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Peri-operative management of caesarean section for the occasional obstetric anaesthetist – an aide memoire

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Abstract

Anaesthesia practice for caesarean section (CS) has evolved in the past 20 years. This article aims to update occasional obstetric anaesthesiologists, obstetricians and clinicians involved in the management of pregnant women on the latest guidelines and recommendations for anaesthesia management, including pre-operative evaluation, informed consent, intra-operative and postoperative management for CS. In addition, this article will also summarise the management of CS associated emergencies such as difficult intubation, obstetric major postpartum haemorrhage, local anaesthetic toxicity and (pre-) eclampsia. At the end of the article, a charted summary will be provided as an aide memoire.

Keywords

Caesarean section, anaesthesia, informed consent, difficult intubation, haemorrhage, local anaesthetic toxicity, pre-eclampsia, eclampsia

Introduction

Anaesthetic management of caesarean section (CS) has an important influence on maternal and foetal outcomes. The anaesthesia practice for CS has changed with time, reflecting the latest research evidence, international guidelines and changes in demographics of the parturient. The purpose of this article is to give occasional obstetric anaesthesiologists, clinicians and health professionals involved in peri-partum care an overview of the anaesthetic management for CS and the latest recommendations on management of anaesthetic and obstetric emergencies arising from CS. We also aim to present a charted summary to serve as a useful aide-memoire at the end of this article. The readers can store the summary in their hand held devices for quick reference in the future. This article aims to explain the summary guide in more detail and outlines the source of the evidence. This article does not aim to replace formal teaching, training, textbooks or local departmental guidelines.

Pre-operative evaluation

The aims of pre-operative evaluation are as follows:

1. To identify medical and obstetric comorbidities that may increase anaesthetic and surgical risks.
2. To establish the urgency and reason of CS.
3. To obtain anaesthetic informed consent.
4. To enable patient preparation.

To identify medical and obstetric comorbidities

In addition to the general anaesthetic history and examination, anaesthesiologists should enquire about obstetric specific issues during the pre-operative evaluation. Comprehensive pre-operative assessment of complicated obstetric patients, which should be done early during the antenatal period,[1,2] is outside the scope of this article. It is important to note that many hospitals have established anaesthetic antenatal clinics and complicated patients may have already been reviewed in such clinics where plans such as early labour epidural might have been drafted. Anaesthetic involvement should start from early antenatal period for complicated patients (e.g. congenital heart diseases); and for uncomplicated patients, early patient education on various anaesthetic and analgesic options for

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Table 1. Categories of caesarean section.

Category 1	Immediate threat to life of woman or foetus (e.g. placental abruption, uterine rupture, active bleeding, severe foetal compromise)
Category 2	Maternal or foetal compromise, not immediately life threatening (e.g. breech, previous caesarean section in labour, non-reassuring foetal status (NRFS))
Category 3	Needing early delivery but no maternal or foetal compromise (e.g. low AFI, previous caesarean section but not in labour
Category 4	At a time to suit the woman and maternity team

vaginal and caesarean deliveries is important. Anaesthesiologists should aim to be familiar with all the patients in labour ward as some of them may benefit from early anaesthetic involvement such as early labour epidural analgesia (e.g. obese parturient or twin pregnancies etc.). The key relevant issues in clinical assessment of obstetric patients are summarised in the summary sheet.

Establish reason and urgency of CS

Anaesthesiologists need to establish the reason for CS for two reasons:

1. To identify anaesthesia and surgical risks as explained above.
2. For emergency CS, urgency depends on the indication for CS and this will influence the choice of anaesthetic technique. Table 1 shows a commonly used system for CS categorization.[3]

Foetal distress and extreme foetal bradycardia frequently cause much anxiety for the patients, relatives and staff. While awaiting CS, anaesthesiologists and obstetricians should consider intrauterine foetal resuscitation.[4] Communication between obstetricians and anaesthesiologists is vitally important and should start from the moment the parturient is admitted to labour ward through to the post-partum period. The key steps are shown in the summary sheet.

Obtaining informed consent

There are unique considerations for consent taking in obstetrics, the main being capacity during active labour and the lack of time during emergency CS. Ideally the consenting process should be initiated when the patient is not in pain or under distress e.g. during antenatal consultation. Nonetheless, the review by Broaddus and Chandrasekhar showed that 'despite pain and anxiety, women maintain the capacity to understand and recall inform imparted during labour'.[5]

There is a wide variation in information given to mothers with respect to the complications associated with neuraxial blocks (NABs) and their actual incidence.[6] The amount and the nature of information that should be provided to the patient should be determined by the question: 'What would this particular patient regard as relevant when coming to a decision about which of the available options to accept?'[7] When counselling for the risks and benefits between general anaesthesia (GA) and regional anaesthesia (RA), the increased risk of maternal airway complication and neonatal depression that are associated with GA,[8] and the occasional requirement of conversion from RA to GA, have to be mentioned. A summary of the risks counselled for obstetric anaesthetic procedures for CS is shown in the summary sheet.[9–13]

Patient preparation for anaesthesia

Due to increased risk of gastric reflux and regurgitation, gastric acid prophylaxis is commonly used in obstetric anaesthesia. H_2 receptor blocker, oral or intravenous (IV), depending on urgency of the CS, and antacids such as sodium citrate are commonly used. If time allows, basic investigation such as full blood count and blood group and screen should be carried out before every CS, and other investigation as appropriate. However, urgent CS should not be delayed due to lack of investigation. In emergency CS, the anaesthesiologist could start anaesthesia while waiting for investigation result.

Intraoperative management

Preparation for CS

Irrespective of the mode of anaesthesia and patients' risk factors, every CS should be prepared in such a way that a patient can be resuscitated efficiently if haemorrhage occurs or conversion to GA becomes necessary. Please see summary sheet for preparations required for CS.

Modes of anaesthesia

The mode of anaesthesia is dependent on patient, anaesthetic and obstetric considerations. In general, RA (spinal anaesthesia, combined spinal epidural or epidural top up) is preferred over GA due to concerns of increased incidence of difficult airway and risk of pulmonary aspiration in the obstetric population. The common indications of general anaesthetics are maternal request, very urgent CS, RA contra-indicated (e.g. coagulopathy, maternal hypovolaemia) and failed RA. RA has the added benefit of minimal maternal-foetal drug transfer and allowing skin-to-skin bonding after birth. In certain parturient where CS is anticipated to be prolonged and difficult, anaesthesiologist may prefer the use of a neuraxial catheter to allow local anaesthetic (LA) top up in prolonged operation. The commonly used techniques for CS are shown in the summary sheet.

Coagulation abnormalities and NAB

NAB in patients with coagulation abnormalities require special consideration as they have increased risk of vertebral canal haematoma post block. A guide of safety threshold is shown in the summary sheet. It excludes patients with trauma, sepsis, massive transfusion, disseminated intravascular coagulation (DIC) and liver failure.[14]

Management of NAB or GA associated hypotension

It is common post NAB or GA induction that maternal hypotension occurs. It is important to treat maternal hypotension as it may decrease uteroplacental blood flow. Treatment threshold for hypotension should depend on normal maternal blood pressure, presence of symptoms (e.g. hypotension induced dizziness, nausea and vomiting) and foetal condition (if undelivered). A rough guide is to avoid blood pressure less than two thirds of normal maternal blood pressure. Controversies regarding the appropriate treatment of maternal hypotension had revolved around the use of fluids pre-loading versus co-loading and type of vasopressor (phenylephrine versus ephedrine due to effects on foetal acid-base status).[15] For fluid therapy, co-loading may be more effective than pre-loading but fluid resuscitation remains an unreliable treatment for maternal hypotension.[16] Vasoconstrictors are usually needed, of which phenylephrine may be a better choice compared to ephedrine as it leads to better foetal acid-base status. Phenylephrine boluses of 20–100 mcg or infusion of 25–50 mcg/min after spinal anaesthesia seem effective.[17] Maternal reflex bradycardia may occur after phenylephrine administration which can be treated with glycopyrrolate 200–300 mcg. Ephedrine in boluses of 3–6 mg is a useful second line vasopressor when phenylephrine alone cannot achieve the desired vasopressor effect.

Management of the obstetric airway

Difficult and/or failed intubation is more common in pregnant patients and is associated with increased risk of morbidity and mortality compared to the general population. Guideline published by the Obstetric Anaesthetists' Association and Difficult Airway Society for the management of difficult and failed tracheal intubation in obstetrics provides useful frameworks and algorithms on how to optimize obstetric airway management and algorithm for failed intubation.[18] The essential take home messages are:

- Preparation of additional airway equipment as deemed necessary (difficult airway trolley).
- Presence of specialist anaesthesiologist.
- Ramp patient up for intubation such that the tragus of the ear is in the same horizontal plane as the sternal notch.
- Ensure the operating table can be tilted.
- Properly applied cricoid pressure (right angle to tilt), which should be released partially if impairing view of cords, mask ventilation or LMA insertion.
- Pay meticulous attention to effective pre-oxygenation, with the aim of achieving an end tidal oxygen concentration (etO_2) of ≥90% before anaesthetic induction.
- Consider concurrent oxygenation via nasal cannula (5 l/min) during pre-oxygenation and intubation.
- One can also consider the use of high flow humidified nasal oxygenation systems (up to 60 l/min) to increase apnoea time,[19] although studies in the obstetric population are lacking.
- Consider gentle face mask ventilation with peak airway pressure <20 cmH_2O while waiting for muscle relaxant to take effect.
- Use short handle laryngoscope or videolaryngoscope ± ETT introducer as default.
- Use adequate dose of muscle relaxant: succinylcholine 1.5–2 mg/kg or rocuronium 1–1.2 mg/kg. If rocuronium is used, sugammadex in a dose of 16 mg/kg should be readily available for reversal of rocuronium in situations of 'cannot intubate and cannot ventilate'.
- Team decision whether to proceed with CS or to abandon and wake upon intubation failure should be made before induction. Factors that influence the decision include maternal condition, anaesthesiologist experience, aspiration risk, surgical factors, feasibilities of alternative airway devices and anaesthesia method and foetal condition.
- Three attempts to intubation only, the third attempt should be done by experienced personnel, thereafter,
- The focus should be on oxygenation either with a supraglottic airway device (SAD) or face mask. Early insertion of SAD should be considered if face mask ventilation is difficult or the decision to proceed with CS has been decided. Second generation SAD with a gastric channel is preferred.
- Call for help and declare emergency early.
- If 'cannot intubate and cannot ventilate' occurs, front of neck procedure (e.g. cricothyroidotomy) to gain airway access is necessary.
- If attempts to oxygenate fail and cardiac arrest occurs, start maternal cardiopulmonary resuscitation (CPR) and peri-mortem CS. Preparation of difficult airway and management of obstetric fail intubation is shown in the summary sheet.

Antibiotics prophylaxis

In the past, fear of unnecessary foetal exposure to antibiotics masking foetal infection and leading to emergence of resistant strains has discouraged clinicians from giving antibiotics before delivery of the baby (before clamping of the umbilical cord). However, recent evidence strongly advocates administration of antibiotics before knife to skin, as this practice significantly reduces the rate of endometritis with no significant neonatal adverse effects.[20,21] The antibiotics that are commonly used are third generation cephalosporin such as cefazolin 2 g IV bolus or Augmentin 1.2 g IV bolus or IV clindamycin 600–1200 mg (for penicillin allergy).

Uterotonics

Oxytocin (Syntocinon) is used to reduce the risk of postpartum haemorrhage (PPH) from uterine atony. However, in high doses or rapid IV infusions, it can cause hypotension, cardiac dysrhythmias and ischaemia which can be fatal in patients with cardiac disease or haemodynamic instability.[22] There has been much debate in recent years regarding its effective dose, which varies between 1 and 3 IU as a slow bolus. In general, elective CS requires a smaller dose for effective uterine contraction as compare with emergency CS especially when labour had been augmented.[23,24] Our institution has a pragmatic approach to oxytocin dose at CS, which is 5 IU

slow IV after cord clamping and if obstetricians feel the uterus is still not well contracted after oxytocin, an infusion of 5–10 IU h^{-1} for 4 h will be started. An alternative to oxytocin is carbetocin (Duratocin) 100 mcg IV slow bolus. Studies had shown that it is more effective in preventing PPH at CS,[25] but its safety in parturient with cardiac diseases and haemodynamic instability has not yet been proven. For patients who are at high risk of PPH and require other uterotonics, please see under major PPH. A list of commonly used uterotonics, their doses and side effects is shown in the summary sheet.

Post-operative management

Analgesia

Post-operative analgesia is important for maternal well-being and should start intra-operatively. A common post-CS analgesic combination in our institution is shown in the summary. In patients who are at high risk of or suffer from post-operative nausea and vomiting (PONV), anti-emetics should be considered.

Precaution in breast feeding mothers

Nursing mothers are often reluctant to take post CS analgesia because of the fear of adverse effects of the drugs on the infants. One should advise nursing mothers that the harmful effects of excessive pain on maternal and infant wellbeing (decreased ability to breast feed and bond with the infant) should be balanced against the possibilities maternal transfer of drugs into breast milk and causing harm. A multimodal strategy is widely adopted, with the analgesic choice based on knowledge of transfer characteristics into breast milk and potential impact on the infant. The lowest possible effective dose should be used and the infant should not be breastfed when drug levels in breast milk peak.[26] In general, regular paracetamol and NSAID in short term use are safe and milk levels are low. Ibuprofen (600–800 mg oral every 8 h) has the best-documented safety, followed by mefenamic acid (most commonly prescribed in our local setting) and ketorolac. The use of COX2 specific inhibitors like celecoxib and parecoxib also showed no harm. The use of naproxen and indomethacin, however, is less recommended.[27] Short-term maternal use of opioids is also considered safe and rarely presents a hazard to the newborn.[26,28,29] The worry about opioid exposure in breast milk is respiratory depression in the infant, leading to apnoea and hypoxic sequelae. Morphine is the opioid of choice as only small amounts reach the infant.[30] Lipophilic opioids like fentanyl and alfentanil are also not likely to cause problems. There may be minimal risk with the use of oxycodone and tramadol in the first 3 days after CS as breast milk consumption by the neonate is not too high. Repeated doses thereafter should be used with caution as milk intake increases and infant should be monitored for central nervous system depression. The use of codeine and pethidine is not recommended.

Post-operative follow-up

It is good practice for anaesthesiologists to follow their patients post-operatively. This practice is even more important in obstetric anaesthesia. Post-operative follow-up allows anaesthesiologists to identify complications from anaesthesia and sub-optimal post-operative management early.

CS-related emergencies

Hypertensive disorders in pregnancy

Clinicians should be familiar with recognition and management of pre-eclampsia and eclampsia as they contribute significantly to maternal morbidity and mortality. Hypertensive disorders in pregnancy can generally be divided into four categories.[31]

1. Pre-existing or chronic hypertension – hypertension diagnosed before pregnancy or before 20 weeks gestation
2. Gestational hypertension – hypertension (>140/90 mmHg) after 20 weeks gestation but without features of pre-eclampsia (below)
3. Pre-eclampsia – hypertension (>140/90 mmHg) after 20 weeks gestation with new onset proteinuria.
4. Severe pre-eclampsia is pre-eclampsia with presence of severe end-organ complications:
    a. Cardiorespiratory: pulmonary oedema
    b. Renal: severe proteinuria >3+ on dipstick, oliguria <500 ml/24 h, rise in serum creatinine, raised uric acid
    c. Hepatic: elevated bilirubin, transaminitis, right upper quadrant pain.
    d. Neurological: visual disturbances, headache, hyperreflexia with clonus
    e. Haematological: thrombocytopenia, DIVC, haemolysis.
5. Eclampsia – pre-eclampsia with presence of seizures.

For CS, both RA and GA are suitable modes of anaesthesia but RA is preferred as it obviates the need for instrumentation of an oedematous airway and avoids excessive sympathetic stimulation and hypertensive response to direct laryngoscopy. However if RA is contraindicated, the intubation response can be attenuated with boluses of esmolol (1.5 mg/kg), GTN (2 mcg/kg), labetalol (10 mg titrate up to 1 mg/kg), lignocaine (1–1.5 mg/kg given 2–3 min before laryngoscopy) or remifentanil (1 mcg/kg).[32] If remifentanil is used for GA induction, it is important to warn the attending neonatologist regarding possible transient neonatal respiratory depression.[33]

For severe pre-eclamptic and eclamptic patients, delivery of the foetus is the only effective treatment. The decision on timing and mode of delivery should be a shared management decision made between the obstetricians, maternal–foetal medicine specialists, neonatologist and anaesthesiologists this should take into consideration both maternal and foetal wellbeing. Generally, delivery should be performed within 8 h of an eclamptic fit. Before delivery, the patient needs to be stabilised first. Generally, the goals of therapy are:

- Control of blood pressure but not compromising placental perfusion.

- Agents that can be used include IV labetalol (10–20 mg IV boluses for acute control, maintained with infusion of 5–20 mg/h) or IV hydralazine (5–10 mg boluses, maintained with infusion of 10–20 mg/h). Oral medications include labetalol, nifedipine, prazosin or methyldopa if patient is well enough for oral intake and absorption.
- Seizure prophylaxis.
- All patients with neurological symptoms should have magnesium sulphate 4 g IV over 15 min given as a loading dose, followed by a maintenance of 1–2 g per hour infusion, aiming for plasma concentration within the therapeutic range of 2–4 mmol/l. While on therapy, the patient should be monitored for loss of patellar reflexes, oliguria (<0.5 ml/kg per hour) and respiratory or CNS depression which will require reduction in rate or cessation of infusion.[34]
- Seizure treatment.
- Seizures should be promptly aborted with IV magnesium sulphate (IV 4g loading over 15 min, a further of 2–4 g given if initial bolus has already been given) or IV diazepam 5–10 mg, if magnesium is not available or contra-indicated. All supportive measures such as left lateral tilt, airway, breathing and circulation management is mandatory as per any obstetric emergency.
- Strict control of fluid balance.
- Due to increased capillary permeability in pre-eclampsia, fluid intake must be strictly maintained, as these patients are prone to pulmonary oedema. The standard IV fluid regime is 85 ml/h, inclusive of all intravenous drug volumes. Consider central venous measurement in patients with precarious cardiorespiratory function.
- After delivery, patient should be kept in critical care area for hemodynamic monitoring, antihypertensive therapy, magnesium infusion if required and strict fluid control. Management of pre-eclampsia and eclampsia is shown in the summary.

Major post-partum haemorrhage (PPH)

The traditional definition of primary PPH is the loss of 500 ml or more of blood from the genital tract within 24 h of the birth of a baby. The causes of PPH can be conveniently recalled by the '4 Ts':

1. Tone – uterine atony
2. Tissue – retained products of conception
3. Trauma – genital tract injury
4. Thrombin – acquired or inherited clotting deficiencies

PPH can be minor (500–1000 ml) or major (more than 1000 ml). Major could be divided into moderate (1000–2000 ml) or severe (more than 2000 ml). Allowing for the physiological increase in pregnancy, the total blood volume at term is approximately 100 ml/kg. A blood loss of more than 40% of total blood volume is generally regarded as 'life-threatening'. The volume of blood loss that triggers PPH protocols is usually around 1500 ml; however, this figure is only a reference, as transfusion trigger also depends on maternal comorbidity (e.g. pre-op anaemia), speed of transfusion services and degree of ongoing blood loss. Each institute should have a major haemorrhage protocol. This article's recommendation is based on the Royal College of Obstetricians and Gynaecologists' latest green top guidelines.[35]

Management of massive obstetric haemorrhage should be a multi-disciplinary effort. It includes early recognition and communication with the rest of the multi-disciplinary team. The multi-disciplinary team includes obstetricians, anaesthesiologists, haematologists, interventional radiologists, midwives, theatre, anaesthetic nurses and neonatologists. Major obstetric haemorrhage can become fatal very quickly and experienced clinicians should be involved as early as possible. The management of primary major PPH is shown in the summary. It involves supportive therapy with airway control and supplemental oxygen ± ventilation to decrease oxygen consumption from work of breathing; aggressive maintenance of intravascular volume with fluids and blood products; while simultaneously identifying the underlying cause and giving directed treatment. These may include non-pharmacological / surgical means (such as mechanical manoeuvres to increase uterine tone, bimanual compression, controlled cord traction, uterine compression suturing, tamponade balloon, artery ligation, peri-partum hysterectomy or interventional radiology) and pharmacological means (predominantly uterotonic drugs and correction of coagulation deficits). Good supportive care such as avoiding hypothermia by using rapid infusers with warming ability and warming device for patients and correction of electrolytes (e.g. calcium and potassium) during massive transfusion are also very important. Uterotonic drugs should be used in a stepwise approach. If no coagulation test is available, 12–15 ml/kg of fresh frozen plasma should be given after 4 units of pack red cells transfusion. FFP should be considered earlier for conditions with a suspected coagulopathy, such as placental abruption or amniotic fluid embolism, or where detection of PPH has been delayed. If prothrombin time/ activated partial thromboplastin time is more than 1.5 times normal and haemorrhage is ongoing, more than 15 ml/kg of FFP are likely to be needed to correct coagulopathy. Cryoprecipitate should be used for fibrinogen replacement to keep plasma fibrinogen level of greater than 2 g/l during ongoing PPH. Platelets should be transfused when the platelet count is less than 75×10^9/l. In addition to blood products, anti-fibrinolytic agents such as tranexamic acid seems to be a useful complement for treatment of PPH.[36] If available, thromboelastography can provide timely coagulation parameters to direct replacement of blood product,[37] and cell salvage can minimise use of allogenic blood transfusion.[38] The main concern surrounding the use of cell salvage during obstetric haemorrhage is the risk of reinfusing foetal contaminants with the theoretical risk of causing amniotic fluid embolus (AFE). However, to date there are no proven cases in the literature of AFE caused by reinfusion of salvaged blood. The use of leucodepletion filters in this situation has also shown a significant reduction in contamination from amniotic fluid.[39] Appropriate levels of monitoring, including intra-arterial and central venous pressure monitoring should be considered and established early. When bleeding is severe and cannot be stopped, temporary pressure on the aorta by

the surgeon can halt the bleeding and allow anaesthesiologist time to catch up with volume and blood product replacement. If resources are available early involvement of interventional radiologist for uterine artery embolization or internal iliac artery balloon catheterization can decrease the need for caesarean hysterectomy, morbidity and mortality.[40]

Systemic LA toxicity

Systemic LA toxicity in the obstetric context may occur when a dose of LA meant for epidural administration is inadvertently given intravascularly due to a migrated or misplaced epidural catheter. Signs of toxicity occur when plasma levels of LA exceed toxic concentrations and involved both cardiovascular and neurological manifestations. CNS effects range from initial excitation (tingling, peri-oral numbness, metallic taste in the mouth), progressing to generalized tonic-clonic seizures and eventually coma. Cardiovascular effects include direct myocardial depression, bradycardia, arrhythmias and ultimately cardiovascular collapse. Immediate treatment involves supportive care and administering lipid emulsion.[41,42] The management of LA toxicity is shown in the summary.

Conclusion

This article and its attached summary do not aim to replace formal teaching, textbooks, local hospital guidelines or protocols. Instead, it serves to provide a quick and easy to follow guide for obstetricians, occasional obstetric anaesthesiologists, clinicians and health professionals when needed.

Declaration of Conflicting Interests

The authors declare that there is no conflict of interest.

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Charted summary

Peri-operative management of Caesarean Section – an aide memoire

This is a reminder of the important points of anaesthesia for CS. It does not replace formal training or text book.

Pre-operative evaluation and preparation

Aims of Pre-operative evaluation:

- To identify risk factors for difficult intubation, haemorrhage, NAB, sepsis, pre-eclampsia and to be aware of maternal and fetal well being
- To confirm the reason and urgency of CS
- To obtain informed consent
- To administer or prescribe gastric prophylaxis

Informed consent:

The basic elements of informed consent include procedural description, potential risks, benefits, complications and alternate therapeutic options.

Risks of GA	Incidence
Shivering, sore throat, PONV, muscle pain	> 1 in 10
Oral dental trauma	1 in 20 to 4500
Failed intubation	1 in 250
Awareness	1 in 400
Serious complication e.g. brain damage or death	< 1:100,000
Neonatal respiratory depression	Insignificant to 50% depending on foetal condition

Risk of NAB	Epidural	Spinal
Itching	1 in 3 to 10	1 in 3 to 10
Hypotension	1 in 50	1 in 5
Ineffective for labour pain	1 in 10	NA
Ineffective for CS	1 in 7	1 in 20
Need GA conversion for CS	1 in 50	1 in 20
Severe headache	1 in 100	1 in 500
Nerve damage	Lasts < 6 months 1 in 1,000 to 2,000 Lasts > 6 months 1 in 24,000	
Haematoma, abscess, LA toxicity, meningitis	Very rare < I in 50,000	

Gastric prophylaxis:

H_2- receptor antagonist + sodium citrate

If signs of fetal compromise, consider **intrauterine fetal resuscitation**

- Left lateral/ right lateral/ knee-elbow positioning.
- Optimize maternal BP with 1L fast IV non-glucose crystalloid.
- Maternal high flow O2 administration.
- Inhibition of uterine contractions by stopping syntocinon infusion ± tocolytics (e.g. terbutaline 0.25mg IV).

Obstetric relevant pre-operative evaluation	
Aim to identify difficult airway, PPH risk, neuraxial block (NAB) risk and hypertensive diseases	
Past and current obstetric history	Previous CS, high parity, previous PPH, induction of labour, prolonged labour, multiple gestation, chorioamnionitis, macrosomia, gestational age and fetal condition, intra-uterine death (IUD)
Maternal condition	Hypertensive disorders, gestational diabetes, BMI > 35
Drug history	Anti-coagulation, anti-hypertensive, magnesium etc.
Examination	As per non-obstetric patients and directed by history
Investigation	Placental position on latest ultrasound FBC and blood group Renal, clotting profile and liver function test etc. if necessary

Pre-operative preparation

Be prepared for haemodynamic instability, haemorrhage and difficult intubation for every case.

Preparation for haemorrhage		
Must have in theatre	**Readily available**	**If uncontrollable haemorrhage, consider**
18G+ IV	2nd large bore IV line	Haematologist
IV giving set with filter	IA or CVP line	Vascular surgeon
Fluid and body Warming device	O –ve, group specific or crossed matched blood	Interventional radiologist
Blood group and save	Coagulation factors, platelets and fibrinogen	TEG
Uterotonics	Major haemorrhage protocol	Cell saver
Tranxaemic acid if required	Senior surgeon and anaesthetist	

Preparation for difficult airway	
Must have	**Consider or readily available**
Ramp patient up for intubation	Help from experienced anaesthetist
Operating table that can tilt	Videolaryngoscope
Short handle laryngoscope + LMA + ETT introducer + various sizes ETT	Front of neck access kit and difficult airway trolley (if applicable)
Properly applied cricoid pressure by competent assistant, right angle to maternal tilt	Concurrent oxygenation via nasal cannula (5 l/min) during pre-oxygenation and intubation
Pre-oxygenation to $P_{et}O_2$ > 0.9	Gentle face mask ventilation with peak airway pressure < 20cmH_2O
Adequate succinylcholine 1.5-2 mg/kg	Rocuronium 1-1.2mg/kg
	Sugammadex 16mg/kg (for immediate reversal)

Intra-operative management

Common anaesthesia technique (left lateral TILT at 30°)		
Spinal anaesthesia	**Epidural top-up**	**GA (with RSI)**
L3/4 or L4/5 interspace 25-27G pencil point spinal needle Hyperbaric bupivacaine 0.5% 10-12.5mg (2 - 2.2ml)	(In divided doses) 15 - 20ml 2% lignocaine + 1:200,000 adrenaline (0.1ml of 1:1000) + 2ml 8.4% sodium bicarbonate Or 20ml 0.5% (levo-) bupivacaine	Pre-oxygenation, suction, cricoid pressure Thiopentone 4-5 mg/kg or Propofol 2-2.5 mg/kg + succinylcholine (1.5-2 mg/kg) Or Rocuronium (1 -1.2 mg/kg)
+Fentanyl 10-15 mcg or morphine 100 mcg	+fentanyl 50-100mcg +morphine 3mg after baby is delivered	

Other aspects of intra-op management:

1. Standard monitoring
2. RA is preferred unless contra-indicated e.g. Patient refusal or inability to cooperate, increased intracranial pressure, skin or soft tissue infection at the site of needle placement, coagulopathy, uncorrected maternal hypovolemia.
3. In RA, sensory block to T4 bilaterally needs to be achieved for adequate anaesthesia for CS.
4. Use fluid and vasoconstrictors to treat hypotension:
   - Phenylephrine 1st line, ephedrine 2nd line, phenylephrine has better foetal acid base status; can consider phenylephrine infusion 25-50mcg/min.
   - Consider 10-20ml/kg crystalloid coload.
4. Antibiotics before knife-to-skin.
5. AFTER delivery of baby(ies), give uterotonics such as syntocinon 5iu slow IV bolus or Carbetocin (duratocin) 100mcg IV bolus.
6. Consider paracetamol and NSAID for all unless contra-indicated.
7. Post op respiratory monitoring is required if morphine is used in neuraxial block.
8. TAP block: no benefit over intrathecal morphine but beneficial if no intrathecal or epidural opioid has been given.

Abnormal coagulation and neuraxial block (NAB)	
Coagulation abnormalities	**Safe interval before NAB**
Prophylactic LMWH	10-12 hours
Therapeutic LMWH	24 hours
UFH – infusion or prophylactic bolus	Infusion stopped > 4 h and APTTR ≤ 1.4 Bolus last given > 4 h
Aspirin alone	No need to stop
Warfarin	INR ≤ 1.4
ITP	Platelets >75 x10^9/L
Pre-eclampsia	Platelets >100 x10^9/L within 6 hours of NAB. If platelets 80-100 x10^9/L with normal coagulation profile, risks and benefits of NAB need to be weighed.
Intra-uterine death	FBC and coagulation screen normal within 6 hours of block, without evidence of overt sepsis or abruption.
Cholestasis	INR ≤ 1.4 within 24 hours of NAB

Post-operative management

Common practices for post-op management
Routine post-op monitoring as per local hospital protocol. Patients that are unstable needs HDU or ICU care.
Regular oral paracetamol 1g Qds + NSAID e.g. ibuprofen 600mg Tds (if no C/I) + PRN oral tramadol 50mg 4 hourly or oromorph 10mg 4 hourly or oral oxycondone 5mg 4 hourly + PRN anti-emetics
PCA morphine if patient cannot tolerate oral intake
In patients with neuraxial morphine, post op respiratory monitoring (1-2 hourly) is required for 24h. - Be cautious with additional opioids via other routes whilst neuraxial opioid is still effective.
All obstetric patients who had an anaesthetic intervention should be followed up the next day to look out for complications of RA or GA.

Abbreviation

ACLS – advanced cardiac life support
BMI – body mass index
C/I – contra-indication
CPR – cardio-pulmonary resuscitation
CVP – central venous pressure
ENT – ear nose and throat
FFP – fresh frozen plasma
FM – face mask
GA – general anaesthesia
IA – Intra-arterial
ICU – intensive care unit
IV – intra-venous
KTS – knife to skin
LA – local anaesthetics
LMWH – low molecular weight heparin
NSAID – non steroidal anti-inflammatory
PONV – post-operative nausea and vomiting
PPH – post partum haemorrhage
PR – per rectal
PRN – as required
Qds - four times each day
SAD – supra-glottic airway device
TEG – thromboelastography
Tds – three times a day
UFH – unfractionated heparin

Peri-operative management of Caesarean Section - special circumstances and emergencies

Pre- eclampsia and eclampsia
(a multi-disciplinary approach together with obstetricians and midwives)

Treatment for severe pre-eclampsia	**Treatment for eclampsia**
1. Treat hypertension - treat if SBP >150-160 mmHg or DBP >110 mmHg consider using oral or IV labetalol, IV hydralazine or oral nifedipine 2. Treat fits / potential fits - Magnesium 4g IV loading dose over 15 mins, 2g additional for further seizure - Maintenance at 1g/h by IV infusion - Monitoring: reflexes, urine output, signs of toxicity 3. Meticulous attention to fluid balance 4. Plan delivery 5. Treat systemic complications e.g. HELLP syndrome if necessary.	1. Address ABCs 2. Terminate seizure (see left) 3. Stabilize and plan for delivery (see left) **Anaesthesia for CS** 1. Patient should be stabilized from severe hypertension and seizures first before CS 2. RA is preferred if no contraindications e.g. coagulopathy and decreased consciousness etc. 3. If GA, beware airway edema and severe hypertension during airway manipulation. Consider IV esmolol 1.5mg/kg or GTN 2mcg/kg or labetalol 10mg titrate up to 1mg/kg or remifentanil 1mcg/kg or lignocaine 1-1.5mg/kg at induction to decrease hypertensive response at intubation. 4. Consider intra-arterial line and central venous pressure monitoring
Strict control of fluid balance e.g. intake of 85 ml/hour and fluid balance chart. Consider central venous measurement in patients with precarious cardiorespiratory function.	
Patient should be kept in critical care area before and after delivery	
Early multidisciplinary involvement e.g. ICU, renal, haematology and GI etc.	

Obstetric haemorrhage

1. Recognize – estimate blood loss > 1500ml, also take into account pre-op haemoglobin and body weight.
2. Communicate – with senior anaesthetist, obstetrician, midwives +/- haematologist and interventional radiologist. Activate massive haemorrhage protocol as per local hospital policy.
3. Resuscitate – left lateral tilt if undelivered, support airway, breathing (100% O2) and circulation (large bore cannulae x2 + 20ml/kg warm crystalloids, repeat another 20ml/kg if necessary). Fluid, blood and blood product administration as directed by patient's condition
4. Stop bleeding – look for causes of bleeding (4T's): tone, tissue, trauma, thrombin; see below for pharmacological, surgical and interventional radiological options
5. Aftercare – monitored in critical care

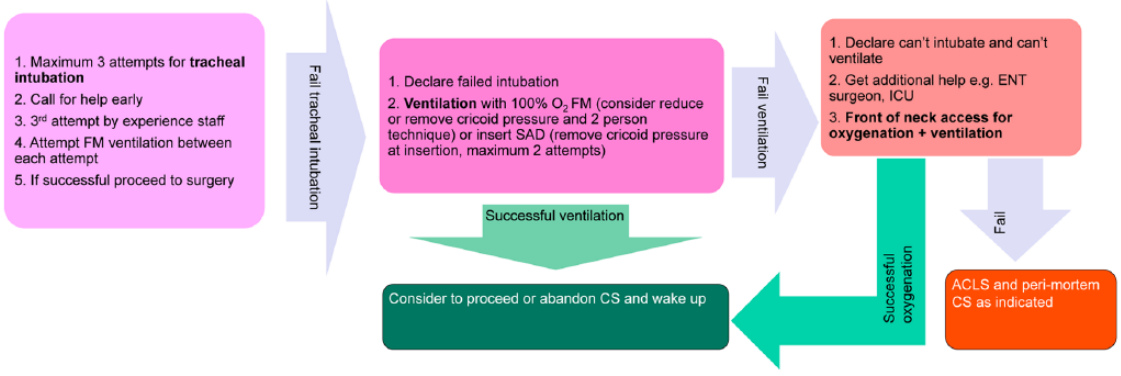
Uterotonics	**Dose**	**SE and Contra-indication (C/I)**	**Surgical**
Syntocinon	5 iu IV slow bolus, may be repeated (+ 40 iu in 500ml Hartman's infused over 4 hours)	Hypotension, water retention. Cautious and slow bolus in cardiac disease.	Empty uterus
			Repair genital tract trauma
Carbetocin (Duratocin)	100 µg in 1 ml, slow IV bolus (in place of syntocinon, not in addition to)	C/I in serious cardiovascular disease.	Tamponade (gauze packing / intrauterine balloon)
			Uterine compression (manual or brace suture)
Ergometrine	0.5 mg slow IV or IM (in addition to the above)	Headache, nausea and vomiting, C/I in hypertension	Internal iliac artery ligation (but this will exclude embolization)
Carboprost/ Haemabate	IM 250 mcg **(Not IV)** can be repeated at 15 min intervals as needed; max 2mg (in addition to above)	C/I in asthma	Aortic compression to temporarily halt bleeding
			Hysterectomy
Misoprostol	800-1000 mcg PR (useful if other uterotonics are not available)		**Radiological**
Optimize coagulation			Pre-op internal iliac artery balloon catheterisation
Tranexamic acid 0.5-1g IV			Embolization of bleeding vessel
Blood products: packed cells, FFP and platelets.			
Cryoprecipitate if fibrinogen < 1g/l, guided by coagulation studies			
Consider use of TEG to guide therapy			

Peri-operative management of Caesarean Section - special circumstances and emergencies

Treatment of systemic local anaesthetic (LA) toxicity

1. **Recognize** - Initial CNS excitation (tingling, peri-oral numbness, metallic taste in the mouth), progressing to generalized tonic clonic seizures and eventually coma. Cardiovascular effects include direct myocardial depression, bradycardia, arrhythmias and ultimately cardiovascular collapse.
2. **Communicate** – call for help.
3. **Resuscitate** – stop LA injection, left lateral tilt if undelivered.
   - Support airway, breathing (100% O2) +/- ventilation.
   - Support circulation (Fluid and vasopressor) + CPR if cardiac arrest + treat arrhythmia according to ACLS protocol (avoid vasopressin, calcium channel blockers, beta blockers, or local anesthetic), reduce individual epinephrine doses to treat hypotension e.g. <1 mcg/kg as it may further impair cardiac contractility.
   - Seizure suppression: benzodiazepines are preferred; avoid propofol in patients having signs of cardiovascular instability.
   - Expect prolonged CPR.
4. **Treat** – administer 20% lipid emulsion
   - Bolus 1.5 ml/kg (lean body mass) intravenously over 1 minute (~100mL).
   - Continuous infusion 0.25 ml/kg/min.
   - Repeat bolus once or twice for persistent cardiovascular collapse.
   - Double the infusion rate to 0.5 ml/kg/min if blood pressure remains low.
   - Continue infusion for at least 10 minutes after attaining circulatory stability.
   - Recommended upper limit: Approximately 10 ml/kg lipid emulsion over the first 30 minutes.
5. **Monitor** in critical care

Management of failed intubation



For detailed guidelines for the management of difficult and failed tracheal intubation in obstetrics, please consult Mushambi et.al. Anaesthesia 2015;70:1286-1306.