



Peri-operative care of the pregnant patient

Before completing this tutorial please answer the following MCQs:

1. Regarding the anatomy of the pregnant patient:
 - a) An anterior larynx increases the risk of a difficult intubation
 - b) Use of a Miller blade makes intubation easier in cases of breast enlargement
 - c) Gaseous induction of anaesthesia is more rapid due to the increase in FRC
 - d) The GFR increases in pregnancy with a decrease in the creatinine clearance
 - e) Pregnant women require a lower MAC

2. Regarding the choice of drugs:
 - a) Ketamine is the primary choice for IV induction in a pregnant patient
 - b) Muscle relaxants should be avoided where possible
 - c) Volatile agents are safe in pregnancy
 - d) Local anaesthetics should be avoided in the first trimester
 - e) Opioid administration leads to foetal dependence syndrome

3. Regarding the cardiovascular physiology of a pregnant patient:
 - a) Cardiac output increases by 50% by the second trimester
 - b) A heart murmur during pregnancy suggests new onset mitral valve prolapse
 - c) ECG changes are always abnormal during pregnancy
 - d) The placenta is auto-regulated in the third trimester
 - e) Vasoconstriction is caused by the action of progesterone



4. The pregnant patient:

- a) May have a smaller epidural space than a non-pregnant patient
- b) Will have a decrease in haematocrit leading to dilutional anaemia
- c) Glycosuria may be normal in a pregnant patient
- d) Has an increase in renal blood flow at term
- e) Is likely to have an increase in blood albumin levels at term

5. Regarding surgery in a pregnant patient:

- a) Tocolytic drugs have been proven to have a positive outcome
- b) Cardiotocography should always be used peri-operatively
- c) Regional anaesthesia is generally preferable to a general anaesthetic
- d) The risk of early labour is highest in the second trimester
- e) The first trimester is associated with the highest risk for organ development

Key points:

- The pregnant patient poses challenges for the anaesthetist due to changes in anatomy, physiology and pharmacology
- Difficulties arise when weighing up risks and benefits for the mother and the foetus
- Senior anaesthetists, obstetricians and surgeons should be involved in multi-disciplinary management early



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Introduction

A pregnant woman may require surgery at any stage. This patient poses both clinical and ethical challenges for the anaesthetist, not only during the moments of childbirth and labour, but perhaps more importantly when we encounter these individuals during non-obstetric surgery. The immense variations in physiology and anatomy, and therefore pharmacology, need to be taken into account when forming a management plan. This includes staffing, training, equipment, drugs and above all, an insight into the difficulties that may arise when anaesthetising a pregnant patient. This article will discuss the basic changes that take place during the different trimesters of pregnancy, and following this will go into more detail about the effects of an anaesthetic on the foetus as well as surgical considerations that may need to be addressed.

The incidence of anaesthesia during pregnancy is approximately 2%ⁱ, however this may be underestimated due to undiagnosed cases in the first trimester. Common general surgical cases faced by the anaesthetist include acute appendicitis and cholecystitis, however these should only be carried out if deemed urgent. Far less common include patients with trauma or malignancyⁱⁱ, whose management is based around weighing up risks and benefits, focusing primarily on the life of the mother. This can generate ethical and moral issues for the patient, their family and the team of health professionals caring for them. Essentially, any surgery that takes place during pregnancy involves balancing the risks and benefits to two patients, each of whom have very different needs and requirements.

Physiological and anatomical changes during pregnancy

Airway

Pregnant patients present an increased risk of difficult ventilation and failed intubation, primarily due to changes in anatomy and physiology. The presence of airway mucosal oedema and an increased risk of aspiration due to presence of foetus and relaxation of lower oesophageal sphincterⁱⁱⁱ, merit the need for a thorough airway assessment as part of a pre-operative visit. Any pregnant patient beyond the second trimester should therefore undergo a rapid sequence induction for a general anaesthetic, keeping in mind the increased friability and engorgement of laryngeal vessels. Breast enlargement in the pregnant patient causes difficulty inserting a normal laryngoscope, so a difficult airway trolley containing a short handle should always be available.



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Respiratory system

The effects on the respiratory system are especially pertinent to anaesthetists, again due to changes in both anatomy and physiology. An increase in the tidal volume by 40% and the respiratory rate by approximately 20% leads to an overall increase in minute ventilation, mediated by the hormone progesterone. This is accompanied by a rise in oxygen demand to over 50% at term^{iv}. However, a decrease in the functional residual capacity (FRC) due to the presence of the foetus means that these patients are more likely to desaturate during a short period of apnoea. Advantageous to the anaesthetist is the fact that a smaller volume FRC leads to a faster onset of anaesthesia owing to more rapid equilibration of gaseous agents.

The increase in minute ventilation also causes the pregnant patient to have a mild respiratory alkalosis with a low-normal partial pressure of carbon dioxide, which should be closely monitored during a general anaesthetic. An alteration in the P_aCO_2 by only 1kPa can lead to foetal acidosis due to a loss of the maternal-foetal gradient^v, which normally favours diffusion of CO_2 from the foetus to the mother.

Cardiovascular system

Similar to the respiratory system, the cardiovascular system sees an increase in cardiac output by approximately 50% at term, due to an increase in stroke volume more so than heart rate. This is to prepare for the physiological stress of childbirth, but can also give rise to benign heart murmurs. ECG changes may be seen due to physical displacement of the heart. Clinically, pregnant patients have a decreased systolic and diastolic blood pressure owing to the vasodilatory effects of progesterone^{vi}.

Importantly for anaesthesia during non-obstetric surgery, the placenta receives 10% of the maternal cardiac output but is not auto-regulated, hence depends solely on the cardiovascular stability of the woman. For this reason, maintaining a mean arterial pressure close to the starting blood pressure is key for adequate foetal perfusion. It is crucial to avoid aortocaval compression from the beginning of the second trimester, where the gravid uterus compresses the great vessels when lying supine. A left lateral tilt or manual displacement of the uterus will be adequate in managing this issue.

Gastrointestinal system

As mentioned previously the primary concern for the anaesthetist is the increased prevalence of reflux and heartburn in the pregnant patient, which merits pre-medication and an RSI from the second trimester.



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Haematology

Pregnant patients are hypercoagulable, therefore present as particularly high risk post-operatively of venous thromboembolism. Emphasis should be placed on the need for thromboprophylaxis according to the weight of the patient.

Additionally, there is an increase in blood volume three times more than a rise in haematocrit, leading to the dilutional anaemia of pregnancy. This is relevant to trauma patients that may bleed excessively.

Renal and endocrine

The renal blood flow and glomerular filtration rate both increase in pregnancy with an associated increase in creatinine clearance. Glycosuria can suggest a diagnosis of gestational diabetes mellitus, which needs careful peri-operative management.

Nervous system

Alterations in the nervous system lead to a reduced MAC (minimum alveolar concentration). Epidural vein engorgement means that the likelihood of vessel puncture during epidural insertion is higher than in the non-pregnant patient.

Pharmacological considerations for the pregnant patient

The physiological and anatomical changes discussed above have an impact upon drug handling by the body during pregnancy. The increase in blood volume leads to an increase in the volume of distribution of a given drug, and a decrease in plasma albumin concentrations means alterations in drug-protein binding^{vii}. Careful consideration needs to be given to the commonly used anaesthetic agents and their use in a pregnant patient, including the impact that the drugs may have on the unborn foetus.

Risks to the foetus

The challenges associated with the foetus when anaesthetising a pregnant patient include transfer of agents used; the risk of foetal asphyxiation; and the possibility of inducing early labour^{viii}. These will be discussed in turn with regards to appropriate consideration of anaesthetic and surgical equipment, monitoring and drugs.

The effect of drugs on the foetus

As well as considering the changes in pharmacology and the effect on maternal handling, careful assessment needs to be made of the gestation of the foetus and therefore the potential for teratogenicity. This will depend on the type, formulation, dose and duration of



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an agent being given, and hence the placental transfer to the foetus. The first trimester is associated with the highest risk for organ development. The commonly used anaesthetic induction agents, muscle relaxants, opioids and volatile agents have been deemed as safe for use in pregnancy^{ix}.

Anaesthetic agent	Effect on foetus	Trimester
Nitrous oxide	Inhibits methionine synthase. Teratogenic in rodents, no evidence in humans.	1 st trimester – early development.
Volatile agents	Relax uterus. High concentrations cause vasodilation and hypotension.	Can be used up to 1 MAC.
Ketamine	Increases uterine tone.	Avoid in first two trimesters.
Benzodiazepines	Animal studies: cleft palate.	Avoid multiple doses during pregnancy.
Vasopressors	Phenylephrine and metaraminol should be used instead of ephedrine – less risk to foetus.	All trimesters.
Local anaesthetics	Increase uterine tone.	Avoid giving via IV route.

Table 1: the effect of anaesthetic agents on the developing foetus.

Foetal asphyxiation

A lack of adequate oxygen is thought to be a serious risk during maternal surgery, and onus is placed upon the anaesthetist to ensure that both mother (and therefore foetus) are maintained on sufficient concentrations of oxygen with continuous cardiovascular stability. Extremes of physiology should be avoided, taking into account the effects of hypo- and hyper-capnia on the maternal circulation. Particularly important is the fact that the placental circulation is not auto-regulated, so provision of a good foetal blood supply is dependent upon the maternal mean arterial pressure. Induction and maintenance of anaesthesia deliberately causes an increase in vasodilation and decreased vascular tone, be it through a general or regional anaesthetic. Therefore pre-operative resuscitation with fluids, vasopressors and positioning in the left lateral tilt are crucial prior to any procedure.

Early labour

The risk of early labour is thought to be highest during the first trimester, with the overall miscarriage rate halving after this period^x. Any surgical procedure that takes place during a pregnancy has an increased chance of spontaneous abortion and early labour, therefore the



decision should not be made lightly; early involvement of the obstetric team and multi-disciplinary management are crucial.

Tocolytic drugs can be considered peri-operatively, but its effects have not been clinically proven to have an added benefit^{xi}. In addition, the side effects to the mother mean that they are only really considered in the third trimester in patients undergoing abdominal surgery. Continuous cardiotocography (CTG) of the foetus is thought to be controversial; as well as being physically difficult to carry out, it also needs constant interpretation by a trained member of staff. However, changes in the CTG may be acted upon in terms of optimising maternal blood pressure and oxygenation, so it is thought to be prudent to consider its use when the foetal is of a viable age (post 24 weeks)^{xii}. An obstetrician should always be available should there be a need for immediate delivery.

Anaesthetic management

Pre-operatively

As with any patient, pre-operative anaesthetic management includes a thorough pre-assessment with particular focus on any cardiovascular or respiratory conditions, the pregnancy itself, and an airway examination. In this case, the patient is likely to be especially anxious, hence a discussion with regards to the risks for her and the foetus needs to be had. It is important to stress that although anaesthesia and surgery do pose a risk, so too (for example) does the effect of an infected appendix if not appropriately managed. Pregnant women should also be pre-medicated with antacids such as ranitidine.

Intra-operatively

Senior anaesthetists should be involved with regards to the choice of anaesthetic technique, agents used and monitoring. Preference is for a regional anaesthetic, which is thought to be lower risk for the foetus, allowing the mother to maintain her own airway and be comfortable post-operatively without the need for opiates. However, obesity can lead to a difficulty in placing neuraxial and nerve blocks, and sympathetic block can lead to a sudden and pronounced hypotension in patients if not managed appropriately.

If a general anaesthetic is going to be carried out, patients need to be placed in the left lateral tilt and if possible, head up for maximal pre-oxygenation. The changes in the anatomy mean that these individuals are more likely to be difficult airways, so adequate time, equipment, drugs and staffing need to be present and provided. Once the airway is secured, the focus should be on maintaining good oxygenation and perfusion for both mother and foetus.



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Post-operatively

Pregnant women are considered high risk post-operatively, and there should be a low threshold for management on a high dependency unit. As previously mentioned, numerous factors cause these individuals to be at significantly higher risk for venous thrombo-embolism, so correct dosing pharmacological prophylaxis, TED stockings and early mobilisation are all essential. Adequate analgesia should also be made available for the patient, as pain can cause an exaggerated sympathetic response, which may lead to decrease placental perfusion. Foetal monitoring and scanning should be carried out as soon as possible post procedure.

Conclusion

Non-obstetric surgery during pregnancy leads to increased levels of anxiety not only for the patient, but also equally for the healthcare professionals involved in her case. For the anaesthetist, changes in physiology, anatomy and pharmacology require a tailored, patient-centred anaesthetic plan with escalation to seniors when appropriate. Whilst management should prioritise the safety of the mother, foetal wellbeing needs to be considered peri-operatively in order to maximise the chances of a good outcome for both mother and foetus.

Multiple-choice answers:

1. FFFFT
2. FFTFF
3. FFFFF
4. TFTTF
5. FFTFT

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