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Anaesthesia for the pregnant patient undergoing non-obstetric surgery: Contemporary evidence and practical guidance

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INTRODUCTION

The intersection of obstetric physiology with non-obstetric surgery presents a high-stakes challenge for anaesthetists. While elective surgery is best delayed until after delivery, urgent and emergent surgical procedures in pregnancy are not uncommon and often proceed in the context of limited institutional guidance. This article provides a comprehensive review and practical framework for anaesthetising pregnant patients undergoing non-obstetric surgery, with trimester-specific considerations and up-to-date evidence on anaesthetic techniques, drug safety, monitoring strategies, and multidisciplinary planning.

Internationally, there is an increasing focus on the rising or, at the very least, stagnant rates of maternal morbidity and mortality. In the United States, maternal mortality has more than doubled in the past two decades.[1] While maternal mortality rates in Australia and New Zealand remain comparatively low, they have plateaued rather than declined, with increased risk observed in persons aged 35 and older.[1] Furthermore, the lifetime societal cost of a disabled child is estimated to be $USD2.4 million each year.[2] Improving anaesthetic care for pregnant patients, especially in non-obstetric contexts, is a significant opportunity to optimise outcomes and support this vulnerable group.

SUMMARY OF MANAGEMENT PRINCIPLES AND GOALS

Surgical factors

Urgent or emergency surgery should be performed, regardless of trimester.[3]

Elective surgery that cannot wait until after delivery is best performed in the second trimester, but if feasible, it should be delayed until after delivery.[3]

Surgical techniques should aim to minimise intra-abdominal pressures, and care should be taken with the insertion of laparoscopic ports and trocars to avoid the gravid uterus.

Modifications may be needed to facilitate left lateral tilt and intraoperative fetal monitoring.

Patient factors

Fetal heart rate should be documented pre- and postoperatively.[3] Individualised decision-making is required regarding the decision to monitor fetal heart rate intraoperatively, in conjunction with the obstetric team.

Counselling of pregnant patients on the accurate rate of preterm delivery associated with non-obstetric surgery varies depending on their medical comorbidities. Reported values are based on observational studies and expert opinion.

Anaesthetic factors

The safest technique is a regional anaesthetic with no sedation.

Endotracheal intubation should be considered from the first trimester and is usually required from the second trimester onwards due to hormonal and mechanical factors**.** Uterine displacement should be initiated in the second trimester to prevent aortocaval compression. Consider from the time the patient is visibly pregnant, certainly from 20 weeks onwards and earlier in cases of multiple gestation (such as twins).

Formulate a plan and ensure that multidisciplinary communication is in place. This is essential for both preparing for and responding to the variety of situations that may arise during the perioperative journey.

TRIMESTER-SPECIFIC CONSIDERATIONS

First trimester

Timing of surgery

Risk of teratogenicity is highest <10 weeks' gestation, and baseline miscarriage rates can be up to 10%.[3] Non-elective surgeries that cannot wait until after delivery are best deferred until the second trimester, as rates of pregnancy loss are lower and organogenesis is largely complete.[3]

Fetal monitoring

The appropriateness of fetal monitoring should be decided in consultation with the on-call obstetric team. Handheld Doppler assessment of the fetal heart rate (FHR) at early gestation may not be technically possible. Inability to assess the FHR with a handheld Doppler may cause anxiety for the patient and the medical team. Before 10 weeks, a simple bedside ultrasound scan is recommended to confirm the presence of a fetal heartbeat. A handheld Doppler may be attempted as early as 10 weeks of gestation. However, a bedside ultrasound should be immediately available if this is not successful. This process should be repeated postoperatively at the bedside to confirm fetal wellbeing. Continuous fetal heart monitoring has not been shown to improve outcomes in this trimester.[3]

Non-viable pregnancies

Disseminated intravascular coagulation (DIC) is very uncommon following a first-trimester pregnancy loss unless there is massive haemorrhage. Cases of incomplete miscarriage or retained products of conception are at greater risk of infection than patients with a non-viable pregnancy with no bleeding. Current guidance is to check the patient's coagulation profile before neuraxial procedures if a non-viable pregnancy is confirmed, especially if the time of fetal demise may not be known, or >48 hours.[4]

Anaesthetic drug safety

Avoid medications like benzodiazepines, nitrous oxide, and ondansetron due to potential teratogenicity (refer to Table 4).

Other considerations

Maintain normothermia, low-normal $PaCO_2$, PaO_2 and mean arterial pressure (MAP). Evidence suggests first-trimester losses are more associated with these factors than with sedatives.[3]

Second trimester

Timing

The second trimester is an optimal time for surgery due to a lower risk of miscarriage (<1%) or preterm labour,[3] as well as technical aspects (uterus is smaller, easier to position pregnant persons and easier to monitor fetus). Consider antenatal steroids for fetal lung maturation at 24 and 48 hours preoperatively if the fetus is considered viable, usually after 24 weeks. This requires discussion with obstetrics and neonatology and will depend on the assessment of fetal weight before proceeding with surgery. Surgery may be delayed to facilitate fetal optimisation, and this decision must be balanced against any potential increased risks to the patient (e.g. deep vein thrombosis, infection).

Fetal monitoring

At a minimum, fetal heart rate should be documented both pre- and post-surgery. Consider intraoperative cardiotocography (CTG) if the fetus is at a viable gestation. This decision will ultimately be based on the obstetric team's recommendations for the patient in the context of the proposed surgery and pathology. This will require the availability of a midwife to remain with the patient to monitor the CTG throughout and communicate the fetal condition to the anaesthetic and surgical teams.

There should be clear documentation and communication of the multidisciplinary team's (MDT) plan if abnormalities in the CTG are detected intraoperatively.

Be aware that if a CTG has an abnormal trace, an obstetrician and neonatologist must be available in the event of an emergency caesarean section (C/S) being required. Ensure this is appropriate in the clinical setting for this patient and has been well-discussed with the midwifery, obstetric, surgical, and NICU teams at a pre-procedural huddle or time-out.

Continuous CTG may be challenging in obese patients or those having abdominal surgery, which is frequently the nature of the required emergent surgical procedure.

Interpretation of CTG may also be difficult given the expected decrease in fetal heart rate under anaesthesia. Increasing intravenous fluids and FiO_2, maintaining adequate maternal MAP, and facilitating left tilt may be incorporated to improve utero-placental perfusion.

Non-viable pregnancy

The risk of DIC and sepsis may be higher in the second and third trimesters due to greater placental and fetal tissue. Blood tests should be taken within 48 hours if intrauterine fetal demise (IUFD) occurs at <4 weeks. In cases of IUFD >4 weeks (or earlier if sepsis is present), the risk of DIC increases; therefore more recent complete blood count and coagulation studies should be performed. If it is diagnosed on hospital admission, the duration of demise may be unclear, as the last normal scan may have been an anatomy scan at 18–22-week gestation.

Anaesthetic drug safety

Some antiemetics previously not used in the first trimester may be used, such as ondansetron and dexamethasone (refer to Table 4).

Positioning

Uterine displacement should be initiated after 18–20 weeks of gestation to help address aortocaval compression. This should be considered earlier in cases of multiple gestations.

Other

Aspiration prophylaxis with a combination of sodium citrate and omeprazole is strongly recommended.

Third trimester

Timing

Procedures in the third trimester carry an increased risk of preterm labour and premature rupture of membranes. Surgical positioning can be more challenging in the setting of a large gravid uterus, and there is a subsequent higher risk of aortocaval compression.

Fetal monitoring

Fetal monitoring should be continuous, which can be challenging to integrate with surgery. It will ultimately be based on discussions with the obstetrics and gynaecology team and their recommendations for this patient and surgery. The requirements for thorough documentation and MDT discussion on the plan of action if a CTG trace becomes abnormal are the same as those for second trimester considerations. Overall, fetal monitoring is technically easier to carry out and interpret in the third trimester compared with other trimesters.

Non-viable pregnancy

See sections on first trimester and second trimester.

Anaesthetic drug safety

See sections on first trimester and second trimester.

Other

Peripartum risks to the pregnant patient return to baseline six weeks postpartum.[3] The gastrointestinal effects of progesterone (lower oesophageal tone, increased gastric residual volume and lower pH) can return to normal as early as 72 hours after caesarean section or 48 hours post vaginal delivery.[5] Evidence is conflicting in this area, with some studies indicating a delay if opioids are used.[6]

PREOPERATIVE CONSIDERATIONS

Timing

Non-emergency, non-obstetric surgery should be delayed until post-delivery, where possible.[7] If this is not possible, surgery should be completed in the second trimester, as this is associated with the lowest risk to the fetus and pregnant patient.[3]

Fetal monitoring

Fetal monitoring should be considered, especially after 24 weeks of gestation, depending on the procedure and gestational age. Some centres will discuss viability from 22 weeks' gestation.

Non-viable pregnancy

If there has been a fetal demise >48 hours prior, DIC and/or sepsis should be considered, and platelets and a coagulation profile should be ordered.[4] Fibrinogen should be > 2 g/L, and all other tests within a normal range.[4]

Anaesthetic drug safety

Avoid known teratogenic drugs and consider pharmacokinetics altered by pregnancy.

Safest technique

A regional technique with no sedation and avoiding airway manipulation is the safest technique when appropriate.

Multidisciplinary planning

Collaboration with surgeons, obstetricians, midwives and neonatologists is vital.

Counselling patients

When counselling patients about the risks of anaesthesia to the fetus, it should be conveyed that the risk of anaesthesia-related teratogenicity is an area of ongoing research; however, there is no strong evidence of increased risk from single exposure to anaesthetic agents, even when used during early pregnancy.[7] The risk of miscarriage and preterm labour is mitigated with appropriate planning, timing, anaesthetic/surgical technique and MDT involvement. Commonly encountered questions are presented in Table 1.

Table 1. Patient counselling and guidance: Common questions asked by obstetric patients having non-obstetric surgery

Question	Answer
Does general anaesthesia (GA) increase the risk of miscarriage or preterm labour?	Studies show there is a small increase in risk of miscarriage if you have had surgery. It is unclear if this is due to the health problem or illness that has caused the need for surgery, the surgery itself, the anaesthesia, or the stress on the body around the time of surgery.[3,8] The risk of a miscarriage after surgery in the first trimester is estimated to be about 10%, less than 1% in the second trimester and between 5-8% in the third trimester. This is in addition to the baseline miscarriage risk of 10-20% in the first trimester and 2-3% in the second and third trimester. These numbers are based on observational studies and should be individualised to the patient by considering medical, obstetric and surgical risk factors.[3,8]
Does GA increase the risk of future behaviour or learning issues for children?	A single anaesthetic is unlikely to cause future behaviour or learning challenges. Research shows these types of outcomes are more likely due to a combination of factors such as prolonged medication use, multiple surgeries, and broader social or economic influences.[3,7]

INTRAOPERATIVE CONSIDERATIONS

Surgical

Ensure the surgical team is aware of the need to do the operation with left lateral tilt, pneumoperitoneum with limited insufflation pressures <15 mmHg, and guided insertion of trocars to avoid uterine trauma. A NICU bed should be available (depending on stage of gestation) and a clear plan should be in place if concerning features develop on intraoperative CTG and emergency C/S is required.[3]

Positioning

In the second trimester, left lateral tilt is required to avoid aortocaval compression. Guidelines recommend 15 degrees; however, studies show 30 degrees may be more effective.[9] The degree of tilting may need to be increased depending on the uterine size/gestation/multiple pregnancy. Notably, many newer models of operating tables have limits on their side-to-side tilt, with many restricted to a maximum of 20 degrees. Ensure the patient is securely strapped and a side rail is in place. If prone positioning is required, the Jackson table may be preferred due to its open frame design, which reduces abdominal pressure.

Monitoring of blood pressure

If the supine position is required for surgery, expect blood pressure to fall due to aortocaval compression syndrome, which may not be easily corrected despite intravenous fluid and vasopressors. Invasive and non-invasive blood pressure at the arm may not reflect perfusing pressure at the placenta, regardless of position, and leg non-invasive blood pressure monitoring (focusing on MAP) or Doppler may be considered as an adjunct in high-risk patients. There are no current guidelines to support this emerging trend.[10,11]

Monitoring of anaesthetic depth

Depth of anaesthesia monitoring is encouraged if a GA is considered. There are no guidelines to suggest that the readings being displayed are significantly altered for pregnant patients. Obstetric patients may have a lower anaesthetic requirement, but this must be balanced with higher rates of awareness.[12] There is no evidence to support the superiority of a proprietary processed EEG system (SEDline vs BIS, etc.) in this patient cohort.

Anaesthetic technique

General anaesthesia (GA)

If a GA is required, sevoflurane may be preferred in some instances as it may reduce uterine contractions

and preterm delivery.[3] Ketamine can increase uterine tone.[3] Propofol total intravenous anaesthesia (TIVA) has the benefit of a reduction in postoperative nausea and vomiting, which is advantageous in this at-risk group, especially in the context of morning sickness/hyperemesis gravidarum.

The occurrence of propofol infusion syndrome (PRIS) in neonates born preterm following maternal GA with TIVA is not well-documented.[13] However, it may be a concern when doses exceeding 4 mg/kg/hr are administered for more than 48 hours, such as during prolonged operations and/or sedation in the ICU. If the mother is carnitine-deficient, the neonate is likely to be deficient at birth, given that it passes through the placenta, which can impair fatty acid metabolism in the newborn and theoretically increase risk.

Regional anaesthesia

A regional technique (neuraxial or peripheral nerve block) is the preferred modality for avoiding systemic drug administration and airway risks. Lower doses of spinal/epidural may be required in the third trimester due to mechanical and hormonal factors.[14] There may be a faster onset and shorter duration of block in this cohort, too. Prior to the third trimester, similar or slightly higher doses compared to those in non-pregnant patients may be required.[14] A combined spinal and epidural (CSE) may be a good option to allow titratability and rescue a failed block, if time allows.

Airway

Pregnant patients have increased oxygen consumption and a lower functional residual capacity, making them prone to desaturation.

Positioning

Ramp the patient well (flextension and torso elevation) to improve airway and respiratory mechanics. Note, flextension is a relatively new term to describe optimal head and neck positioning for airway management.[15]

Aspiration risk

Due to changes in the lower oesophageal sphincter and a gravid uterus displacing abdominal contents, rapid sequence induction with endotracheal intubation is strongly recommended. There is currently a lack of high-quality evidence to support the use of cricoid pressure in obstetric patients; hence, its use should be individualised. There is no consensus for a gestational age where endotracheal intubation is required; however, it should be considered in all trimesters, especially as pregnancy progresses and if the patient has nausea/vomiting/reflux or a full stomach. Patients can have gastrointestinal symptoms from as early as four weeks.[16]

Difficult airway

Historically, it was reported that one in 250 pregnant patients had a failed intubation. In the NAP4 national UK audit, only four cases of failed intubation (incidence of one in 1700–16,000) were reported.[17] For these reasons, it is difficult to draw robust conclusions that demonstrate a confirmation of this previous concern. A "difficult" airway may be expected due to anatomic and physiological changes in pregnancy; however, failed intubation may be less common due to increased awareness and advances in technology and training.

The Difficult Airway Society (DAS) and the Obstetric Anaesthetists' Association (OAA) recommend that video laryngoscopy should be used as a first-line approach in this population.[17] If using direct laryngoscopy, a short handle should be used. Videoscopes with a screen attached to the handle (e.g. Glidescope Go) can create a longer handle, which can pose ergonomic challenges. Consider using a separate screen or an alternative video laryngoscope with a more favourable ergonomic profile.

Note in DAS's *Management of difficult and failed intubation in obstetrics guidelines,* two attempts at laryngoscopy are recommended as opposed to three to reflect increased airway oedema/friability.[17]

Figure 1. Management of difficult and failed intubation in obstetric patients

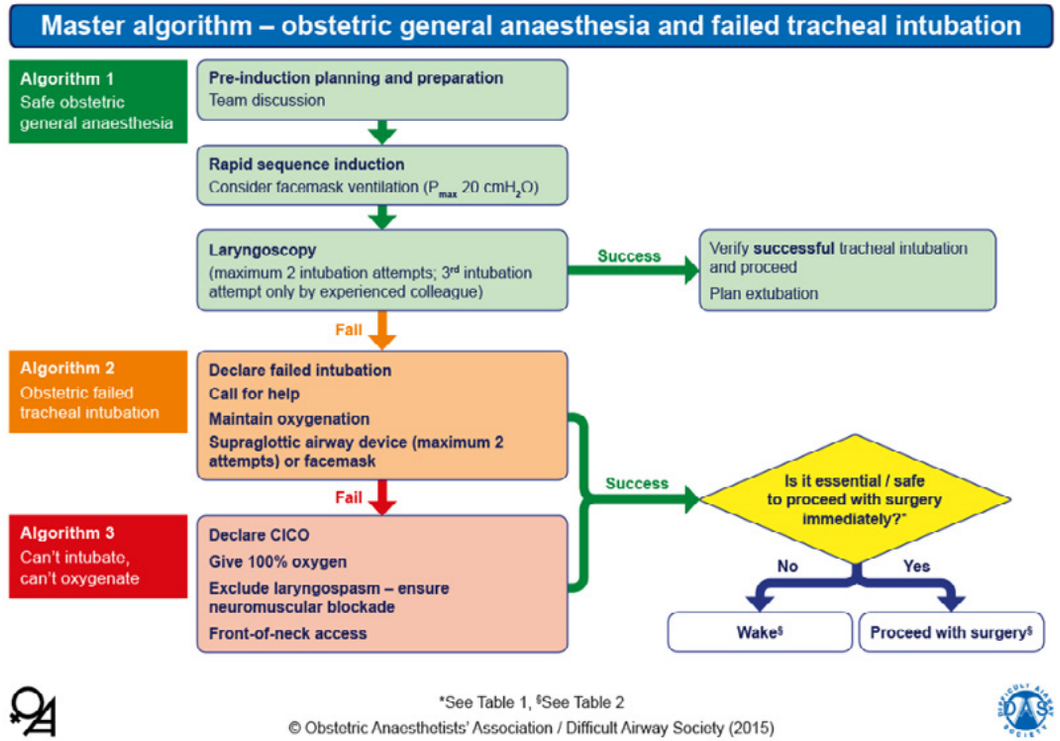

Image reproduced from Obstetric Anaesthetists' Association and Difficult Airway Society (2015)[18]

High-flow nasal prongs (HFNP) aiming for an ETO_2 > 90% can provide a longer apnoeic time until desaturation compared with standard face mask preoxygenation. The benefits of HFNP may be limited when BMI exceeds 50 in pregnancy.[19]

Breathing

Ventilation

Set ventilator to high-normal tidal volume (VT) (5-7 mL/kg) and target low-normal $ETCO_2$ (30-32 mmHg or 4-4.3 kPa), to reflect compensated metabolic alkalosis. This may theoretically facilitate fetal oxygenation at the placenta (a right shift in the oxygen-dissociation curve on the maternal side, allowing oxygen to be offloaded). Excess CO_2 crosses the placenta and can cause fetal myocardial depression and acidosis.

Oxygenation

A universally prescribed FiO_2 threshold is not well-established in the literature. Current guidelines emphasise the importance of preserving normal maternal oxygenation, acid–base balance, and uteroplacental perfusion to optimise fetal outcomes. FiO_2 may be set at a higher value during preoxygenation and vulnerable periods to provide an adequate buffer, acknowledging that fetal oxygenation is dependent on maternal oxygen tension. However, routine prolonged use of higher FiO_2 has not been shown to provide benefit and may be associated with fetal retinopathy.

Circulation

Ensure stable blood pressure and uteroplacental perfusion. Hypotension should be promptly treated with fluids and vasopressors, such as phenylephrine, metaraminol, noradrenaline or ephedrine.

Choice of vasopressors

There are no international guidelines on blood pressure targets; however, a systolic >100 mmHg and

MAP>65 (or within 20% of baseline) is reasonable. While there are no specific guidelines solely focused on the choice of vasopressors for obstetric patients undergoing non-obstetric surgery, evidence from caesarean section anaesthesia suggests early peripheral noradrenaline (7 mcg/mL concentration) may offer advantages as it is not associated with the reflex bradycardia that is sometimes seen with phenylephrine/metaraminol, nor reduced fetal pH/increased fetal heart rate, as seen with ephedrine.[20] This is likely due to its mixed alpha and beta action, which increases both cardiac output (CO) and systemic vascular resistance (SVR), thereby enhancing placental perfusion. The risk of extravasation injury is low with concentrations <8 mcg/mL and short-duration infusions.[21] If unfamiliar with peripheral noradrenaline, metaraminol is a good alternative. If bradycardia occurs with its use, consider atropine or glycopyrrolate rather than ephedrine.

Deep vein thrombosis (DVT) prophylaxis

The risk of DVT is 5x greater in pregnancy.[22] The hypercoagulable state is highest in the first six weeks postpartum, peaks in the first three weeks (20x higher than non-pregnant) and returns to normal at 12 weeks postpartum. Sequential compression devices (SCDs) and limb mobilisation are required every 2-3 hours during lengthy procedures. A decision can be made together with the surgical team at surgical sign-out regarding whether low-molecular-weight heparin (LMWH) or thromboembolic stockings (TEDs)/SCDs are preferred, along with avoidance of dehydration and encouragement of early mobilisation.

Obstetric haemorrhage

Pregnant patients have high CO and may be at higher risk of cardiac arrest if hypovolemia is not recognised early and corrected.

In the third trimester, a blood loss of more than 1.5 L is required in a 70 kg patient before signs of decompensation develop. Individualised calculation of blood volume by weight is necessary to ensure that a significant haemorrhage is not missed in smaller patients, as well as vigilance and strong communication among surgeons, nurses, and anaesthetists. An overreliance on blood pressure and heart rate is not recommended, especially since pregnant patients typically have a higher resting heart rate and lower blood pressure. Common estimates for different patient weights are presented in Table 2.

Table 2. Calculated blood volumes in the third trimester

Body mass index (BMI)	Blood volume in third trimester (100 mL/kg)	20% blood loss
18.5-24.9 – healthy Example: 50 kg	5 L	1 L
18.5-24.9 – healthy Example: 70 kg	7 L	1.4 L
> 30 – obesity Example: 100 kg	7 L*	1.4 L

*In obesity, lean body weight should be used to calculate blood volume or 70 mL/kg if total body weight is used.[23]

When managing major bleeding in obstetric patients undergoing non-obstetric surgery, the principles of permissive hypotension, balanced blood products, and damage control surgery are generally applied as for non-obstetric patients, with additional considerations outlined in Table 3.

Table 3. Considerations for pregnant patients with major bleeding

Principle	Additional considerations	Practice point
Permissive hypotension	MAP of 50-60 will significantly reduce fetal perfusion pressure given the placenta is pressure passive.	This is a high-stakes intervention. It is considered when maternal life is at imminent risk and resuscitative hysterotomy may also be under consideration. Maternal survival is the priority and a period of reduced uteroplacental perfusion may be required. If fetal demise is already confirmed or very likely this decision is clear. The extent of permissive hypotension should be guided by: 1. Severity of maternal injury. 2. Fetal viability. 3. Likelihood of ability to gain surgical control of bleeding.
Balanced blood products	Pregnancy is a hypercoagulable state with higher fibrinogen (4-6 g/L) and clotting factors. Studies in postpartum haemorrhage reveal fibrinogen is consumed faster than clotting factors despite volume of blood loss.[24] Excessive fresh frozen plasma (FFP) can lead to dilutional coagulopathy, volume overload, acute/delayed immune reactions and, specific to pregnancy, reduced oxygenation of the fetus. Recent MBRRACE reports reveal inadequate or delayed correction of coagulation, especially fibrinogen, leading to maternal deaths.[24] Tranexamic acid (TXA) is safe in pregnancy.[25] Cell salvage may increase the risk of maternal alloimmunisation if Rh D incompatibility and fetal red cells are present in salvaged blood.[24] There is little evidence it may increase the risk of amniotic fluid embolism.[24] Evidence from postpartum haemorrhage cannot be directly extrapolated to non-obstetric causes of bleeding or early pregnancy but can be used as a guide.	Obstetric massive haemorrhage pathway (MHP) should be activated for advanced pregnancy or uterine-related bleeding with early Cryoprecipitate or fibrinogen concentrate and TEG or ROTEM guided provision of blood products. Standard non-obstetric MHP can be activated for early pregnancy with non-obstetric bleeding. Fibrinogen should be maintained >2 g/L in the later stages of pregnancy. If it falls to a normal range for non-obstetric patients, this may be early DIC, which requires aggressive correction. Prothrombin time and activated partial thromboplastin time should be maintained at less than 1.5x normal.[24]
Damage control surgery	This may be more challenging in advanced pregnancy given the ergonomics of a gravid uterus.	Fetal delivery may be required to optimise maternal morbidity and mortality.[25] In cases of uterine abruption, trauma or rupture, uterine emptying will be required.[25]

Drugs

If a general anaesthesia (GA) is required, propofol induction followed by sevoflurane maintenance, paralysis, fentanyl, morphine, noradrenaline, metaraminol, atropine, and reversal with neostigmine and glycopyrrolate is safe in all trimesters.

Other common drugs used during general anaesthesia and the recovery period can be found in Table 4. In the US, the Food and Drug Administration removed the A, B, C, D and X risk categories in 2015 and replaced them with the new classification system, the Pregnancy and Lactation Labelling Final Rule (PLLR).[26] The authors have utilised information from the New Zealand Drug Formulary in the creation of this guideline and recommend its use when caring for pregnant patients in the perioperative period.

Evidence for teratogenicity secondary to perioperative interventions is an area of ongoing research, with no strong evidence of increased risk from anaesthetic agents.[3]

Maintenance of normal physiology – blood pressure, O_2, temperature and compensated metabolic alkalosis with CO_2 (30-35 mmHg) and pH (7.4-7.45) provides the best conditions to reduce fetal distress intraoperatively.[3]

Table 4. Drugs used in pregnancy: Safety profile of commonly used anaesthetic drugs

Drug	Safety in pregnancy
Dexamethasone	Utilise if the potential maternal benefit far outweighs the potential fetal risk.[27] **Caution:** Use in the **first trimester** has a small absolute risk of oral clefts.
Midazolam	No association with congenital deformities in the first or second trimesters. **Caution:** Use in **third trimester** may be associated with adverse neonatal neurobehaviours. This is based on animal data after repeated or lengthy use.[27]
NSAIDs	Can be considered in the second trimester, if benefits to parturient outweighs risk to fetus, and at the lowest dose, shortest duration. **Caution:** Contraindicated in the **third trimester** as can cause closure of patent ductus arteriosus, renal or platelet impairment. Potential association with teratogenicity in **first trimester**. Risk of neonatal renal impairment present in **second and third trimester.**[27,28]
N_2O	Weak teratogen in animals. Theoretical risk given mechanism (inhibiting methionine synthetase and impairing DNA production). No evidence in humans that it increases rates of congenital malformations. **Caution:** Despite this reassuring evidence, it is generally avoided in the **first trimester**.[27]
Ondansetron	Two large national studies, one from Denmark and the other from Sweden, have found significant increases of cardiac anomalies when ondansetron was used in the first trimester. Association with oral clefts may be present. **Caution:** Generally avoided in **first trimester**.[27]
Opioids	The National Birth Defects Prevention Study found evidence that opioid use during organogenesis is associated with a low absolute risk of congenital birth defects. A second study also found a similar association.[27] **Caution:** Avoided in **first trimester** unless benefits to mother outweigh risks to fetus and used at the lowest dose, shortest duration.
Sugammadex	The Society for Obstetric Anaesthesia and Perinatology (SOAP) issued a consensus statement that sugammadex should be avoided in early pregnancy and used with caution or avoided at near term or term.[29] **Caution:** Avoided in **first trimester** and used with caution in **second and early third trimesters.**

Sugammadex

Neostigmine should be used where possible; however, if clinically indicated, sugammadex is reasonable given growing evidence and case reports of its safety in pregnancy. Earlier concerns are related to the potential for the drug to encapsulate progesterone and potentially disrupt the integrity of the pregnancy.[29] Theoretically, sugammadex could pose a greater concern in the first trimester, as early pregnancy is highly dependent on progesterone. Although no human studies have demonstrated teratogenicity, it is reasonable to exercise caution due to the limited human data available.

Antibiotics

Aminoglycosides, penicillin, cephalosporins and clindamycin have good safety profiles.

Magnesium

This may be started preoperatively by the obstetric team in cases of severe preeclampsia/toxemia (PET) to minimise maternal seizure risk, or for fetal neuroprotection or expected premature labour (for tocolysis).

Local anaesthetics

LAST (local anaesthetic systemic toxicity) risk is increased due to a relative reduction in the concentration of protein, pH changes, and increased sensitivity of nerve and cardiac tissue to local anaesthetics.

Tocolysis

It may be requested by the obstetric team to mitigate the risk of preterm delivery. Some tocolytic drugs (magnesium, beta agonists, GTN) can cause haemodynamic instability. Prostaglandin inhibitors (indomethacin) and slow-release calcium channel blockers may cause less haemodynamic instability. These medications should only be administered under the guidance of an obstetrician.

Other considerations

Fetal considerations

Avoid significant maternal hypoxia, hypotension, hypercarbia, hypothermia or hyperthermia and acidosis to prevent fetal distress.

Radiology

Radiology should be completed if needed. Discuss with the radiologist to pick the best modality and minimise fetal exposure. Non-abdominal/pelvic imaging exposes the fetus to <1 mGy and can proceed normally. Abdominal/pelvic imaging (single abdominal X-ray or limited computed tomography (CT) scan) may expose the fetus to >1 mGy (mean: 1 mGy, max: 4 mGy).[30]

Doses >10 mGy may be associated with a small increased risk of childhood cancer.[30] Doses >100 mGy may be associated with first-trimester loss and neurological effects.[30] Some CT abdominal/pelvis protocols used in trauma, obesity, and with older machines may expose the fetus to 10-35 mGy.[30]

Some guidelines recommend shielding the breasts during radiological procedures due to the theoretical risk of breast cancer and increased breast tissue in pregnancy.[31]

Other considerations include incorporating the risk of radiology scans into consent paperwork and discussions, considering whether ultrasonography can be used as an alternative, optimising radiation dose, calculating fetal dose exposure, and positioning boards pre-emptively before patient positioning.

POSTOPERATIVE CONSIDERATIONS

Position

Continue left lateral tilt until the patient can mobilise or easily adjust their position.

Pain management

Use of multimodal analgesia is encouraged to minimise opioid use.

Fetal monitoring

The obstetric team may recommend ongoing fetal monitoring for viability and recovery.

Preterm labour risk

The obstetric team may recommend commencing or continuing tocolysis if necessary to prevent preterm labour.

DVT risk

Patients should be commenced on weight-based dosing of LMWH as soon as it is safe. Early mobilisation and TEDS or SCDs are encouraged.

SPECIAL POPULATIONS

Preeclampsia

These patients require adequate sympathetic blockade for laryngoscopy and surgical stimulus to avoid catastrophic hypertension and associated subarachnoid haemorrhage.

Tramadol and pethidine are not strictly contraindicated but are generally avoided in preeclampsia due to their potential risks of lowering seizure threshold. Alternatives with better safety profiles are commonly available now and should be considered.

Careful maintenance of fluid balance is required. Consider an arterial line and early involvement of obstetricians if blood pressure is difficult to manage.

Recent consensus guidelines state that if pre-eclamptic toxaemia (PET) alone is suspected, it is unlikely to cause a precipitous fall in platelets within 72 hours.[32]

A subsection of patients will develop HELLP syndrome and will require an up-to-date coagulation screen and platelets. SOAP states that platelet counts may fall rapidly in these patients, and the optimal frequency of platelet testing prior to neuraxial procedures remains uncertain.[32]

Between 15-20% of patients may develop atypical HELLP without hypertension or proteinuria. Consider screening for HELLP if PET symptoms are present.[32]

There is limited evidence on the safety of neuraxial procedures with PET, particularly in patients with low platelet counts and those using aspirin.[32]

Gestational diabetes

Usual considerations for non-pregnant diabetic patients apply. These patients should have their procedures scheduled as early in the morning as possible and their blood sugar level should be checked on arrival and intraoperatively. Consider glucose/insulin/potassium (GIK) infusion and resume insulin postoperatively. These patients are at higher risk of PET and preterm birth.

Intrahepatic cholestasis of pregnancy (ICP)

Consider a recent (<6 hours prior) coagulation panel to assess for Vitamin K deficiency and early replacement of deficient factors if significant bleeding is present. This may also contraindicate the use of a neuraxial technique if these levels are deranged.

Obstetric trauma

Trauma surgery in the obstetric patient necessitates a combination of obstetric and trauma management principles.

Airway

1. Secure the endotracheal tube early, given the risk of regurgitation. Expect difficulty and manage appropriately, as discussed prior.

Breathing

2. Thoracostomy should be inserted two spaces higher when needed.[33]
3. Thoracic trauma may cause abdominal organ involvement.[25]
4. Ventilator settings and targets are as discussed prior to optimise fetal perfusion.

Circulation

Manual left uterine displacement is advised, as opposed to tilting the patient. This is to improve CPR success, if needed.[33]

CT has improved sensitivity and specificity compared with trauma eFAST scans.[25] It should be considered and prioritised for maternal wellbeing despite the radiation risk to the fetus.[33]

Resuscitative hysterotomy is required in cardiac arrest, with delivery <5 mins of arrest.

Provision of blood products may be required, with early administration of cryo, O-blood, TXA, warming devices and viscoelastic haemostatic assays (VHAs) guiding further transfusion, as briefly presented in Table 3.

Vasopressors are suggested after fluid resuscitation if time allows.[33]

Pelvic trauma requires rapid escalation, given the risk of rapid cardiac arrest from dilated and exposed blood vessels. The ergonomics of placing a pelvic binder may require adjustments and compromise. In trauma, pelvic binders usually sit over the greater trochanters; however, this may be challenging in advanced pregnancy if purpose-made binders are unavailable.[25]

Damage control surgery may not be possible without emptying the uterus.

Placental abruption can occur in 50% of major traumas.[25] This can be concealed and challenging to diagnose on ultrasound alone.[33] A vaginal exam may be performed as part of the A-E assessment once placenta praevia is ruled out by the obstetric team. The timing and necessity of this exam should be coordinated with the obstetric team.

Disability

ATLS guidelines recommend hard C-spine collar and manual in-line stabilisation.

Treatment for raised ICP (osmotic therapy, hyperventilation, hypothermia, barbiturates and sodium nitroprusside) can impair fetal oxygenation.[25] Head elevation should be performed with ongoing L uterine displacement.

Extra

- Fetal assessment and monitoring are indicated after primary surgery of the patient, following ATLS guidelines. Fetal distress may be the first sign of placental abruption, uterine rupture and/or impending maternal hypovolemic shock.[33]
- Anti-D, tetanus and antibiotics are safe for the fetus and the pregnant patient.
- Kleihauer testing should be performed to calculate the Anti-D dose.
- Screening for interpersonal violence should be considered.
- Tocolytics are generally not recommended if evidence of preterm labour as the underlying cause is pathological rather than uterine irritability.
- Steroids may be indicated, as discussed previously.

REFERENCES

1. World Health Organization. Trends in maternal mortality 2000 to 2023: estimates by WHO, UNICEF, UNFPA, World Bank Group and UN DESA/Population Division. Geneva: WHO; 2025. Available from: https://iris.who.int/bitstream/handle/10665/381012/9789240108462-eng.pdf?sequence=1
2. Centers for Disease Control and Prevention. Case definitions for infectious conditions under public health surveillance. MMWR Morb Mortal Wkly Rep. 2004 Jan 23;53(2):1–47.
3. Brakke BD, Sviggum HP. Anaesthesia for non-obstetric surgery during pregnancy. BJA Educ. 2023;23(3):78–83. https://doi.org/10.1016/j.bjae.2022.12.001
4. Royal College of Obstetricians and Gynaecologists. Late intrauterine fetal death and stillbirth (Green-top Guideline No. 55). London: RCOG; 2010 [revised 2022]. Available from: https://www.rcog.org.uk/guidelines
5. Whitehead EM, Smith M, Dean Y, O'Sullivan G. An evaluation of gastric emptying times in pregnancy and the puerperium. Anaesthesia. 1993 Jan;48(1):53–7. doi:10.1111/j.1365-2044.1993.tb06793.x.
6. Lawson J, Howle R, Popivanov P, Sidhu J, Gordon C, Leong M, et al. Gastric emptying in pregnancy and its clinical implications: a narrative review. Br J Anaesth. 2025 Jan;134(1):124–67. doi:10.1016/j.bja.2024.09.005
7. American College of Obstetricians and Gynecologists. ACOG Committee Opinion No. 775. Washington (DC): ACOG; 2019.
8. Mazze RI, Källén B. Reproductive outcome after anesthesia and operation during pregnancy: A registry study of 5405 cases. Am J Obstet Gynecol. 1989;161(5):1178.
9. Higuchi H, Takagi S, Zhang K, Furui I, Ozaki M. Effect of lateral tilt angle on the volume of the abdominal aorta and inferior vena cava in pregnant and nonpregnant women determined by magnetic resonance imaging. Anesthesiology. 2015;122(2):286–93. https://doi.org/10.1097/aln.0000000000000553
10. Dobson G, Chow L, Flexman A, Hurdle H, Kurrek M, Laflamme C, et al. Guidelines to the practice of anesthesia – Revised edition 2019. Can J Anaesth. 2018;66(1):75–108. https://doi.org/10.1007/s12630-018-1248-2
11. Drake MJP, Hill JS. Observational study comparing non-invasive blood pressure measurement at the arm and ankle during caesarean section. Anaesthesia. 2013 May;68(5):461–6. doi: 10.1111/anae.12194
12. Cook TM, Andrade J, Bogod DG, Hitchman JM, Jonker WR, Lucas N, et al. 5th National Audit Project (NAP5) on accidental awareness during general anaesthesia: patient experiences, human factors, sedation, consent, and medicolegal issues. Br J Anaesth. 2014;113(4):560–74. https://doi.org/10.1093/bja/aeu314
13. Michel-Macías C, Morales-Barquet DA, Reyes-Palomino AM, Machuca-Vaca JA, Orozco-Guillén A. Single dose of propofol causing propofol infusion syndrome in a newborn. Oxf Med Case Rep. 2018 Jun 18;2018(6):omy023. doi: 10.1093/omcr/omy023.
14. Adesope OA, Einhorn LM, Olufolabi AJ, Cooter M, Habib AS. The impact of gestational age and fetal weight on the risk of failure of spinal anesthesia for cesarean delivery. Int J Obstet Anesth. 2016;26:8–14. https://doi.org/10.1016/j.ijoa.2016.01.007
15. 15. Cook, T.M. and Chrimes, N. (2025), 'Flextension': a new term to describe optimal head and neck positioning for airway management. Anaesthesia, 80: 220-221. https://doi.org/10.1111/anae.16484
16 Haggerty E, Daly J. Anaesthesia and non-obstetric surgery in pregnancy. BJA Educ. 2021;21(2):42–3. https://doi.org/10.1016/j.bjae.2020.11.002
17. Difficult Airway Society. Management of difficult and failed intubation in obstetrics guidelines. London: DAS; 2015. Available from: https://das.uk.com/guidelines/obstetric_airway_guidelines_2015/
18. Mushambi MC, Kinsella SM, Popat M, Swales H, Ramaswamy KK, Winton AL, et al. Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics. Anaesthesia. 2015;70(11):1286–306. doi:10.1111/anae.13260
19 Preston K. Preoxygenation in pregnant women—is it time to update the 2015 OAA/DAS guidance in light of the expanding evidence base for high flow nasal oxygen?. Annals of Palliative Medicine. 2023 Jul 31;12(4):66569-669.
20. Singh PM, Singh NP, Reschke M, Ngan Kee WD, Palanisamy A, Monks DT. Vasopressor drugs for the prevention and treatment of hypotension during neuraxial anaesthesia for Caesarean delivery: a Bayesian network meta-analysis of fetal and maternal outcomes. Br J Anaesth. 2020;124(3):e95–107. doi:10.1016/j.bja.2019.09.045
21. Liu L, Luo L, Li L, Jin M. Safety of high-concentration norepinephrine for peripheral intravenous use: comment on Br J Anaesth 2020; 124:e108-e114. Br J Anaesth. 2021 Oct;127(4):e135–e137. doi:10.1016/j.bja.2021.07.004
22. Royal College of Obstetricians and Gynaecologists. Reducing the Risk of Venous Thromboembolism during Pregnancy and the Puerperium. Green-top Guideline No 37a. London: RCOG; April 2015.
23. Westcott-Clark CJ, Patel M, Munie T, Jones MM, Roberts JT. Maternal body weight and estimated circulating blood volume: a practical, nonlinear adjustment model with increasing body mass. Best Pract Res Clin Obstet Gynaecol. 2023;S0007-0912(22)00453-6. doi:10.1016/j.bpobgyn.2022.00453
24. Lalonde AB, Nunes K, Lee L, Connor E, Tunçalp Ö, Magee LA. Major obstetric haemorrhage. BJA Educ. 2022 Aug;22(8):265–72. doi: 10.1016/j.bjae.2022.04.009.
25. Miller RD, McKeown DW, Gaba DM, et al. Trauma during pregnancy. BJA Educ. 2020;20(9):323–30. doi:10.1016/j.bjae.2020.06.003.
26. U.S. Food and Drug Administration. Pregnancy and Lactation Labeling Final Rule. 2014 Dec 4 [cited 2025 Jul 22]. Available from: https://www.fda.gov/media/100406/download
27. Briggs GG, Freeman RK, Yaffe SJ. Drugs in pregnancy and lactation. 12th ed. Philadelphia: Lippincott Williams & Wilkins; 2022. Advice from this text referenced via NZF between Nov 2023 – Jan 2024.

28. Medsafe. Non-steroidal anti-inflammatory drugs (NSAIDs): Avoid use in pregnancy. Prescriber Update. 2022;43(3):31–2. Available from: https://medsafe.govt.nz/profs/PUArticles/September2022/Non-steroidal-anti-inflammatory%20drugs-NSAIDs-avoid-use%20in-pregnancy.html
29. Willett AW, Butwick AJ, Togioka B, Bensadigh B, Hofer J, Zakowski M. Society for Obstetric Anesthesia and Perinatology statement on sugammadex during pregnancy and lactation. 2019.
30. The Royal Australian and New Zealand College of Radiologists. Diagnostic radiology and pregnancy: Clinical radiology position statement. Version 2.0. Sydney: RANZCR; 2017. Available from: https://www.ranzcr.com/college/document-library/diagnostic-radiology-and-pregnancy-policy
31. American College of Radiology (ACR) Committee on Radiation Safety. ACR–SPR practice parameter for imaging pregnant or potentially pregnant adolescents and women with ionizing radiation. Revised 2020. Available from: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/pregnancy.pdf
32. Bauer ME, Arendt K, Beilin Y, et al. The Society for Obstetric Anesthesia and Perinatology interdisciplinary consensus statement on neuraxial procedures in obstetric patients with thrombocytopenia. Anesth Analg. 2021 Jun;132(6):1531–44. doi: 10.1213/ANE.0000000000005355.
33. Vesoulis Z, Jain V, Garzon S, et al. Guidelines for the management of the pregnant trauma patient. J Obstet Gynaecol Can. 2015 Jun;37(6):551–60. doi:10.1016/S1701-2163(15)30232-2.