



NONOBSTETRIC SURGERY DURING PREGNANCY

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- ▶ In the United States, up to 2% of pregnant women require nonobstetric surgical interventions .
- ▶ The most frequent nonobstetric procedures are excision of ovarian cysts, appendectomy, cholecystectomy, breast biopsy, and surgery related to trauma.
- ▶ The **goal** is complicated by the need to consider **the well-being of both mother and fetus.**

OUTLINE

- ▶ Maternal consideration
- ▶ Fetal consideration
- ▶ Practical consideration
 - ▶ Timing of surgery
 - ▶ Anesthetic management

MATERNAL PHYSIOLOGY

- ▶ During pregnancy, profound changes in physiology
 - ▶  various hormones
 - ▶ Mechanical effects of the gravid uterus
 - ▶ Greater metabolic demand
 - ▶ Hemodynamic consequences of the low- pressure placental circulation

MATERNAL PHYSIOLOGY

- ▶ Respiratory system and acid-base balance
- ▶ Cardiovascular system
- ▶ Hematologic system
- ▶ GI system

RESPIRATORY SYSTEM AND ACID-BASE BALANCE

- ▶ Alveolar ventilation increases by 30%
 - ▶ Chronic respiratory alkalosis (PaCo₂ of 28 to 32 mmHg)
 - ▶ Slightly alkaline pH ~7.44
 - ▶ Decreased levels of bicarbonate and buffer base.
- ▶ Although  O₂ consumption ->  PaO₂
- ▶  FRC ~20%

RESPIRATORY SYSTEM AND ACID-BASE BALANCE

- ▶ Weight gain during pregnancy and capillary engorgement of the respiratory tract mucosa -> Difficult airway
- ▶ Faster equilibration of inhaled agents
- ▶ **Rapid development of hypoxemia and acidosis** during periods of hypoventilation or apnea

CARDIOVASCULAR SYSTEM

- ▶  Cardiac output up to 50% during pregnancy ( SV & HR)
- ▶  Systemic and pulmonary vascular resistances
- ▶ Supine hypotension syndrome
 - ▶ Mid-pregnancy
 - ▶ Left lateral tilt should be applied after 18 to 20 weeks' gestation

HEMATOLOGIC SYSTEM

- ▶ Smaller increase in RBC than plasma volume-> dilutional anemia
- ▶ Pregnancy induces a **hypercoagulable state**
 - ▶ increases in fibrinogen, factors VII, VIII, X, and XII and fibrin degradation products

GASTROINTESTINAL SYSTEM

- ▶  Risk for gastroesophageal reflux & aspiration
 - ▶ Beginning of the second trimester
 - ▶ Incompetence of the lower esophageal sphincter
 - ▶ Distortion of gastric and pyloric anatomy

FETAL CONSIDERATIONS

- ▶ Risk for teratogenicity
- ▶ Fetal monitoring
- ▶ Prevention of preterm labor

RISK FOR TERATOGENICITY

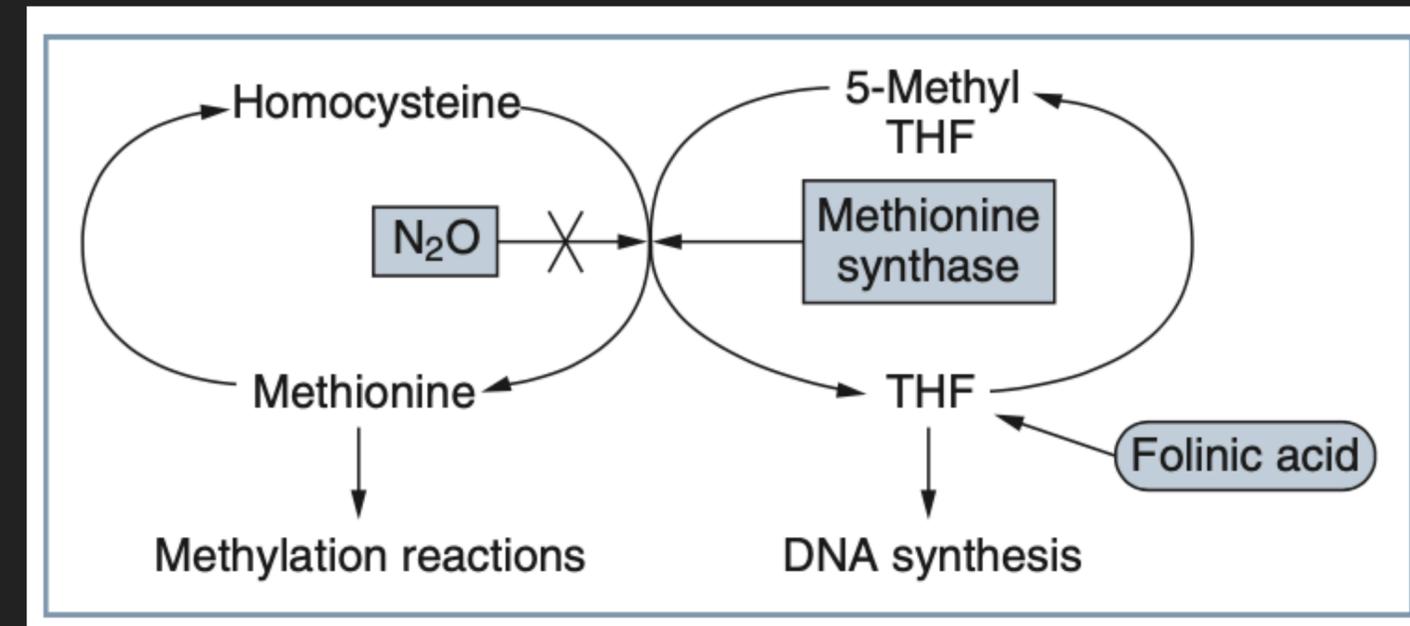
- ▶ **Teratogenicity** has been defined as any significant post-natal change in function or form in an offspring after prenatal treatment.
- ▶ Factors influence the teratogenicity
 - ▶ Species susceptibility
 - ▶ Dose of the substance
 - ▶ Duration and timing of exposure
 - ▶ Genetic predisposition

RISK FOR TERATOGENICITY

- ▶ Manifestations : death, structural abnormality, growth restriction, and functional deficiency.
- ▶ Most structural abnormalities result from **exposure during the period of organogenesis**, which extends from approximately **day 31 to day 71** after LMP.
- ▶ **No anesthetic agent is a proven teratogen in humans**, although some anesthetic agents, specifically **nitrous oxide**, are teratogenic in animals under certain conditions.

RISK FOR TERATOGENICITY

- ▶ Teratogenicity associated with nitrous oxide was thought to result from
 - ▶ its oxidation of vitamin B12, which interferes with its function as a coenzyme for **methionine synthase**.
- ▶ Methionine synthase inhibition
 - ▶ decrease in THF (with a resultant decrease in DNA synthesis)
 - ▶ lower methionine levels (with resultant impairment of methylation reactions)



PREGNANCY RISK CLASSIFICATION

Table 2. Outdated FDA Pregnancy Risk Letter System

Category A	Adequate and well-controlled studies have failed to demonstrate a risk to the fetus in the first trimester of pregnancy (and there is no evidence of risk in later trimesters).
Category B	Animal reproduction studies have failed to demonstrate a risk to the fetus and there are no adequate and well-controlled studies in pregnant women.
Category C	Animal reproduction studies have shown an adverse effect on the fetus and there are no adequate and well-controlled studies in humans, but potential benefits may warrant use of the drug in pregnant women despite potential risks.
Category D	There is positive evidence of human fetal risk based on adverse reaction data from investigational or marketing experience or studies in humans, but potential benefits may warrant use of the drug in pregnant women despite potential risks.
Category X	Studies in animals or humans have demonstrated fetal abnormalities and/or there is positive evidence of human fetal risk based on adverse reaction data from investigational or marketing experience, and the risks involved in use of the drug in pregnant women clearly outweigh potential benefits.*

* Content and format of labeling for human prescription drug and biological products; requirements for pregnancy and lactation labeling (Federal Register/Vol. 73, No. 104/Thursday, May 29, 2008).

PREGNANCY RISK CLASSIFICATION

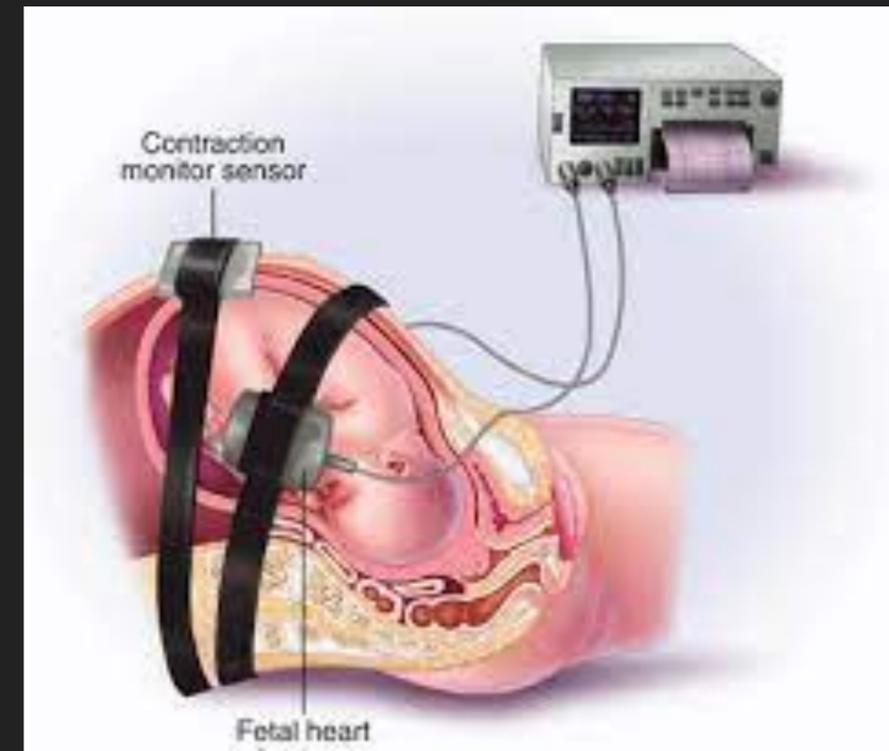
THE PREGNANCY AND LACTATION LABELING RULE (PLLR)

Table 3. Current FDA Pregnancy Risk Narrative System

<i>Sections</i>	<i>Subsections</i>
Pregnancy (includes labor and delivery)	Pregnancy exposure registry Risk summary Clinical considerations Data
Lactation (included nursing mothers)	Risk summary Clinical considerations Data
Females and males of reproductive potential	Pregnancy testing Contraception Infertility

FETAL MONITORING

- ▶ **ACOG and ASA guidelines** : FHR and uterine activity should be monitored both before and after surgery
- ▶ Continuous fetal heart rate (FHR) monitoring (using trans-abdominal Doppler ultrasonography) is feasible beginning at GA 18-20 wks



FHR MONITORING

- The ACOG/ASA guidelines state that **intraoperative electronic FHR monitoring** “may be appropriate when all of the following apply:
 - (1) The fetus is viable
 - (2) Possible to perform intraoperative electronic [FHR] monitoring
 - (3) Health care provider is available and willing to intervene during the surgical procedure
 - (4) Woman has given informed consent to emergency cesarean delivery
 - (5) The nature of the planned surgery will allow the safe interruption or alteration of the procedure to provide access to perform emergency delivery

FHR MONITORING

BOX 17.2 Maneuvers for Intrauterine Resuscitation during Nonobstetric Surgery

- Increase left uterine displacement
- Increase oxygen concentration
- Treat hypotension or administer vasopressor to return blood pressure to baseline
- Release surgical retraction, manipulation, or abdominal insufflation
- Ensure appropriate end-tidal CO₂ level^a
- Ensure appropriate acid-base status
- Check maternal hemoglobin
- Consider administering medications to improve uterine relaxation (e.g., increase volatile agent, nitroglycerin administration)

^a28–32 mm Hg

- ▶ Intraoperative FHR monitoring allows for the optimization of the maternal condition if the fetus shows signs of compromise

PREVENTION OF PRETERM LABOR

- ▶ Women who undergo nonobstetric surgery during pregnancy have reported a **higher incidence of abortion and preterm delivery.**
- ▶ Monitoring for uterine contractions may be performed intraoperatively with an external tocodynamometer (if technically feasible) and for several days postoperatively
- ▶ No routine use of prophylactic tocolytic agents

TIMING OF SURGERY

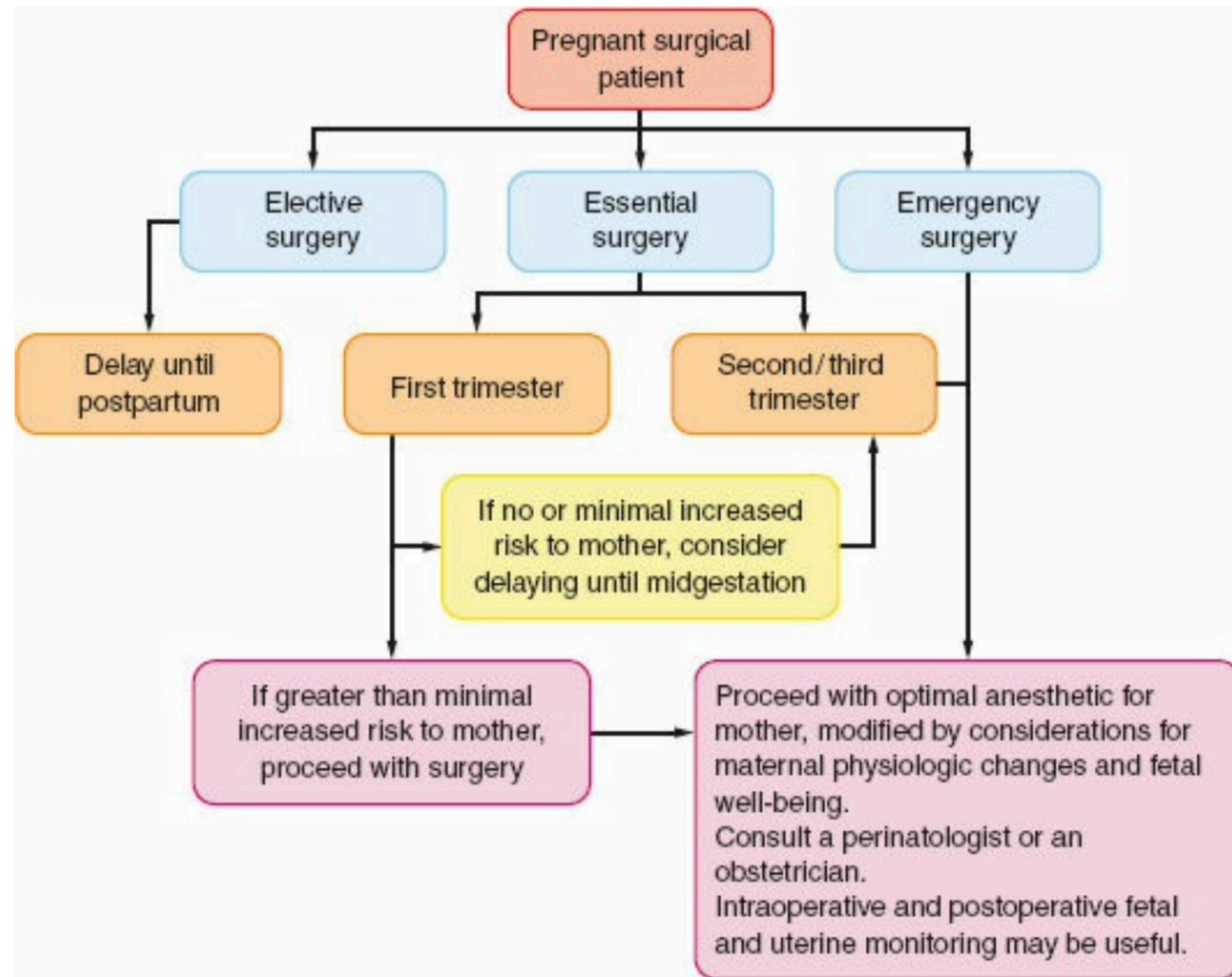


Figure 41-11 Recommendations for management of parturients and surgical procedures. (Adapted from Rosen MA. Management of anesthesia for the pregnant surgical patient. *Anesthesiology*. 1999;91:1159.)

LAPAROSCOPIC VS OPEN SURGERY

- ▶ Many practitioners believe, that the potential benefits of laparoscopic surgery compared with open abdominal surgery outweigh the risks. Potential benefits include

(1) shorter hospitalization

(2) less postoperative pain

(3) decreased risk for thromboembolic and wound complications

(4) faster return to normal activities

ANESTHETIC MANAGEMENT

- ▶ **Preoperative management**
 - ▶ Multidisciplinary personnel
 - ▶ Physical examination
 - ▶ Informed anesthetic consent, including a discussion on the risks and benefits of maternal and fetal anesthetic exposure

ANESTHETIC MANAGEMENT

- ▶ **Preoperative management**

- ▶ GA 18-20 wks -> increased risk for acid aspiration

premedication

: Histamine₂-receptor antagonist

: Metoclopramide

: Antacid such as sodium citrate

ANESTHETIC MANAGEMENT

- ▶ **Choice of anesthesia**
- ▶ Local or regional anesthesia (with the exception of paracervical block) is preferred
 - Less respiratory complications
 - It permits the administration of drugs with no laboratory or clinical evidence of teratogenesis.

ANESTHETIC MANAGEMENT

- ▶ **Anesthetic technique**
 - ▶ Prevent aortocaval compression
 - ▶ Drugs with a history of safe use during pregnancy include thiopental, propofol, morphine, fentanyl, succinylcholine, and the nondepolarizing muscle relaxants.
 - ▶ **Avoid hypoxemia, hypotension, acidosis, and hyperventilation**

ANESTHETIC MANAGEMENT

- ▶ **Postoperative Management**
 - ▶ FHR and uterine activity should be monitored during recovery from anesthesia.
 - ▶ Mechanical compression devices for thromboembolism prophylaxis is recommended.

ANESTHETIC MANAGEMENT

- ▶ **Postoperative Management**

- ▶ Adequate analgesia :  risk preterm labor

- ▶ **Avoid NSAID**

- ▶ 1st trimester : increase risk for miscarriage & fetal malformation

- ▶ 3rd trimester : premature closure of ductus arterioles & oligohydramnios

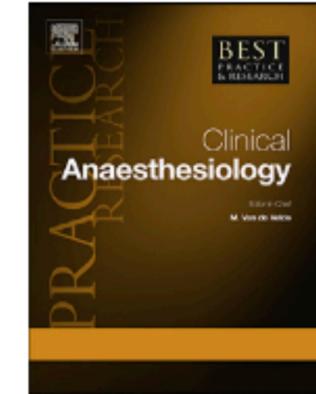


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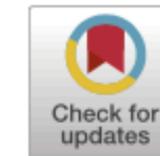
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10

Clinical management of the pregnant patient undergoing non-obstetric surgery: Review of guidelines



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PREGNANT PATIENT UNDERGOING NON-OBSTETRIC SURGERY

- ▶ The goals of non-obstetric surgery are to ensure maternal safety, maintain the pregnancy, and ensure fetal well-being.

PREOPERATIVE CONSIDERATIONS

- ▶ Any procedure that can wait until after delivery should be **postponed for up to 6 weeks postpartum.**
- ▶ Although no anesthetic drugs have been proven to be hazardous to the fetus.
- ▶ Performing surgery in the second trimester, after organogenesis has been completed, minimizes the risk of any potential teratogenic effects of anesthetic drugs.

PREOPERATIVE CONSIDERATIONS

- ▶ Antacid prophylaxis is recommended after week 14 given the increased risk of aspiration.
- ▶ As pregnancy is a hypercoagulable state, mechanical and/or pharmacologic thromboprophylaxis is recommended for all pregnant patients undergoing surgery.
- ▶ In surgeries occurring in the late second and third trimesters (24-34 weeks), antenatal glucocorticoids administered 24-48 h before surgery.

ANESTHESIA MANAGEMENT

- ▶ **Position**

- ▶ After 18-20 weeks' gestation : avoid aortocaval compression
- ▶ **15 degrees of left uterine displacement**

- ▶ **Intraoperative fetal heart rate (FHR) monitoring**

- ▶ Current ACOG recommendations are to continuously monitor FHR in all viable fetuses greater than 23 weeks' gestation age throughout surgery
- ▶ Regardless of gestational age, FHR should be documented pre and postoperatively.

PERIOPERATIVE CARE

- ▶ **For the pre-viable fetus (24 weeks)**

: assessment of the FHR using Doppler ultrasound in the pre- and post-operative time periods is sufficient to alleviate and reassure the mother.

- ▶ **In the viable fetus (>24 weeks)**

: a minimum of pre- and post-operative FHR and uterine contractions should be monitored to ensure fetal well-being and the absence of uterine contractions that would indicate pre-term labor.

PERIOPERATIVE CARE

- ▶ Postoperative period
 - ▶ Fetal assessment via FHR and uterine contraction monitoring
- : Ensure the health of the fetus and assess the risk of preterm labor
- : Postoperative analgesia may mask mild, early contractions and delay administration of tocolytics to terminate preterm labor
- ▶ NSAIDs should be avoided after 32 weeks gestational age due to premature closure of the fetal ductus arteriosus.



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ESSENTIAL NOTES

Anaesthesia and non-obstetric surgery in pregnancy

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FETAL CONSIDERATIONS

- ▶ Postponing elective cases until 6 weeks postpartum is recommended.
- ▶ In the context of an anaesthetic, the following are harmful to the fetus and **should be avoided: prolonged maternal hypo-/hyperthermia, hypoxaemia, hypercarbia and hypotension.**
- ▶ NSAIDs should be **avoided after 32 weeks of gestation** because of concerns for premature patent ductus arteriosus closure.

FETAL MONITORING

- ▶ The American College of Obstetricians and Gynecologists recommends fetal heart rate (FHR) measurement using
 - ▶ Doppler ultrasound before and after any given surgery regardless of gestational age
 - ▶ Contraction monitoring in the viable fetus.
- ▶ Fetal monitoring can alert you if optimisation of *maternal positioning, oxygenation or blood pressure is needed*

MATERNAL CONSIDERATIONS

- ▶ GI : Rapid sequence induction with **aspiration prophylaxis should be considered in any trimester** if the patient is experiencing N/V, pain, infection, and gastroesophageal reflux; has a history of hiatus hernia; or has a full stomach.

ANESTHESIA MANAGEMENT

- ▶ Regional or neuraxial anaesthesia, monitored anaesthesia care and general anaesthesia can be safe during any trimester.
- ▶ **Positioning**
 - ▶ using LUD starting at 18 weeks : Multiple gestation and obesity may require using LUD earlier in the pregnancy.

NEONATAL (BREASTFEEDING) CONSIDERATIONS

- ▶ The old recommendation of discarding breast milk while in the PACU is not supported by the ASA or the Association of Anaesthetists.
- ▶ All anaesthetic medications transfer to breast milk to some degree, the vast majority are in very low concentrations, which are **considered safe for the newborn**.
- ▶ Some exceptions to this are opioids that have genetic variants for metabolism (e.g. codeine and pethidine), certain antibiotics (e.g. tetracycline) and cardiovascular agents (e.g. amiodarone and statins).

ANESTHETIC MANAGEMENT

BOX 62.3 Anesthetic Considerations for Nonobstetric Surgery in the Pregnant Patient

- Postpone elective surgeries until after delivery.
- Regional anesthesia should be utilized when possible.
- Consider aspiration prophylaxis.
- Left uterine displacement to relieve aortocaval compression after 20 weeks' gestational age
- Consider intraoperative fetal monitoring.
- Regional anesthesia
 - Reduced local anesthetic requirements in pregnancy
- General anesthesia
 - Maximize preoxygenation
 - Rapid sequence induction
 - Avoid hypoxia and hypotension
 - Goal $ETCO_2$ 28-32 mm Hg. Avoid hyperventilation as hypocarbia can decrease placental blood flow secondary to uterine vasoconstriction.
 - Extubate when awake
- Fetal heart rate and uterine tone should be monitored postoperatively.
- Provide appropriate postoperative analgesia.

$ETCO_2$, End-tidal carbon dioxide.

An illustration of a pregnant woman with dark hair, wearing a white face mask and a light pink top. She is holding her belly with both hands. The background features stylized light blue foliage and leaves. The text "THANK YOU" is centered over the image in a bold, dark blue font.

THANK YOU