



Non-obstetric surgery during pregnancy

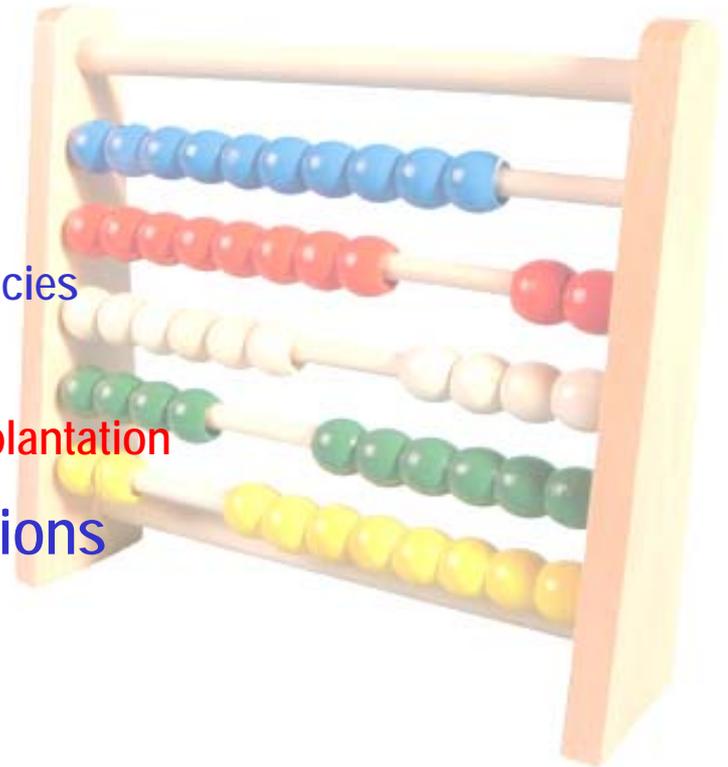
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Incidence

- 1 – 2 % of pregnant women undergo surgery unrelated to delivery
 - Ovarian cysts
 - Appendicitis
 - Cholelithiasis
 - cervical incompetence
 - breast or other malignancies
 - traumatic injuries
 - **Craniotomy, Liver transplantation**
- Intra-uterine interventions



Risks & Problems

- Effects of the disease process
- The possible teratogenicity of anesthetic agents
- Intraoperative changes of uteroplacental perfusion and/or fetal oxygenation
- Risk of abortion or preterm delivery





Anesthesiological objectives

- Optimize or maintain normal maternal physiological function
- Optimize or maintain utero-placental blood flow and oxygen delivery
- Avoid unwanted drug effects on the fetus
- Avoid stimulating the myometrium (oxytocic effects) = uterine contractions, abortion
- Avoid awareness during general anesthesia
- Preferential use of regional anesthesia

Pre-anesthetic assessment

- Interdisciplinary approach (+ surgeon, obstetrician, neonatologist)



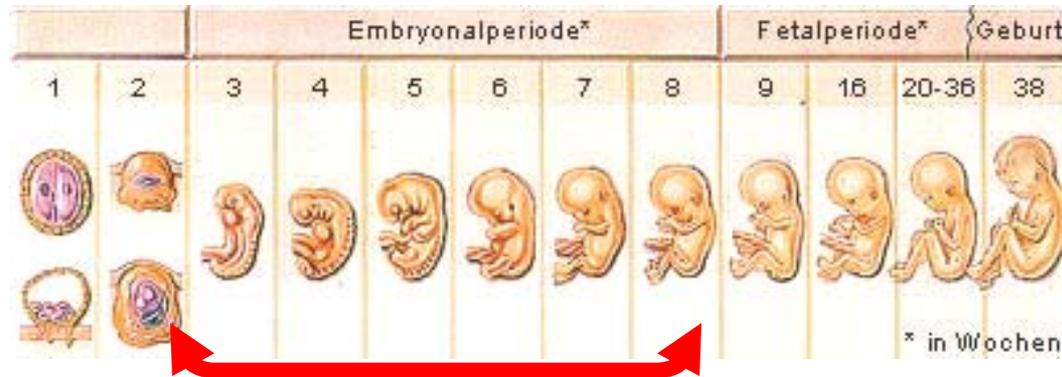
- Specific symptoms which are normal during pregnancy
 - dyspnoea
 - heart murmurs
 - edema
 - ECG changes: left axis deviation, premature beats and non-specific ST and T-wave changes

Pre-anesthetic measures

- **Restrictive** indication of X-rays
- **Generous** indication of ultrasound
- Crossmatched blood tests
- Resuscitation vigorously performed according ALS or ATLS protocols with the addition of left lateral tilt
- Pre-medication include aspiration prophylaxis (ranitidine, sodium citrate and metoclopramide)



Pharmacological considerations



Between the **15th** and **56th** days of gestation the embryo is most vulnerable to teratogenic effects

Pharmacological considerations

Major malformations with prenatal exposure to benzodiazepines

Cohort studies

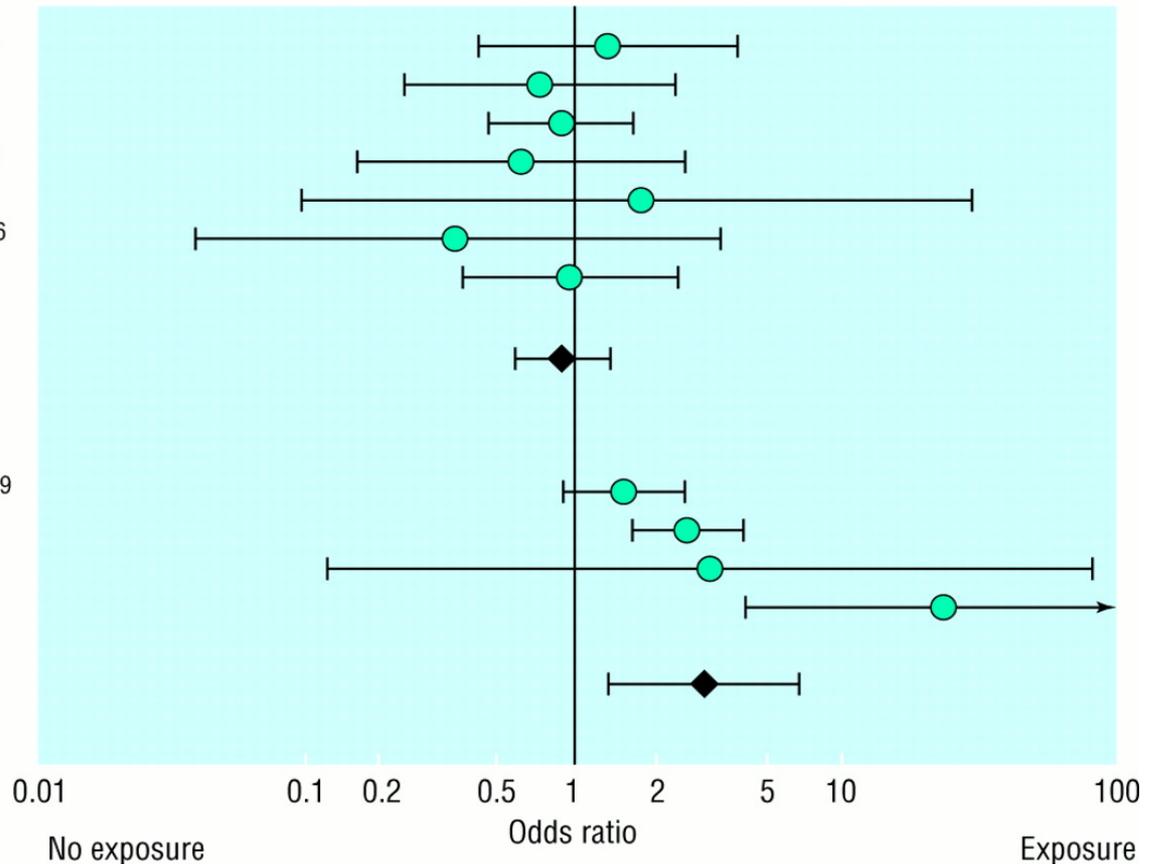
- Milkovich (1974)¹¹
- Crombie (1975)²³
- Hartz (1975)¹⁴
- Kullander (1976)²⁴
- Laegreid (1992)²⁵
- Pastuszek (1996)²⁶
- Ornoy (1997)²⁷

Overall effect

Case-control studies

- Greenberg (1977)²⁹
- Bracken (1981)²⁸
- Noya (1981)³²
- Laegreid (1990)¹³

Overall effect



Pharmacological considerations

Oral clefts and prenatal exposure to benzodiazepines

Cohort studies

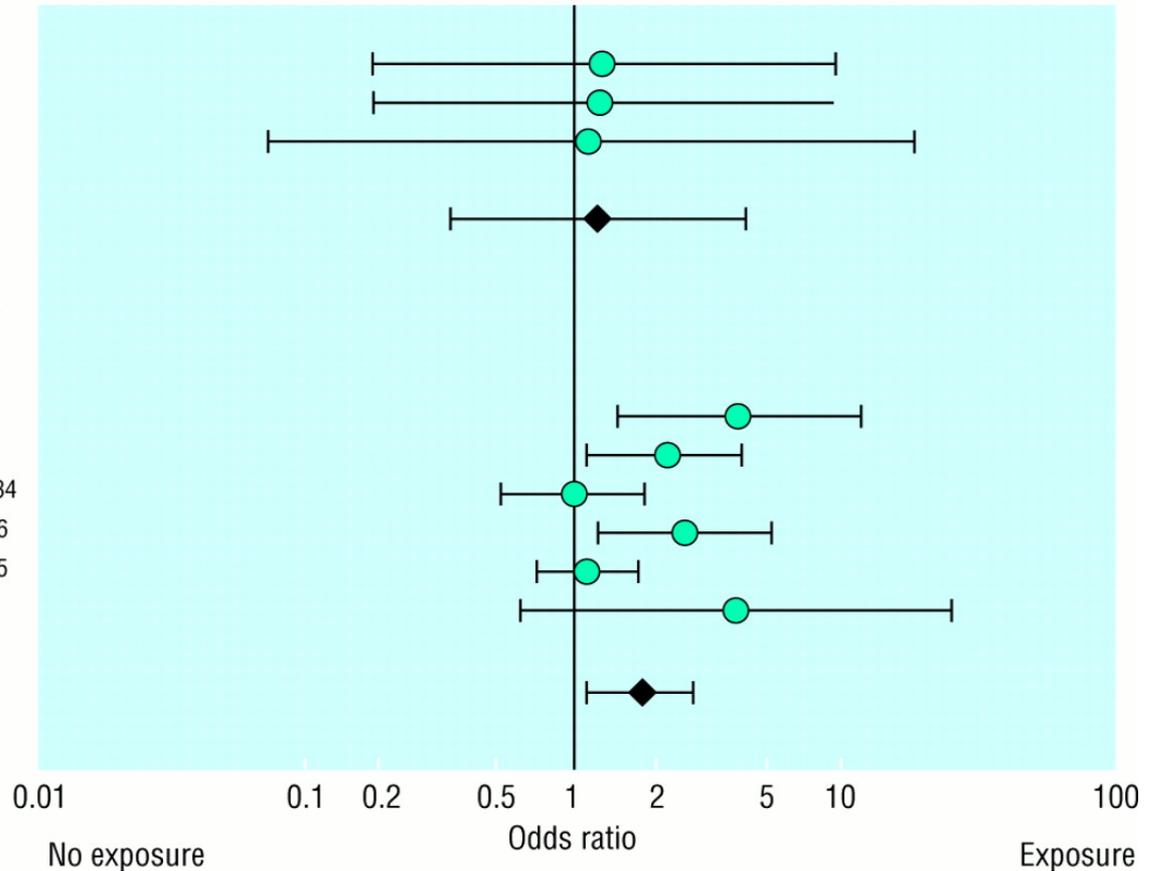
Shiono (1984)³³
Bergman (1992)¹
Ornoy (1997)²⁷

Overall effect

Case-control studies

Safra (1975)¹⁰
Saxen (1975)⁷
Rosenberg (1983)³⁴
Rodriguez (1986)³⁶
Czeizel (1987-88)³⁵
Laegreid (1990)¹³

Overall effect



Pharmacological considerations

- Concerns for Benzodiazepines (BZD) about increased risk of cleft palate
- BZD are not teratogenic and a single dose appears safe
- Regular use of BZD in the first trimester should be avoided



*Koren G, Pastuszak A, Ito S.
Drugs in pregnancy.
N Engl J Med 1998; 338: 1128–37*

Proven teratogens

ACE inhibitors

Alcohol

Lithium

Mercury

Androgens

Antithyroid drugs

Phenytoin

Carbamazepine

Radiation

Chemotherapeutic agents

Streptomycin

Kanamycin

Cocaine

Tetracycline

Coumarin

Thalidomide

Diethylstilbesterol

Trimethdione

Lead

Valproic acid

Vitamin A Derivatives

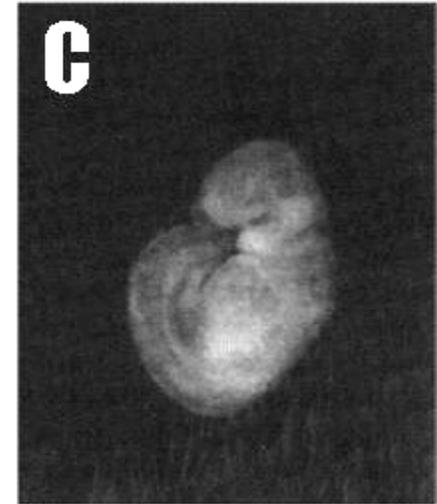
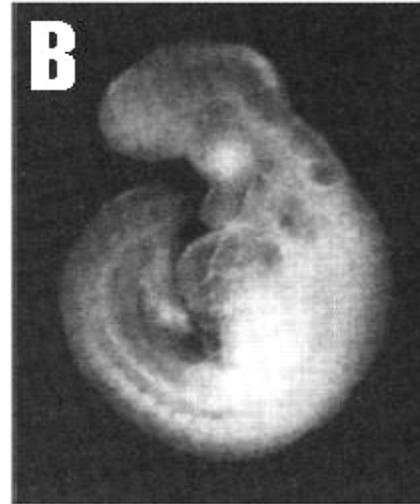
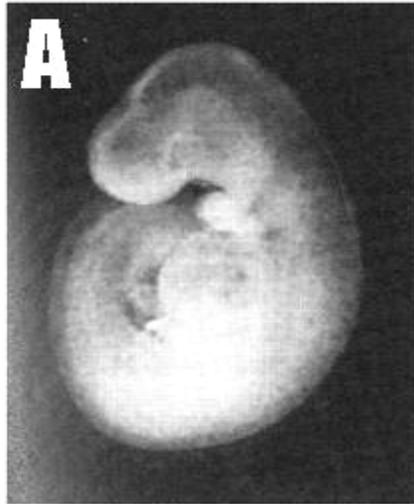
Nitrous oxide

- Teratogen in rodents even when normal homeostasis is maintained
- Increased incidence of fetal resorption and skeletal and visceral anomalies (situs inversus)
- At least 50% N₂O is required to consistently produce these anomalies and exposure of >24 hr
- Inactivates methionine synthase in both humans and animals by oxidation of Vit B12
- Alpha₁ adrenergic stimulation



Fujinaga M, Baden JM, Suto A, et al. Preventive effects of phenoxybenzamine on nitrous oxide induced reproductive toxicity in Spague Dawley rats. Teratology 1991;43:151-7).

Nitrous oxide



- A. Normal Day 11 rat embryo.**
- B. Day 11 embryo treated with 75% nitrous oxide for 24 hours from Day 9. The embryo has a relatively small head as compared with other parts of the body.**
- C. Day 11 embryo similarly treated with 75% nitrous oxide on Day 9. The embryo is smaller than normal and is severely malformed.**

*Baden JM, Fujinaga M.
Effects of nitrous oxide on day 0 embryos grown
in culture. Br J Anaesth 1991;66:500-3).*

Pharmacological considerations

Outcomes studies in large numbers of women who underwent surgery during pregnancy suggest **no increase in congenital abnormalities but a greater risk of abortion, growth restriction and low birth weight.**

These studies concluded that problems resulted from primary disease or the surgical procedure itself rather than exposure to anesthesia.



outcome

Goodman S. Anaesthesia for non obstetric surgery in the pregnant patient. Semin Perinatol 2002; 26: 136–45

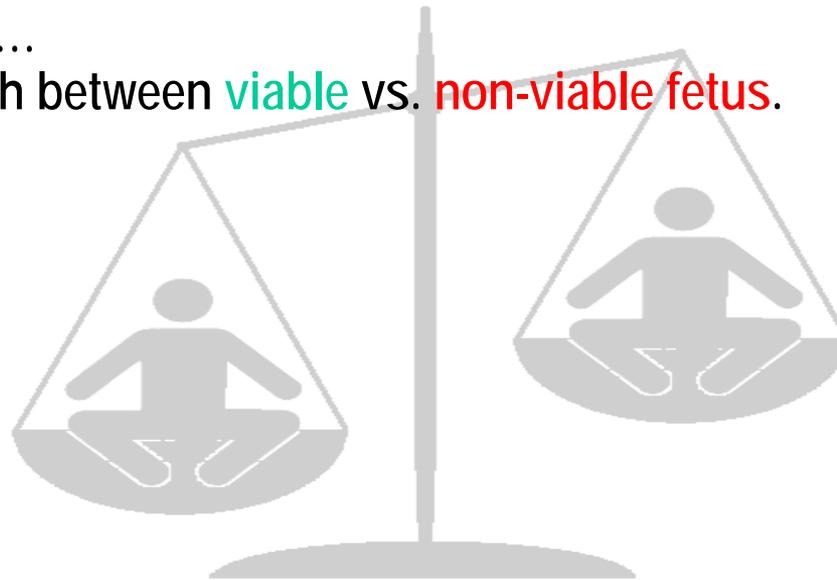
Pharmacological considerations

Hypnotics or opioids have no deleterious effects on embryonic or fetal development...

BUT

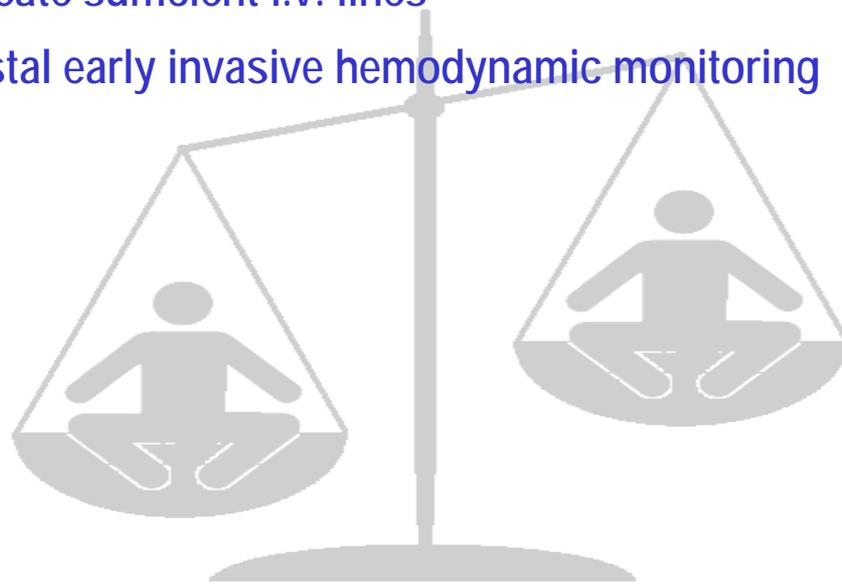
...may impede fetal adaptation in case of accidental delivery (> 24 w.o.g)

Therefore...
distinguish between **viable** vs. **non-viable fetus**.



Dead or non-viable fetus

- Same as for the pregnant patient, but no benzodiazepine or opioid restriction
- Preference for general anesthesia
- Be prepared for severe coagulopathy and septic complications
 - Check (and re-check) coagulation parameters
 - Create sufficient i.v. lines
 - Instal early invasive hemodynamic monitoring



Vi^{able} preterm fetus

- Same as for the pregnant patient (with the usual benzodiazepine and opioid restriction)
- Preference for regional anesthesia
- Preparation for delivery (neonatologist available)



Pharmacological considerations

- Avoid non-steroidal anti-inflammatory drugs (risk of premature closure of the ductus arteriosus).
- Low dose aspirin appears to be safe in this respect
- Ketamine increases uterine tone (in early pregnancy) and should not be used



Pharmacological considerations

- Preference for loco-regional techniques as far as possible
- If GA mandatory, preference for volatile anesthetics
- Careful co-medication with tocolytic agents if necessary



Pharmacological considerations

- Distinguish between primary vs. secondary effects of drugs
- EXAMPLE Vasoactive drugs (e.g. noradrenaline)
 - primary effect (desired): correction of low blood pressure
 - secondary effects (undesired): reduction of placental blood flow



Preterm labor

- Most epidemiologic studies of non-obstetric surgery during pregnancy report **increased incidence of preterm delivery and abortion**
- It is unclear whether surgery, manipulation of uterus or underlying condition is responsible
- In one study **22%** of 778 patients who underwent appendectomy between 24 to 36 weeks gestation delivered within first week after surgery.
- No increased risk of delivery after first week following surgery
- Second trimester procedures and those not involving uterine manipulation carry the lowest risk of preterm labor.

*Mazze RI, Kallen B. Appendectomy during pregnancy.
A Swedish registry study of 778 cases . Obstet
Gynecol 1991;77:835-40*

Preterm labor

- Evidence doesn't suggest that any anesthetic agent or technique influence the risk of preterm labor (Ketamin?)
- Prophylactic tocolytics may be considered but are associated with side effects and it is unclear whether they affect the outcome due to their limited efficacy for prevention of preterm labor
- Selective administration to patients at high risk (e.g. cervical cerclage) or after 24 weeks gestation
- Monitoring of uterine contractions with external tocodynamometer intra and postoperatively should be performed when feasible
- Additional surveillance for patients receiving potent analgesics postoperatively



General principles

- Elective surgery should not be performed at all during pregnancy
- Surgery should be avoided during 1st trimester (2nd trimester probably optimal time)
- Tubal ligation may be performed during the first days/weeks postpartum (procedure as during pregnancy)



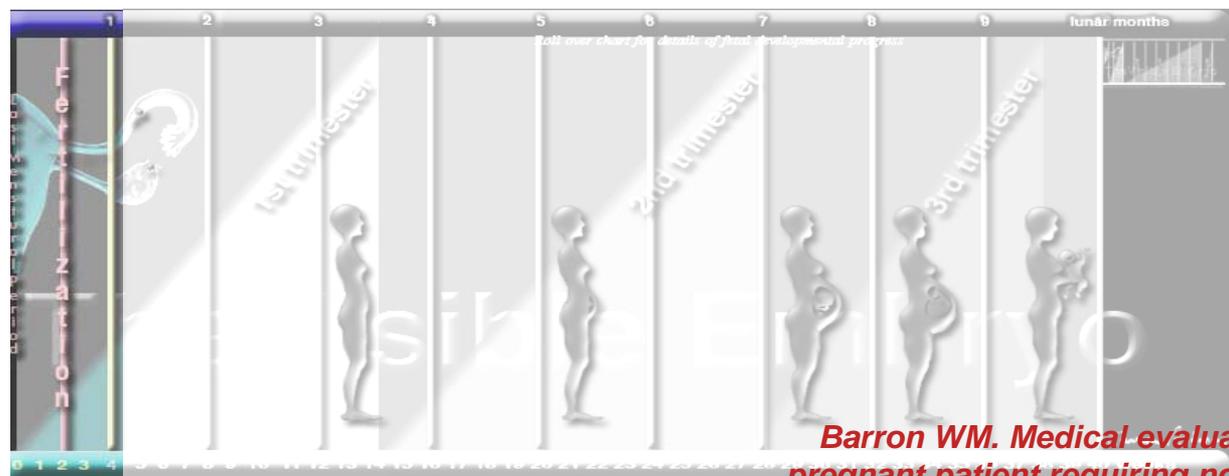
General principles

- Emergency surgery must proceed regardless of gestational age and the primary goal is to preserve the life of the mother
- When surgery is necessary and possible, it should be delayed until the second trimester to reduce the risk of both teratogenicity and miscarriage (not evidence based!)



Principles acc. age of gestation

- Anesthetic technique should not interfere with fertilization or early embryo development
- Minimal postoperative nausea, sedation, pain and psychomotor impairment
- Common procedures:
 - Continuous propofol sedation
 - Continuous remifentanyl analgesia
 - Locoregional techniques
- Nitrous oxide is to be avoided

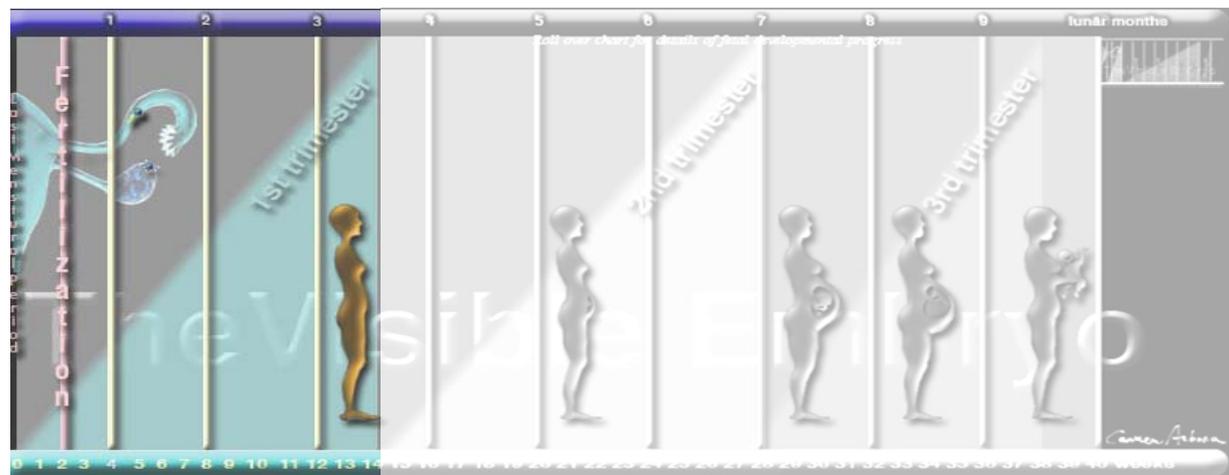


Barron WM. Medical evaluation of the pregnant patient requiring nonobstetric surgery. Clin Perinatol 1985; 12: 481–96

Conception

Principles acc. age of gestation

- After 6–8 weeks gestation, maternal cardiac, haemodynamic, respiratory, metabolic and pharmacological parameters are considerably altered
- Nasal tube airways should be avoided in pregnancy because of increased vascularity of mucous membranes
- Marked reduction of plasma cholinesterase concentrations (30% reduction) theoretically cause succinylcholine, ester local anesthetics and other drugs to have prolonged effects



1st Trimester

Principles acc. age of gestation

- Aspiration prophylaxis
- 30% lower anesthetic requirements (mechanism unknown)
- Risk of aortocaval compression from 20 weeks onwards
- Fetal well-being should be assessed by ultrasound or Doppler before and after anesthesia and surgery
- Thromboembolic complications are 5 times greater. Thromboprophylaxis is essential.



2nd Trimester

Principles acc. age of gestation

- Aspiration prophylaxis
- Delivery by caesarean section before major surgery is often recommended
- If possible surgery should be delayed 48 h to allow steroid therapy to enhance fetal lung maturation
- It may be appropriate to
 1. deliver the baby under regional anesthesia and
 2. convert to a general anesthesia for definitive surgery



3rd Trimester

Principles acc. age of gestation

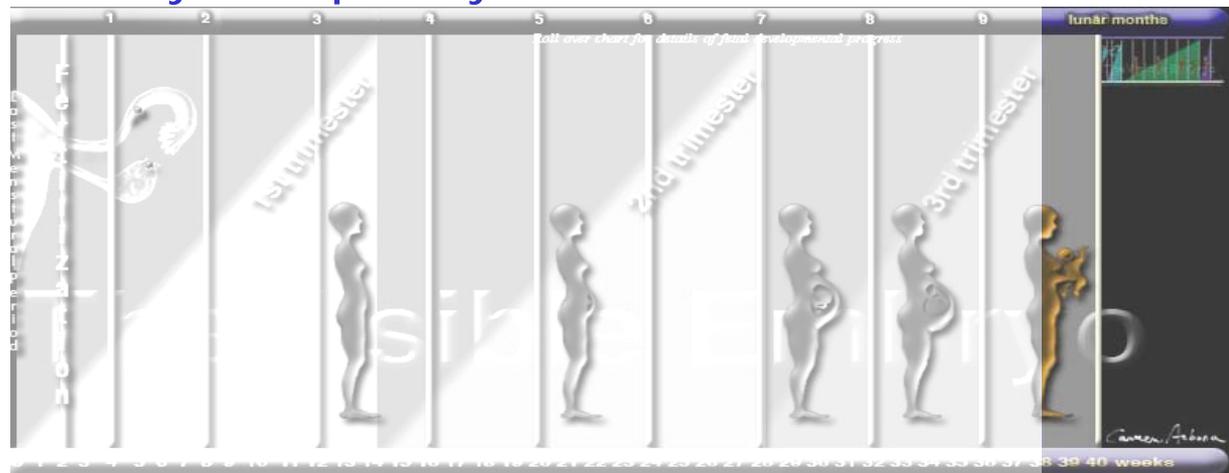
- Aspiration prophylaxis
- In post delivery surgery volatile agents should be discontinued or used only in small doses (<0.5 MAC) along with oxytocics to minimize the risk of uterine atony and hemorrhage



3rd Trimester + after delivery

Principles acc. age of gestation

- Aspiration prophylaxis
- Surgery and stress may suppress (temporarily) lactation
- Most drugs are excreted into breast milk but only a few are absolutely contraindicated:
 - radioactive substances
 - ergotamine
 - lithium
 - psychotropic agents
- Milk may need to be expressed to maintain lactation whilst the baby is temporarily fed with formula food



After delivery

General principles 1

- Aspiration prophylaxis (preoperative H₂ receptor antagonists and 0.3 M Na citrate)
- Rapid sequence induction and intubation mandatory after 18-20 weeks gestation or earlier
- Choice of anesthesia guided by maternal indication, site and nature of surgery
- Use regional anesthesia whenever feasible
- Prevent aortocaval compression by left lateral tilt-significant from 18-20 weeks gestation
- Consider using small sized endotracheal tubes (7.0 mm)
- Avoid nasal intubation whenever possible



General principles 2

- Use drugs like thiopental, propofol, fentanyl, remifentanyl, succinylcholine, majority of nondepolarizing muscle relaxants and local anesthetics
- Avoid N₂O during first six weeks of gestation
- Avoid hyperventilation, hypoxia, acidosis, hypotension and hypothermia
- Administer anticholinesterase agent slowly following prior administration of anticholinergic agent
- Monitor fetal heart rate and uterine activity intra and postoperatively when feasible
- Consider prophylaxis for deep vein thrombosis



In case of laparoscopic intervention

- No longer considered a contraindication
- Use open technique to enter abdomen to prevent uterine or fetal trauma
- Risk of fetal acidosis from absorbed CO₂ (to be compensated by ventilation)
- Expect decreased cardiac output and uteroplacental perfusion
- Use low pneumoperitoneum pressures (<15 mmHg)
- Consider invasive arterial monitoring
- Limit the extent of Trendelenburg and reverse Trendelenburg position and initiate position changes gradually
- Protect uterus with lead shielding during radiation
- Monitor fetal heart rate and uterine activity when feasible through trans-vaginal route



In case of EXIT procedure & fetal surgery

- EXIT = ex utero intrauterine treatment:
 - Oropharyngeal or neck masses
 - Fetal head delivered but placental circulation intact
- Fetal Surgery:
 - Closure of myelomeningocele
 - Risk of preterm labor
 - Tocolysis with indomethacin and/or Mg sulfate
 - General anesthesia with high concentrations of inhalational agent (2 MAC) plus hemodynamic stabilisation
 - Postoperative epidural analgesia for 3 days



Summary

- A multidisciplinary approach with senior involvement needs to be established early in the management
- If possible, surgery should be delayed until the second trimester
- Elective surgery should not be performed at all
- **Avoid (unwanted) drug effects on the fetus**
- **Avoid oxytocic effects to preserve pregnancy**
- **Avoid tocolytic effects postpartum**

