesia. The epidural top-up, when initiated on the labor ward at the time of decision making, was associated with a shorter DDI in all body mass index groups.\textsuperscript{14}

An Australian audit of anesthesia for emergency CS reported the time to carry out general anesthesia (GA), epidural top-up, and spinal anesthesia (SA) as 17, 19, and 27 minutes, respectively.\textsuperscript{15} A single-center study that compared DDI when GA, SA, or epidural top-up were used, found a similar interval with the two regional anesthesia (RA) options. SA was performed with a combination of bupivacaine, fentanyl, and morphine, whereas epidural top-up was achieved with a combination of ropivacaine and fentanyl. Neonatal outcomes were comparable between the two groups.\textsuperscript{16}

Many obstetric units emphasize the importance of decreasing the DDI so as to achieve the 30-minute rule. A high-output obstetrics unit in Tel Aviv instituted a protocol to decrease the DDI over a 54-month period in their institution. They found that simply protocolizing actions following the decision to perform a CS for a nonreassuring fetal heart trace resulted in a shorter DDI and improved early neonatal outcomes. The protocol focused on improving communication between all members of the perioperative team, and practical interventions, such as quick transfer to theater, and emptying the urinary bladder while the abdomen of the patient was being prepared for surgery. The proposed protocol did, however, favor the provision of GA, which may not be the accepted practice in other units worldwide.\textsuperscript{17}

A recent review has highlighted the heterogeneity of indications for CS in studies examining the association between DDI and neonatal outcomes.\textsuperscript{7} The authors

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**Table 1**

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Indications</th>
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<tbody>
<tr>
<td>1</td>
<td>Immediate threat to life of mother or fetus</td>
<td>Placental abruption, uterine rupture, active bleeding, severe fetal distress, and cord prolapse</td>
</tr>
<tr>
<td>2</td>
<td>Maternal or fetal compromise that is not immediately life threatening</td>
<td>Breech presentation, previous CS, and nonreassuring fetal status</td>
</tr>
<tr>
<td>3</td>
<td>No maternal or fetal compromise, but needs early delivery</td>
<td>Low amniotic fluid index, previous CS, not in labor</td>
</tr>
<tr>
<td>4</td>
<td>At a time to suit the mother and the maternity team</td>
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suggest that better evidence could arise from focusing on one indication for CS involving an irreversible cause of neonatal morbidity, such as uterine rupture, where poor outcomes have recently been demonstrated with DDIs greater than 18 minutes. In the setting of placental abruption, an even shorter DDI is necessary to prevent adverse outcomes, with a rapid deterioration of fetal acid base status at approximately 10 minutes.

METHOD OF ANESTHESIA

Risk Versus Benefit

The goals of obstetric anesthesia are to ensure maternal safety and comfort, and the delivery of a healthy infant. When performing purely elective CS, and even in most urgent operative deliveries, RA (spinal, epidural, or CSE) is the preferred and most widely accepted method. This avoids failed tracheal intubation and hypoxemia, and maternal awareness, when CS is performed under GA, and allows for early maternal bonding with her baby, and improved analgesia.

The incidence of failed tracheal intubation in the obstetric population has remained stable over the past 40 years at approximately 1 in 390, with maternal deaths mostly caused by pulmonary aspiration and/or hypoxic brain injury. The recent NAP 5 audit showed that the obstetric population is at high risk for awareness under GA for CS. Risk factors included difficult airway management, obesity, limited time between induction of anesthesia and initiation of surgery, and the high incidence of urgent procedures performed outside normal clinical hours.

Apart from the previously mentioned maternal risks as a result of GA for CS, there are multiple reports of risk to the neonate associated with GA. Time to readiness for initiation of operative delivery has been shown to be shorter for GA when compared with SA. A large Australian study showed that, despite more rapid delivery of the neonate, when adjusted for confounding factors, neonates born by category 1 CS under GA were significantly more likely to have a 5-minute Apgar score less than 7, to require respiratory support, and to be admitted to a neonatal intensive care unit, when compared with those delivered under SA. These findings are supported by Edipoglu and colleagues who found that the 1-minute Apgar score was significantly lower in neonates born by CS performed under GA. These authors report RA to be associated with shorter hospital stays, less maternal morbidity, and higher umbilical blood pH values in the neonate. A study by Hein and colleagues found that the DDI for GA was considerably shorter than for SA and epidural top-up, but Apgar scores of less than 7 at 5 minutes were more frequent in GA-exposed neonates. It is, however, likely that poor neonatal outcomes in category 1 GA for CS are in part because of a higher degree of compromise in utero.

Overall, the choice of GA versus RA is governed by maternal comorbidities, urgency, and available equipment and expertise, in the context of obstetric anesthesia practice in the particular country and unit. A decision-analysis study, based on multiple high-quality systematic reviews, has recently evaluated three anesthesia options for the management of parturients with a predicted difficult laryngoscopy at preoperative assessment, in women requiring a category 1 CS for fetal compromise. Options for anesthetic management were rapid sequence induction with videolaryngoscopy, awake fiberoptic intubation, or SA. Krom and colleagues found that the rate of failure using videolaryngoscopy as a first-line intubation technique was extremely low, at 21 per 100,000. The mean time for induction of GA was 100 seconds, as compared with an SA time of 6.3 minutes, and 9 minutes for awake fiberoptic intubation. One can appreciate that the last option may be impracticable
in low-resource environments, particularly when neonatal outcome is critically depen-
dent on the time to delivery, such as is the case when there is severe fetal bradycardia.

**RECENT ADVANCES**

**The Airway Algorithm**

In recent times the difficult airway algorithm in obstetrics has undergone several im-
provements to reduce failed intubation.\(^{27}\) These include early facemask ventilation
and placement of a second-generation supraglottic airway (SGA), availability of a vid-
elaryngoscope, release of cricoid pressure if laryngoscopy is difficult, and limiting
intubation attempts to two. In addition, the importance of appropriate positioning of
the parturient before tracheal intubation, and the potential utility of transnasal humid-
ified rapid insufflation ventilatory exchange, has been recognized.

It is widely accepted that videolaryngoscopy improves the view obtained at laryn-
goscopy in the nonobstetric population\(^ {28}\) and is an integral tool in the management
of initial failed intubation attempts.\(^ {29}\) The Difficult Airway Society, in conjunction
with the Obstetric Anaesthetists’ Association of the United Kingdom, have developed
a set of guidelines for the safe management of the airway in obstetrics. They recom-
mand that a videolaryngoscope be available in the operating room for all obstetric GA
cases.\(^ {27}\) The obstetric airway is known to be inherently more difficult than in the gen-
eral surgical population, and this is often further complicated by such conditions as
maternal obesity and preeclampsia.

In obese parturients the ramped position, with the external auditory meatus and
sternal notch aligned, has been shown to significantly improve the view at laryngos-
copy.\(^ {30}\) In a recent survey, 57% of participants used the ramped position for all
women undergoing a rapid sequence induction for CS.\(^ {31}\)

Tan and colleagues\(^ {32}\) recently evaluated the use of high-flow humidified oxygen as
an alternative to standard preoxygenation for CS. They found 3 minutes of preoxyge-
nation via high-flow humidified canulae to be inadequate to attain the recommended
end-tidal oxygen concentration of greater than 90% before induction. Transnasal hu-
midified rapid insufflation ventilatory exchange has not been widely adopted in obstet-
ric practice as yet, despite its promising results in the nonobstetric literature.\(^ {31}\) The
main benefit may be prolongation of time to desaturation after administration of mus-
cle relaxant and ensuing apnea.

**Oxygen Supplementation**

Oxygen supplementation at CS has been widely studied. A concern is that hyperoxia
may lead to the formation of harmful oxygen free radical species. It has, however, been
shown that in the setting of urgent RA for CS for fetal compromise supplemental ox-
ygen should be provided, while concurrently using other strategies to improve fetal ox-
ygen delivery. There is no evidence to show increased lipid peroxidation in this
population.\(^ {33,34}\) GA for CS is associated with free radical generation, but this is not
related to the inspired oxygen concentration.\(^ {35}\)

**Postoperative Analgesia**

The method of postcesarean analgesia is dependent on the anesthesia technique
adopted for urgent CS. RA allows for the safe use of 50 to 100 \(\mu\)g spinal or 3 mg
epidural morphine. Transversus abdominis plane blocks are effective in the patient
receiving GA, but confer no additional benefit over spinal morphine.\(^ {36}\) A recent
advance is the introduction of the ultrasound-guided quadratus lumborum block.\(^ {37}\) Ur-
gent CS does not preclude effective postcesarean analgesia.
URGENT REGIONAL ANESTHESIA

In the recent survey by Kinsella and coworkers on anesthesia practice for category 1 CS, many units performed SA if a labor epidural catheter had not been placed. The number of attempts at insertion was limited to two, with a maximum time for insertion of 5 minutes. To decrease the time spent performing SA, while avoiding the risks of GA, the concept of the rapid sequence SA (RSSA) has been developed, which aims to perform SA with only the essential equipment and limit the number of attempts at insertion. Kinsella and colleagues suggest only one attempt at SA, and encourage the notion of the rapid adoption of the next option, as after a limited number of attempts at tracheal intubation (Box 1). The addition of opioids to the spinal injectate is also an area for consideration. Standard practice in the United Kingdom is to use diamorphine as an adjunct to SA. This is, however, not readily available as a low-dose preparation and requires dilution before injection, which is time-consuming. Therefore, the opioid of choice in the performance of RSSA is fentanyl, 50 μg/mL.

In a recent series of 25 patients who required category 1 CS and received RSSA, 22 had severe fetal compromise as assessed by an abnormal fetal heart tracing, and the remaining three presented with cord prolapse. The DDI was 22.5 minutes, and the median time from spinal injection until readiness for surgery, as assessed by the sensory level, was 4 minutes. The authors cautioned against the practice of RSSA by novice anesthesia providers. It is important to assess at the outset whether SA may be difficult to achieve, in which case GA may be preferred. Concerns were that three women reported pain on initiation of surgery requiring conversion to GA, and the abandonment of strict asepsis raises questions regarding safety. For these reasons RSSA is not uniformly supported at this point.

Further RA options are CSE, and top-up of an existing labor epidural catheter for anesthesia purposes. CSE has been found to be more time-consuming than either SA or epidural anesthesia alone in the elective and emergency setting.

Many protocols exist for the extension of labor epidural analgesia for emergency CS. Meta-analysis shows that the fastest onset of surgical anesthesia is achieved with the administration of 2% lignocaine with epinephrine and fentanyl. The use of ropivacaine, 0.75%, results in the lowest requirement for intraoperative supplementation of the epidural block. Bupivacaine and levobupivacaine, 0.5%, were found to be the least favorable with respect to speed of onset and quality of block. All included

Box 1

Components of rapid sequence spinal anesthesia

- Other staff members to secure intravenous access and apply monitoring; spinal dose not to be injected before intravenous cannula is secured
- Preoxygenate during attempt, for more rapid conversion to GA
- Adopt “no-touch” technique (gloves only, no gown necessary). Skin prepared with a single wipe of 0.5% chlorhexidine solution
- Consider omitting intrathecal opioid if this adds unnecessary delay
- If no opioid, consider increased dose of hyperbaric bupivacaine, 0.5%, up to 3 mL
- Surgery is commenced when sensory block is higher than the T10 level, and ascending
- All equipment prepared and staff ready to convert to GA

studies in the meta-analysis using a lignocaine top-up with or without fentanyl had a median onset time of 15 minutes. Despite being common practice, this is not a well-studied area of obstetric anesthesia, and the meta-analysis is difficult to interpret because of the heterogeneity of practice protocols, in the administration and assessment of the level of epidural blockade.

SPECIFIC CLINICAL CONDITIONS: URGENT SPINAL ANESTHESIA

Preeclampsia

After early fears concerning intravascular volume depletion and theoretic risks of hypotension, research in the past 25 years has confirmed the safety of SA in preeclampsia in the absence of contraindications to RA. SA is associated with mild afterload reduction, and a lower vasopressor requirement than in healthy patients. In the only randomised trial comparing GA and SA in patients with preeclampsia and a non-reassuring fetal heart trace, fetal base deficit was higher in the SA group. However, ephedrine, which is associated with more fetal acid-base disturbance, was used more often in the SA group. Modern practice ensuring tight control of blood pressure using phenylephrine might eliminate this difference.

A recent observational study reported favorable outcomes after SA for CS in severe preeclampsia, as evidenced by a lower requirement for maternal critical care support and better neonatal outcomes. These results are, however, difficult to interpret. The patients managed under GA in this cohort were more likely to require blood pressure control with labetalol before induction, possibly indicating more severe disease. The mean gestational age was also lower in the parturients who received GA and the most frequent indication for GA was cited as severe fetal compromise. A further large study, involving a cohort of more than 300,000 women, found that GA for CS in preeclampsia was associated with a greater than two-fold increase in the risk of stroke when compared with SA. This was, however, not a randomized trial, and despite attempts by the authors to correct for confounders, it is likely that the results reflect that patients receiving GA had more severe disease.

Cardiac Disease

Most peripartum cardiac comorbidities (congenital or acquired) may be safely managed under carefully conducted RA, with GA reserved for specific, individualized indications. Wherever possible, a multidisciplinary team in a specialized unit should manage such patients throughout pregnancy. Ideally, patients with advanced cardiac lesions should have carefully planned elective caesarean delivery, including serial echocardiography assessments. However, sudden deterioration of maternal or fetal condition may precipitate urgent CS, and GA may be necessary if the patient is anticoagulated, or if mechanical ventilation, complex cardiac interventions, or extracorporeal membrane oxygenation are required. A thorough understanding of risk categories and pathophysiology are required, as outlined in a recent extensive review.

Premature Delivery

The EPIPAGE studies examined neurodevelopmental outcomes in preterm babies in nine hospitals in France in 1997. A secondary analysis found that in infants of less than 33 weeks gestation, SA was associated with a higher mortality than GA (12.2% vs 10%). However, the data are from a nonrandomized study with many confounding variables, including anesthesia technique and vasopressor use.
Choice of Vasopressor for Urgent Cesarean Section

Spinal hypotension is a common management challenge during CS, and is a major concern for maternal safety and comfort, and neonatal outcome. The most commonly used agents in clinical practice are the mixed $\alpha$ and $\beta$ agonist ephedrine and the $\alpha$ agonist phenylephrine. Recent research has confirmed that in healthy parturients ephedrine results in significant neonatal acidosis, when compared with phenylephrine. This is likely caused by stimulation of fetal $\beta$-adrenergic receptors resulting in an increased metabolic rate.

There are limited data in the setting of urgent delivery. In 2008, Ngan Kee and colleagues conducted a randomized controlled trial evaluating the effects of ephedrine versus phenylephrine in SA for urgent CS. They reported no difference in markers of neonatal acidemia; however, only a small proportion of the deliveries were performed because of fetal compromise. A smaller study, including only patients with severe fetal compromise, showed similar rates of neonatal acidemia in the study groups, but significantly more nausea and vomiting in the ephedrine group, which compromised maternal comfort.

The choice of vasopressor is based on fetal and maternal considerations. A recent randomized trial found the choice vasopressor does not influence fetal acid-base status in cesarean delivery for a nonreassuring fetal heart tracing in preeclampsia, and concluded that the management should be based on maternal hemodynamic responses. In a further randomized trial on SA for urgent cesarean delivery for a maternal indication in preeclampsia, phenylephrine, 50 mg, has been shown to be more effective than ephedrine, 15 mg, in restoring systemic vascular resistance. Phenylephrine is therefore preferred in the management of most cases of spinal hypotension in women with preeclampsia, in the absence of systolic heart failure.

URGENT GENERAL ANESTHESIA

There are instances where SA is ineffective, or contraindicated. Failed SA requires conversion to GA in urgent cases. Primary indications for GA may be maternal, fetal, or combined. The commonest maternal indications include severe hemorrhage, thrombocytopenia and/or coagulopathy, and cardiorespiratory compromise. Abnormal placentaion, which often gives rise to urgent CS, was previously considered a relative contraindication to SA. However, CS has for the past 25 years been safely performed under SA in select groups of this population. The patient presenting with hemorrhage requires context-sensitive management. Some well-equipped units with immediate access to advanced obstetric interventions may offer such patients RA, but for most parturients in whom severe hemorrhage is anticipated, GA is likely to be a safer option.

A survey carried out in the United Kingdom found that 54% of category 1 CS were performed under GA. The authors noted that in larger units there was a trend toward lower rates of GA. The most frequently cited reason for the choice of GA in category 1 CS was that it was the default option in such cases. Some units had specific indications for the choice of GA ahead of RA, including cord prolapse, placental abruption, uterine rupture, and fetal bradycardia.

The choice of induction agent for emergency CS seems to have no significant effect on neonatal outcomes. Recent work has shown that Apgar scores are no different in neonates born to mothers induced with propofol when compared with thiopental. This was despite a longer time to delivery noted in the thiopental group. The choice of induction agent should be based on the clinical situation, maternal hemodynamics, and experience of the anesthesia provider with the agent.
SAFETY CONCERNS IN THE PRACTICE OF GENERAL ANESTHESIA

Resources and Training

A concern in low- and middle-income countries is the lack of resources (human and infrastructural) to provide safe GA to women requiring cesarean delivery. A program for the training of nonphysician practitioners in the provision of GA for CS has been rolled out across Kenya. The ESM-Ketamine program consists of training of appropriate practitioners, including nurse midwives, to safely administer anesthesia with a prepackaged GA toolbox. This includes ketamine as the induction agent and a range of airway management devices. An audit of the service found no serious adverse events, with no deaths being attributed to anesthesia-related complications; however, this was a small cohort of 109 patients and larger series are awaited to establish patient safety.55

Even in high- and middle-income countries, high rates of SA performed for CS has led to a lack of skills, especially among junior trainees, in the safe provision of GA for CS. Anesthesia training is continuously evolving. Simulation has become an integral part of anesthesia trainee curricula worldwide. It has been shown in meta-analysis that simulation training improves clinical skills and knowledge in the short and long term.56 Work from two American training institutions57,58 has evaluated the usefulness of simulation training among trainees on their obstetric anesthesia rotation. Ortner and colleagues58 specifically evaluated the performance of trainees when performing GA for emergency CS. They found that the institution of a structured simulation learning program led to retention of these skills for 8 months post-training. The level of expertise attained was found to be at that of an attending obstetric anesthetist.

Training programs, such as the Safer Anesthesia from Education obstetrics and pediatrics, and the Essential Steps in the Management of Obstetric Emergencies course aim to ensure sound obstetric anesthesia care through the provision of factual knowledge, while emphasizing the acquisition of clinical and nontechnical skills.59

The Use of a Supraglottic Airway During Emergency Cesarean Section

The Difficult Airway Society advocates the use of an SGA as a rescue device in the event of failed intubation in obstetrics.27 Many studies have explored the use of SGA as a first-line airway device in GA for CS without severe fetal compromise.60–62 All of the current work has been performed with second-generation SGAs, based on the concept that higher sealing pressures and a gastric suction port is protective against the higher risk of pulmonary aspiration in parturients. No adverse events, airway or otherwise, have been reported by any of the authors. This work is, however, all observational in nature and remains controversial, not having been widely adopted into current accepted clinical practice, particularly in limited-resource environments.

A single, retrospective observational study has been conducted evaluating the use of an SGA for emergency cesarean delivery.63 The supreme LMA, also a second-generation device, was used in all patients. Outcomes measured were adverse events related to the device, maternal mortality, and neonatal outcomes. The authors reported successful use in 1039 deliveries, with no maternal laryngospasm, bronchospasm, regurgitation, aspiration, or death reported. Neonatal outcomes were similar to those in other studies conducted on outcomes in GA for CS, with a 5-minute Apgar score of 7 to 10 in most cases. However, most patients had a normal body mass index, and no details were supplied of patients with recent oral intake or symptoms of gastroesophageal reflux, in whom there would surely have been a low threshold for tracheal intubation. No randomized controlled trials exist to support the routine use of an SGA for urgent GA for CS, other than in the emergency failed intubation scenario. The
overwhelming body of clinical opinion would be that rapid sequence induction with endotracheal intubation remains the safest management option in emergency GA for CS.

**SPECIFIC CLINICAL CONDITIONS: URGENT GENERAL ANESTHESIA**

**Preeclampsia and Eclampsia**

Preeclampsia remains a major perioperative medical challenge, particularly in lower- and middle-income countries, often involving maternal and fetal indications for GA, most commonly HELLP syndrome, hemorrhage, and cardiorespiratory failure. Anesthesiologists are best placed to assess severity of cardiopulmonary involvement, resuscitation, perform anesthesia for urgent delivery, and assist in critical care management.

Key issues surrounding urgent operative delivery under GA are:

- Fluid management (usually a restrictive policy, but acute intravascular volume changes are best guided by arterial line placement and transthoracic echocardiography, and seldom central venous or pulmonary artery catheter placement),
- Availability of a videolaryngoscope,
- Obtundation of hypertensive response to intubation, and
- Avoidance of nondepolarizing muscle relaxants in patients receiving magnesium sulfate.

The eclamptic patient requires an individualized approach. A South African series found no difference in maternal and neonatal outcomes in women with stable eclampsia who received epidural anesthesia or SA compared with GA for cesarean delivery. This suggests that patients with eclampsia whose seizures have terminated and show no signs of raised intracranial pressure are safely managed with RA. Patients presenting with ongoing, uncontrolled seizures are best managed with GA. Propofol and thiopentone are considered acceptable induction agents because they support favorable neurophysiologic conditions. Mechanical ventilation should be continued after cesarean delivery in patients who have not recovered neurologically, using a sedative with some anticonvulsant activity. An infusion of propofol supplemented with a short-acting opiate is an acceptable alternative to benzodiazepine infusions, which are associated in the nonobstetric setting with more drug accumulation and a potentially longer period of mechanical ventilation. Sedation should be carefully titrated to maintain adequate cerebral perfusion pressure, in view of cerebral edema and raised intracranial pressure.

**SUMMARY**

Access to urgent caesarean delivery, with adequate surgery and anesthesia skills, is essential for maternal and fetal safety worldwide. Categorization of urgency of CS has generated an important audit tool, namely the 30-minute DDI. Focused studies suggest that a considerably shorter DDI is required in cases of irreversible fetal hypoxia. Some form of decision analysis is required in every case, to estimate the risks and benefits to mother and fetus of GA versus RA. RA for CS has become highly sophisticated, including the rapid performance of SA with tight vasopressor control of maternal hemodynamics, epidural anesthesia, and CSE anesthesia. Indications for GA include maternal anticoagulation, hemorrhage, unstable cardiac disease, complicated pre-eclampsia, and fetal bradycardia with imminent fetal demise. Physician and nonphysician education, in the clinical and simulation scenarios, is crucial, so that RA is safely practiced, and GA is safely performed if specifically indicated, or should RA fail.
**Best Practices**

*What is the current practice for anesthesia for urgent CS?*

CS should be classified by urgency and subsequently performed within prescribed time limits. The DDI is an important audit tool. For category 1 CS, this interval should be less than 30 minutes. RA is safe and effective in urgent CS, unless specific contraindications exist. Specific clinical scenarios (hemorrhage, hypertensive disorders, cardiac disease, obesity, the difficult airway, and severe fetal compromise) require an individualized approach to anesthesia.

*What changes in current practice are likely to improve outcome?*

Access to skilled surgery and anesthesia for CS should be prioritized. Ongoing and improving training, including simulation, is integral to the provision of safe anesthesia for urgent CS. Adherence to the latest difficult airway algorithm may improve outcomes after GA.

**Major recommendations**

- RA for CS is favored in the absence of contraindications.
- All clinicians practicing obstetric anesthesia should understand the indications for and contraindications to RA and GA for CS.
- Adequate training in both methods is crucial, and continuously updated.
- There are limited randomized controlled trials on which to base clinical practice.

**Best references for the previous recommendations.**


