Positive Beta HCG… Woe, is me!

General Surgery in the Pregnant Patient

Laura Spector, D.O.

HAOPS Spring 2018 Primary Care Update

March 27, 2018

Disclosures

- None

Objectives

- Describe the challenges of the pregnant patient
- Review more common surgical procedures in pregnancy
- Recommendations for practice

Background and Context

- Less than 1% of pregnant patients will necessitate a non-obstetrical surgery during pregnancy
  - Most commonly appendectomy and cholecystectomy
- Incidence of acute abdomen in pregnancy is 1 in 500-635 pregnancies
- However, need for surgery during pregnancy is encountered and pregnancy does not preclude any diagnosis

Background and Context

- Pregnancy makes the diagnosis of the acute abdomen and other surgical conditions more difficult
  - Expanding uterus, which alters the location of other intra-abdominal organs on physical exam
  - High incidence of nausea, vomiting and abdominal pain in normal pregnancy
  - Lab parameters are nonspecific and may be altered during pregnancy
- Pregnant women are significantly more likely than non-pregnant women to be diagnosed with systemic infection prior to both appendectomy and cholecystectomy
- Physicians may be reluctant to operate due to concerns for the pregnancy and/or litigation

- "It is important for a physician to obtain an obstetric consultation before performing non-obstetric surgery and some invasive procedures (e.g., cardiac catheterization or colonoscopy) because obstetricians are uniquely qualified to discuss aspects of maternal physiology and anatomy that may affect intra-operative maternal–fetal well-being" (ACOG Committee Opinion, Non-obstetrical Surgery During Pregnancy, 2015)
- A team approach (anesthesia and obstetric care providers, surgeons, pediatricians, and nurses) is recommended

A different kind of 'disclosure'

- Because of the difficulty of conducting large-scale randomized clinical trials in this population, there are no data to allow for *specific* recommendations
- The safety of drugs used in pregnancy cannot be conclusively evaluated
- Information obtained is based upon data from observational studies, expert opinion, and extrapolation from trials during cesarean delivery

Let's review…

- Physiologic changes related to pregnancy

(Briefly…)

Cardiovascular changes related to pregnancy

- Cardiac output (CO) increases by 20% at 8 wks and continues to rise until 30-32 wks of gestation, at which it plateaus approximately 50% above baseline and remains stable until the beginning of labor
- These changes are due to an increased preload from a rise in blood volume (by up to 50%), a decreased afterload from declining vascular resistance, and an increased material heart rate by 15-20bpm
- The supine position at term can lower CO by 25-30% compared with left lateral decubitus position, due to compression of the inferior vena cava by the gravid uterus

Pulmonary changes related to pregnancy

- Beginning in the first trimester, progesterone causes an increase in tidal volume and respiratory drive which result in hyperventilation (pCO_2 28-32mmHg) and chronic respiratory alkalosis (pH 7.42 – 7.44)
- Due to compensation for the respiratory alkalosis, the plasma concentration of bicarbonate decreases (18-22mEq/L)
- PaO_2 may be slightly elevated (104-108 mmHg) as a result of increased CO
- Beginning around 20 wks of gestation, upward displacement of the diaphragm leads to a 20% decrease in functional residual capacity (via a decrease in expiratory reserve volume and residual volume)
- Oxygen consumption increases by nearly 20%

Normal ABG in Pregnancy

- May look something like this…

7.43/32/104/2/21

Gastrointestinal changes related to pregnancy

- GERD occurs in 30-50% of pregnancies
  - Likely related to increases in intra-abdominal pressure and decreased lower esophageal sphincter tone during all trimesters related to progesterone production
- Insulin resistance
  - Thought to be due to estrogen, cortisol, and human placental lactogen
- Elevated alkaline phosphatase to 2-4 x the normal range
  - Due to production by the placenta

Renal changes related to pregnancy

- GFR and renal blood flow rise markedly
- Serum creatinine concentrations are lower
  - Normal is 0.8mg/dL or less
- Mild hydronephrosis and predisposition to pyelonephritis
  - Progesterone leads to deceased ureteral peristalsis
  - Gravid uterus compression of ureteral flow

Hematologic changes related to pregnancy

- Plasma volume increases by 50% by 32 weeks of gestation and total RBC mass increases by 20-30%, resulting in hemodilution
  - Normal hemoglobin as low as 11g/dL in the first and third trimesters and 10.5g/dL in the second trimester
- Relative hypercoagulable state caused by an increase in circulating concentration of the majority of coagulation factors, reduced levels of the anticoagulant cofactor protein S, and reduced fibrinolysis due to increases in circulating type 1 and 2 plasminogen activator inhibitor
  - Risk of DVT is highest in the first 4-6 weeks postpartum
- A mild leukocytosis occurs (normal up to 16.9k/mm^3)
- Platelets are unchanged

Incidence of non-obstetrical conditions requiring surgery during pregnancy

Indication	Incidence	Indication	Incidence
Appendicitis	1:1,500	Adnexal Torsion	1:3,000 to 1:4,000
Cholecystitis	1:1,500 to 1:10,000	Breast or Cervical Disease	1:3,000 to 1:5,000
Bowel Obstruction	1:1,500 to 1:3,500	Trauma	*variable

General recommendations

- A pregnant woman should be evaluated in the same manner as non-pregnant patients
- A pregnant woman should never be denied indicated surgery, regardless of trimester
- Urgent surgery should be performed urgently, as it would in a non-pregnant patient
- Elective surgery should be postponed until after delivery.
- If possible, non-urgent surgery should be performed in the second trimester
  - The uterus is still small enough not to obliterate an abdominal operative field
  - Preterm contractions and spontaneous abortion are least likely
- Surgery should be done at an institution with neonatal and pediatric services
- An obstetric care provider with cesarean delivery privileges should be readily available
- A qualified individual should be readily available to interpret the fetal heart rate patterns if fetal heart rate monitoring is indicated

Maternal mortality

- Maternal death from non-obstetrical surgery is rare
  - 0.006%
- No difference in 30-day mortality and morbidity rates

Primum non nocere

- Spontaneous abortion
  - Background miscarriage rate
    - 8-16% under 13 weeks of gestation
    - 2-4% between 13 and 20 weeks of gestation
  - Miscarriage rate of 5.8% in a study of 12,452 women who underwent non-obstetrical surgical procedures during pregnancy
  - Miscarriage rate of 10.5% in a systematic review of 54 studies
  - No increased risk from anesthetic agents

Primum non nocere

- Birth Defects
  - No currently used anesthetic agents have been shown to have any teratogenic effects in humans
    - Regional anesthesia is preferred
  - However, few laboratory and animal studies have showed increase neuronal apoptosis and negative effects on neurodevelopment from inhalation anesthetics, propofol and ketamine
  - Known teratogens should be avoided

Primum non nocere

- Preterm labor
  - Rate of preterm labor induced by non-obstetrical surgical intervention was 3.5%
    - More common following appendectomy (4.6%)
  - Overall prematurity rate after non-obstetrical surgery performed during the pregnancy was 8.2%
  - 2.5% of pregnancies resulted in fetal loss (including all trimesters)

Prophylactic tocolytics

- No proven benefit to the routine administration of prophylactic perioperative tocolytic therapy
  - Indomethacin
  - Terbutaline
  - Magnesium sulfate
  - Nifedipene
- Minimizing uterine manipulation may reduce the risk of the development of uterine contractions
- Labor = contractions with cervical change

Prophylactic glucocorticoids

- A course of antenatal glucocorticoids 24 to 48 hours prior to surgery between 24 and 34 weeks (and now possibly between 34-36 weeks) of gestation can reduce perinatal morbidity/mortality if preterm birth occurs
- Only recommended if delivery is expected within 7 days of steroid administration
- May impair the ability of the maternal immune system to contain infection if given in the setting of systemic infection

Primum non nocere

- Fetal Distress
- The decision to use fetal monitoring should be individualized and, if used, should be based on gestational age, type of surgery, and facilities available. Ultimately, each case warrants a team approach (anesthesia and obstetric care providers, surgeons, pediatricians, and nurses) for optimal safety of the woman and the fetus
  - The fetal heart rate typically displays reduced variability with induction of general anesthesia and decreased heart rate (although normally remaining in the normal range of 110-160bmp)
  - Initial worrisome changes in fetal heart rate should be addressed by optimizing maternal oxygenation and perfusion to the uteroplacental unit (lateral tilt, supplemental oxygen, IVFs, blood, vasopressors) rather than proceeding with emergent cesarean delivery

Fetal heart rate monitoring

- If the fetus is considered previable, it is generally sufficient to ascertain the fetal heart rate by Doppler before and after the procedure
- If the fetus is considered to be viable, simultaneous electronic fetal heart rate and contraction monitoring should be performed before and after the procedure to assess fetal well-being and the absence of contractions
- Intraoperative electronic fetal monitoring may be appropriate when all of the following apply:
  - It is physically possible to perform intraoperative electronic fetal monitoring (either transabdominally or vaginally)
  - A health care provider with obstetric surgery privileges is available and willing to intervene during the surgical procedure for fetal indications
  - When possible, the woman has given informed consent to emergency cesarean delivery
  - The nature of the planned surgery will allow the safe interruption or alteration of the procedure to provide access to perform emergency delivery

Common Procedures in Pregnancy…

Appendicitis in pregnancy

- Common in pregnancy
  - 1 in 500-2,000 pregnancies
  - Young people are more prone to appendicitis
  - Pregnant women are usually young
- More common in the second trimester (40% of cases)
- Difficult to diagnose in pregnancy

Appendicitis in pregnancy

- Diagnosis
  - History/Physical exam
    - RLQ pain
    - Rebound and guarding
    - Psoas sign
    - Flank or back pain
  - Imaging
    - Ultrasound
    - MRI
    - CT

Table 3. Fetal Radiation Doses Associated With Common Radiologic Examinations

Type of Examination	Fetal Dose* (mGy)
Very low-dose examinations (<0.1 mGy)	
Cervical spine radiography (anteroposterior and lateral views)	<0.001
Radiography of any extremity	<0.001
Mammography (two views)	0.001–0.01
Chest radiography (two views)	0.0005–0.01
Low- to moderate-dose examinations (0.1–10 mGy)	
Radiography	
Abdominal radiography	0.1–3.0
Lumbar spine radiography	1.0–10
Intravenous pyelography	5–10
Double-contrast barium enema	1.0–20
CT	
Head or neck CT	1.0–10
Chest CT or CT pulmonary angiography	0.01–0.66
Limited CT pelvimetry (single axial section through the femoral heads)	<1
Nuclear medicine	
Low-dose perfusion scintigraphy	0.1–0.5
Technetium-99m bone scintigraphy	4–5
Pulmonary digital subtraction angiography	0.5
Higher-dose examinations (10–50 mGy)	
Abdominal CT	1.3–35
Pelvic CT	10–50
^{18}F PET/CT whole-body scintigraphy	10–50

Abbreviations: CT, computed tomography; PET, positron emission tomography.
*Fetal exposure varies with gestational age, maternal body habitus, and exact acquisition parameters.
Note: Annual average background radiation = 1.1–2.5 mGy. ^{18}F = 2-[fluorine-18]fluoro-2-deoxy-D-glucose.
Reprinted from Tremblay E, Therasse E, Thomassin-Naggara I, Trop I. Quality initiatives: guidelines for use of medical imaging during pregnancy and lactation. Radiographics 2012;32:897–911.

Radiation in Pregnancy

Radiation in Pregnancy

Table 2. Effects of Gestational Age and Radiation Dose on Radiation-Induced Teratogenesis

Gestational Period	Effects	Estimated Threshold Dose*
Before implantation (0–2 weeks after conception)	Death of embryo or no consequence (all or none)	50–100 mGy
Organogenesis (2–8 weeks after conception)	Congenital anomalies (skeleton, eyes, genitals)	200 mGy
	Growth restriction	200–250 mGy
Fetal period	**Effects**	**Estimated Threshold Dose***
8–15 weeks	Severe intellectual disability (high risk)†	60–310 mGy
	Intellectual deficit	25 IQ-point loss per 1,000 mGy
	Microcephaly	200 mGy
16–25 weeks	Severe intellectual disability (low risk)	250–280 mGy*

*Data based on results of animal studies, epidemiologic studies of survivors of the atomic bombings in Japan, and studies of groups exposed to radiation for medical reasons (eg, radiation therapy for carcinoma of the uterus).
†Because this is a period of rapid neuronal development and migration.
Reprinted from Patel SJ, Reede DL, Katz DS, Subramaniam R, Amorosa JK. Imaging the pregnant patient for nonobstetric conditions: algorithms and radiation dose considerations. Radiographics 2007;27:1705–22.

Appendicitis in pregnancy

- Outcomes
  - Fetal mortality depends on whether appendiceal perforation occurs
    - Fetal loss with perforation = 20-35%
    - Fetal loss without perforation = 1.5%
    - 66% incidence of appendiceal perforation in pregnant patients when surgery was delayed > 24 hours (no cases if patients were taken to surgery within 24 hours)
  - Preterm labor
    - Preterm contractions occur in up to 83%
    - Preterm labor occurs in 5-14% (up to 50% in the 3rd trimester)
  - Maternal mortality
    - Overall < 1% if promptly diagnosed and treated
    - Increased risk with advancing gestational age and with delay in diagnosis/perforation
  - Up to 40% of pregnant patients who undergo surgery for an appendicitis will have a normal appendix
    - However, this is not related to an increase in maternal or fetal morbidity

Appendicitis in pregnancy

- Management
  - Open appendectomy
    - Muscle splitting incision over point of maximal tenderness
    - Right pararectal incision
    - Midline vertical incision
  - Laparoscopic appendectomy
    - Hasson technique
  - Medical management of peritonitis
    - Cefuroxime, ampicillin, metronidazole
    - Supplemental oxygen
    - Copious irrigation
    - Intraperitoneal drain
  - Pregnancy management
    - Delivery may or may not be indicated, depending on gestational age and context
    - Tocolysis or corticosteroids

Acute cholecystitis in pregnancy

- Second most common cause of acute abdomen in pregnancy
  - 1 in 1,600-10,000 pregnancies
  - 90% caused by cholelithiasis
- Cholelithiasis is common in pregnancy
  - Incidence 3.5-10% during routine ob ultrasound
  - Progesterone and estrogen promote stone formation

Acute cholecystitis in pregnancy

- Diagnosis
  - History/Physical exam
    - Nausea, vomiting, dyspepsia
    - Intolerance of fatty foods
    - Colicky or stabbing pain that radiates to the back
    - Murphy's sign is less common in pregnant patients
  - Labs
    - Bilirubin, LFTs
    - Not alk phos
  - Imaging
    - Ultrasound
    - CT

Acute cholecystitis in pregnancy

- Outcomes
  - Fetal mortality
    - Non-operative management carries higher risks
  - Preterm labor
    - Non-operative management carries higher risks
    - Risk greatest in 3rd trimester
  - Maternal morbidity/mortality
    - Recurrence rates of 44-92% if managed non-operatively
    - No increase when compared to non-pregnant patients with cholecystectomy
    - Important to rule out other diagnoses

Acute cholecystitis in pregnancy

- Management
  - Open cholecystectomy
    - With or without cholangiography
  - Laparoscopic cholecystectomy
    - 1st, 2nd, or early 3rd trimesters
  - Medical management
    - Not recommended
  - ERCP
    - Possible during pregnancy
  - Pregnancy management
    - Delivery may or may not be indicated, depending on gestational age and context
    - Tocolysis or corticosteroids

Hepatic rupture in pregnancy

- Uncommon in pregnancy
  - 1 in 40,000-50,000 pregnancies
- Related to disease that occur in association with pregnancy
  - Acute fatty liver of pregnancy
  - HELLP syndrome with liver capsule rupture

Hepatic rupture in pregnancy

- Diagnosis
  - History/Physical exam
    - Nausea, vomiting
    - Epigastric discomfort, RUQ pain, back pain, pelvic pain, contractions
    - Mild jaundice, peritoneal signs
  - Labs
    - Elevated LFTs, bilirubin
    - Hypoglycemia
    - Coagulopathy
  - Imaging
    - Ultrasound
    - CT

Hepatic rupture in pregnancy

- Outcomes
  - Fetal mortality
    - Mortality 40-60% (up to 80%)
  - Preterm labor
    - Preterm delivery is often indicated
  - Maternal morbidity/mortality
    - Mortality 40-60% (up to 80%)
    - Acute renal failure, liver failure, ARDS, hemorrhage, pancreatitis

Hepatic rupture in pregnancy

- Management
  - Delivery
    - Cesarean section
    - Liver packing
  - Conservative management
    - Only indicated in stable patients with a viable pregnancy
    - Serial ultrasound evaluations of liver hematoma
    - Monitor and correct coagulopathy
    - Fetal monitoring
    - Delivery via cesarean section

Intestinal obstruction in pregnancy

- 3rd most common cause of acute abdomen in pregnancy
  - 1 in 1,500-16,000 pregnancies
- Etiologies
  - Adhesions (60-70%)
  - Volvulus (25%)
  - Intussusception
  - Hernia
  - Cancer
  - Diverticulitis/diverticulosis

Intestinal obstruction in pregnancy

- Diagnosis
  - History/Physical Exam
    - Crampy abdominal pain, obstipation, vomiting, fever
  - Labs
    - Leukocytosis
    - Electrolyte abnormalities
  - Imaging
    - Plain abdominal films
    - CT
    - Colonoscopy

Intestinal obstruction in pregnancy

- Outcomes
  - Fetal mortality
    - 26%
  - Maternal mortality
    - Overall 6%
    - Third trimester 10-20%
    - 33% if gangrenous bowel is present

Intestinal obstruction in pregnancy

- Management
  - Same as for non-pregnant patient
    - Conservative therapy
    - Surgical exploration via midline vertical incision
  - Delivery may be indicated depending on gestational age
    - Fetal monitoring
    - Monitoring maternal oxygen saturations

Acute pancreatitis in pregnancy

- Acute pancreatitis occurs in 1 in 1,000-3,000 pregnancies
- Causes include
  - Cholelithiasis (67-100% of cases)
  - Alcohol abuse
  - Abdominal surgery, blunt abdominal trauma, infections, penetrating duodenal ulcers, connective tissue diseases, hyperparathyroidism, hyperlipidemic pancreatitis
  - Rarely acute fatty liver of pregnancy and HELLP syndrome

Acute pancreatitis in pregnancy

- Diagnosis
  - History/Physical Exam
    - Sudden severe epigastric pain radiating to the back, postprandial nausea and vomiting, fever
    - Hypoactive bowel sounds, diffusely tender abdomen
  - Labs
    - Elevated amylase and lipase
    - Elevated amylase/creatinine clearance ratio > 5%
    - Ranson's criteria
  - Imaging
    - Ultrasound
    - CT

Acute pancreatitis in pregnancy

- Outcomes
  - Fetal mortality
    - 25%
  - Maternal morbidity/mortality
    - 17%
    - Pulmonary complications in 10% of patients

Acute pancreatitis in pregnancy

- Management
  - Same as in non-pregnant patients
    - Bowel rest
    - Fluid and electrolyte resuscitation
    - Analgesics
    - Antispasmodics
    - Possibly antibiotics

Blunt trauma in pregnancy

- Trauma effects 6-7% of pregnancies
  - 0.3% of pregnant women require hospital admission due to trauma
- Causes
  - MVAs
  - Physical abuse (up to 10% of pregnancies)
  - Accidental falls

Blunt trauma in pregnancy

- Fetal mortality
  - 3.4-38%
    - Most as a result of maternal death
  - Abruption (40%) or uterine rupture
  - Direct fetal injury (<1%)
  - Can be predicted by the mean Injury Severity Score (ISS)
  - Maternal GCS and arterial blood pH are also predictors

Blunt trauma in pregnancy

- Management
  - Maternal evaluation and resuscitation first!
  - Evaluation of the fetus after maternal stabilization
  - Oxygen, IVFs, transfusions, lateral displacement of the uterus
  - Pressors, inotropes
  - Caution with incidental or unknown pregnancies
    - Order urine and serum beta HCG in female trauma patients

Penetrating trauma in pregnancy

- Most common causes are gunshot and stab wounds
- Uterus may play a “protective” role for the mother
  - Death rate for GSW to abdomen in pregnancy 3.9% vs non-pregnant 12.5%
- However, fetal mortality is higher
  - 47-71% with fetal injury in 59-89% of cases

Penetrating trauma in pregnancy

- Management
  - Same as for blunt trauma
  - Surgical exploration
    - Not an indication for cesarean section
  - Assessment of Rh status and administration of Rhogam if indicated
    - KB test
  - Perimortem cesarean section

Postoperative management

- Progesterone supplementation is recommended when the corpus luteum is removed prior to 7-9 weeks of gestation (e.g. during oophorectomy for ovarian torsion)
  - Progesterone 50-100mg vaginal suppository q8-12hrs or
  - 1mL IM progesterone in oil
  - Oral progesterone is less effective
- After 9 weeks of gestation, progesterone supplementation is no longer needed because luteal support is shifted from the corpus luteum of the ovary to the placenta

Anesthesia considerations

- Higher risk of aspiration
  - Standard adult fasting guidelines apply
  - Preoperative bicitra
- Difficult intubations
- Altered vascular anatomy

Anesthesia considerations

- Most commonly used medications are propofol, fentanyl and midazolam
  - Alternatives are ketamine, etomidate
  - Succinylcholine or nondepolarizing neuromuscular blocking agents may be used
  - Early reports suggested that diazepam used in early pregnancy may be associated with cleft palate, but subsequent studies have failed to demonstrate this association
- Preoxygenation is important
  - Apnea in a pregnant patient leads more rapidly to significant desaturation when compared to nonpregnant women
- Mechanical ventilation should be adjusted to maintain the normal physiological chronic respiratory alkalosis of pregnancy
- Inspired O2 of at least 50% should be used to maintain fetal oxygenation
- General anesthesia is associated with decreased uterine tone and post partum hemorrhage
- Major concern of neuraxial anesthesia is maternal hypotension (from local anesthetic-induced sympathetic block) that may reduce placental perfusion
  - Often seen as FHR changes after epidural on L&D

Thrombosis prophylaxis

- The hypercoagulable state of pregnancy protects against excessive blood loss during delivery but predisposes the pregnant patient to thromboembolic events in the postsurgical period
- Mechanical or pharmacologic thromboprophylaxis is recommended for all pregnant patients undergoing surgery
- After surgery, thromboprophylaixs should be continued until the patient is fully mobile
  - Early mobilization is strongly encouraged

Antibiotic prophylaxis

- Cephalosporins, penicillins, erythromycin, azithromycin, and clindamycin all have good safety profiles in pregnancy
- Aminoglycosides are safe, but carry a risk of fetal (and maternal) ototoxicity and nephrotoxicity
- Avoid
  - Doxycycline
  - Trimethoprim and nitrofurantoin (first trimester)
  - Fluoroquinolones

Pain control

- Opioids can be used as needed to control pain
- Epidural anesthesia is an option for procedures on the chest, abdomen, or lower extremities
- NSAIDs should be avoided (especially after 32 weeks) due to effects on the collecting system (and premature closure of the fetal ductus arteriosus if given for more than 48 hours)

Mode of delivery

- THE PRESENCE OF A RECENT ABDOMINAL INCISION DOES NOT PRECLUDE PUSHING IN THE SECOND STAGE OF LABOR
  - Please do not counsel your pregnant patients on mode of delivery! (Leave this up to the obstetrician)

In conclusion

- Pregnancy presents many unique challenges to the general surgeon
- There are important physiologic changes that occur due to pregnancy
- Surgery itself does not increase morbidity or mortality in pregnant patients
- However, surgical delay has been linked to worse outcomes
  - Increased risk of septic shock, VTE, peritonitis
  - Higher maternal and fetal complication rates

Reminders

- It is okay to treat pain with opioids
- It is okay to order any necessary radiographic studies
- Do not stop necessary medications due to concern for pregnancy
- Do not give recommendations for mode of delivery to patients
- Do not give recommendations for timing of delivery to patients

Advice for calling an ob consult

- State the gestation age in WEEKS (not months)
  - Bonus if you can report how their dating is confirmed (e.g. LMP, $1^{st}/2^{nd}/3^{rd}$ trimester ultrasound, fundal height)
- Make sure an IUP has been confirmed
  - Watch out for pseudocyesis!
- Communicate that you are aware of the main problem may not be obstetrical
  - Not every abdominal pain in pregnancy is labor
- Request to have them involved for obstetrical issues that may arise
  - Even if there are none now
- Know if the patient has established obstetrical care
- Know if they are having any contractions, vaginal bleeding, loss of fluid, or decreased fetal movement (only if above 24 weeks)

References

- Abbasi N, Patenaude V, Abenhaim HA. Management and outcomes of acute appendicitis in pregnancy-population-based study of over 7000 cases. BJOG 2014; 121:1509.
- ACOG Committee Opinion. "Nonobstetrical Surgery During Pregnancy." Committee on Obstetrical Practice. Number 474, February 2011. (Reaffirmed 2015.)
- American College of Obstetricians and Gynecologists (ACOG). Obstetric aspects of trauma management. Educational Bulletin no. 251. Int J Gynaecol Obstet 1999;64:87-94
- Augustin G, Majerovic M. Non-obstetrical acute abdomen during pregnancy. European Journal of Obstetrics & Gynecology and Reproductive Biology 2007; 131:4-12.
- Baer JL, Reis RA, Arens RA. Appendicitis in pregnancy with changes in position and axis of the normal appendix in pregnancy. JAMA 1932;52:1359-64.
- Ballantyne GH, Brouder MD, Beart RWJ, et al. Volvulus of the colon: incidence and mortality. Am Surg 1985;202:83-92.
- Cohen-Kerem R, Railton C, Oren D, et al. Pregnancy outcome following non-obstetric surgical intervention. Am J Surg 2005; 190:467.
- Conklin KA. Maternal physiological adaptations during gestation, labor and the puerperium. Semin Anesth 1991; 10:221.
- Connolly M, Unti J, Nora P. Bowel obstruction in pregnancy. Surg Clin North Am 1995;75:101-13.
- Cosenza CA, Saffari B, Jabbour N, et al. Surgical management of biliary gallstone disease during pregnancy. Am J Surg 1999;178:545-8.
- Curet MJ. Special problems in laparoscopic surgery: previous abdominal surgery, obesity, and pregnancy. Surg Clin North Am 2000;80:1093-110.
- Devore GR, Braken M, Berkoqitz RL. The amylase/creatinine clearance ratio in normal pregnancies and in pregnancies complicated by pancreatitis, hyperemesis, and toxemia. Am J Obstet Gynecol 1980;136:747-54.

References

- Dolovich LR, Addis A, Vaillancourt JM, et al. Benzodiazepine use in pregnancy and major malformations or oral cleft: meta-analysis of cohort and case-control studies. BMJ 1998; 317:839.
- Guyatt GH, Akl EA, Crowther M, et al. Executive summary: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Bsed Clinical Practice Guidelines. Chest 2012; 141:7S.
- Halvorsen AC, Brandt B, Andreasen JJ. Acute appendicitis in pregnancy: complications and subsequent management. Eur J Surg 1992;158:603-6.
- Harer WB, Harer WB, Volvulus complicating pregnancy and puerperium. Obstet Gynecol 1958;12:399-406.
- Hiatt JR, Hiatt JC, Williams RA, et al. Biliary disease in pregnancy: strategy for surgical management. Am J Surg 1986;151:263-5.
- Hodjati H, Kazerooni T. Location of the appendix in the gravid patient: a re-evaluation of the established concept. Int J Gynaecol Obstet 2003;81:245-7.
- Hoff WS. D'Amelio LF, Tinkoff GH, et al. Maternal predictors of fetal demise in trauma during pregnancy. Surg Gynecol Obstet 1991;172:175-80.
- Istaphanous GK, Loepke AW. General anesthetics and the developing brain. Curr Opin Anaesthesiol 2009; 22:368.
- Kammerer W. Nonobstetric surgery during pregnancy. Med Clin North Am 1979;63:1157-64.
- Kaneko T, Iwama H, Tobishima S, et al. [Placental transfer of vecuronium administered with priming principle regimen in patients udnergoing cesarean section]. Masui 1997; 46:750.
- Karsenti D, Bacq Y, Brechot JF, et al. Serum amylase and lipase activities in normal pregnancy: a prospective case-control study. Am J Gastroenterol 2001;96:697-9.
- Katz VL, Dotters DJ, Droegmueller W, Perimortem cesarean delivery. Obstet Gynecol 1986;68:571-6.

References

- Kissinger Dp, Rozycki GS, Morris Jr JA, et al. Trauma in pregnancy. Predicting pregnancy outcome. Arch Surg 1991;126:1079-86
- Kuy S, Roman SA, Desai R, Sosa JA. Outcomes following cholecystectomy in pregnant and nonpregnant women. Surgery 2009; 146:358.
- Mazze RI, Kallen B. Appendectomy during pregnancy: a Swedish registry study of 778 cases. Obstet Gynecol 1991; 77:835.
- Mazze RI, Kallen B. Reproductive outcome after anesthesia and operation during pregnancy: a registry study of 5405 cases. Am J Obstet Gynecol 1989; 161:1178.
- Moldenhauer JS, O'Brien JM, Barton JR, et al. Acute fatty liver of pregnancy associated with pancreatitis: a life-threatening complication. Am J Obstet Gynecol 2004;190:502-5.
- Moore HB, Juarez-Colunga E, Bronsert M, et al. Effect of Pregnancy on Adverse Outcomes After General Surgery. JAMA Surg 2015; 150:637.
- Neilipovitz DT, Crosby ET. No evidence for decreased incidence of aspiration after rapid sequence induction. Can J Anaesth 2007; 54:748.
- Nies RH, Drieiss BJ. Hyperlipidemic pancreatitis in pregnancy: case report and review of the literature. Am J Perinat 1990;7:166-9.
- Olsen EA, Brambrink AM. Anesthetic neurotoxicity in the newborn and infant. Curr Opin Anaesthesiol 2013; 26:535.
- Paranjothy S, Griffiths JD, Broughton HK, et al. Interventions at cesarean section for reducing the risk of aspiration pneumonitis. Cochrane Database Syst Rev 2010; : CD004943.
- Perdue PW, Johnson HW, Stafford PW. Intestinal obstruction complicating pregnancy. Am J Surg 1992;164:384-8.
- Pratt AT, Donaaldson RC, Evertson LR, et al. Cecal volvulus in pregnancy. Obstet Gynecol 1981;57(Suppl.):37S-40S.

References

- Ramin KD, Ramin SM, Richey SD, et al. Acute pancreatitis in pregnancy. Am J Obstet Gynecol 1995;173:187-91.
- SAGES Publication 0023. SAGES guidelines for laparoscopic surgery during pregnancy.
- Satin A, Hemsell DL, Stone Jr IC, et al. Sexual assault in pregnancy. Obstet Gynecol 1991;77:710-4.
- Shah KH, Simons RK, Holbrook T, et al. Trauma in pregnancy: maternal and fetal outcome. J Trauma 1998;45:83-6.
- Schiff MA, Holt VL. The Injury Severity Score in pregnant trauma patients: predicting placental abruption and fetal death. J Trauma 2002;53:946-9.
- Scott LD. Gallstone disease and pancreatitis in pregnancy. Gastroenterol Clin North Am 1992;21:803-15.
- Siddiqui N, Goldszmidt E, Haque SU, Carvalho JC. Ultrasound simulation of internal jugular vein cannulation in pregnant and non-pregnant women. Can J Anaesth 2010; 57:996.
- Silvestri MT, Pettker CM, Brousseau EC, et al. Morbidity of appendectomy and cholecystectomy in pregnant and nonpregnant women. Obstet Gynecol 2011; 118(6):1261-70.
- Swisher S, Schmidt P, Hunt K, et al. Biliary disease during pregnancy. Am J Surg 1994;168:576-9.
- Tamir IL, Bongard FS, Klein SR. Acute appendicitis in the pregnant patient. Am J Surg 1990;160:571-6.
- Usta IM, Barton JR, Amon EA, et al. Acute fatty liver of pregnancy: an experience in the diagnosis and management of fourteen cases. Am J Obstet Gynecol 1994;171:1342-7.
- Wenetick LH, Roschen FP, Dunn JM. Volvulus of the small bowel complicating pregnancy. J Reprod Med 1973;14:82-83.
- Wilcox AJ, Weinberg CR, O'Conner JF, et al. Incidence of early loss of pregnancy. N Engl J Med 1988; 319:189.
- Yahchouchy E, Zaarour P, Prove S, et al. Recurrent idiopathic small bowel volvulus during pregnancy. ANZ J Surg 2001;71:193-4.