Pregnant patients requiring emergency general surgery: a scoping review of diagnostic and management strategies

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Accepted Mar. 6, 2024

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Cite as: *Can J Surg* 2025 May 29;68(3).
doi: 10.1503/cjs.001124

Background: About 1%–2% of pregnant patients develop conditions that require emergency general surgery (EGS). The diagnosis and management of these conditions can be challenging, as surgeons must carefully balance the needs of the pregnant patient and the developing fetus. We sought to summarize the latest literature guiding surgical management of appendicitis, benign biliary disease, bowel obstruction, and hemorrhoids in pregnant patients.

Methods: We performed a comprehensive scoping review using OVID Medline for articles published between January 2000 and June 2023 pertaining to EGS and pregnancy.

Results: Acute appendicitis, benign biliary disease, and bowel obstructions confer increased risk of adverse maternal and fetal obstetrical outcomes. In general, pregnant patients with acute appendicitis and cholecystitis should undergo appendectomy or cholecystectomy, respectively. The management of biliary colic has significant nuance depending on trimester. While an operative approach is favoured in the first 2 trimesters, the role of surgery in the third trimester is less clear. Nonoperative treatment of each of these diseases can result in significant maternal, and possibly fetal, morbidity. Operative management of bowel obstruction must be determined on a case-by-case basis. In all instances, a laparoscopic approach is preferred, if feasible.

Conclusion: A thoughtful approach is crucial for surgeons and institutions caring for pregnant patients with EGS diseases. Treatment should be similar to that in nonpregnant patients, with some important considerations and modifications. Nonoperative or delayed operative management often increases adverse obstetrical events, including death.

Contexte : Environ 1 %–2 % des personnes enceintes devront subir une intervention urgente en chirurgie générale pour un problème de santé dont le diagnostic et la prise en charge sont parfois complexes, car il faut judicieusement prendre en compte les besoins de la personne enceinte et ceux du fœtus. Nous avons voulu faire le point sur les directives récemment publiées relativement au traitement chirurgical de l'appendicite, de la maladie biliaire bénigne, de l'obstruction intestinale et des hémorroïdes chez les personnes enceintes.

Méthodes : Nous avons procédé à une étude de portée globale à partir du réseau OVID Medline pour y trouver les articles publiés entre janvier 2000 et juin 2023 sur les interventions d'urgence en chirurgie générale et la grossesse.

Résultats : L'appendicite, la maladie biliaire bénigne et l'obstruction intestinale aggravent le risque de complications maternelles et fœtales. En général, les personnes enceintes aux prises avec une appendicite ou une cholécystite doivent subir respectivement une appendicectomie ou cholécystectomie. La prise en charge de la colique hépatique varie selon trimestre de grossesse. Une approche chirurgicale est préférable au cours des 2 premiers trimestres, mais son rôle est moins clair pour le troisième trimestre. L'approche non chirurgicale pour chacun de ces problèmes de santé peut comporter une morbidité maternelle significative et une morbidité fœtale potentielle. Le recours à la chirurgie pour l'obstruction intestinale est déterminé au cas par cas. Une approche laparoscopique est toujours à privilégier si possible.

Conclusion : Les établissements qui ont un service d'obstétrique et les équipes chirurgicales doivent impérativement adopter une approche rigoureuse face à des personnes enceintes nécessitant une intervention en chirurgie générale. Le traitement doit équivaloir à celui qui est destiné aux personnes non enceintes, moyennant certaines considérations et modifications importantes. Les modalités non chirurgicales ou un retard à les appliquer augmentent souvent le risque de complications obstétricales, y compris un risque de mortalité.

When pregnant patients develop nonobstetrical surgical conditions, it can be a challenging and intimidating experience for both the patient and surgeon. Initially, establishing a diagnosis can be difficult, as the history, physical exam, and common laboratory values are all affected by the pregnant state.[1–6] For example, symptoms of surgical disease such as abdominal pain, bloating, and nausea are common during pregnancy.[1] Additionally, the gravid uterus alters the location of the intra-abdominal organs, which complicates the physical exam.[1,2,7] Normal laboratory values, such as the leukocyte count, change throughout the course of pregnancy.[1,8] Finally, many surgical diagnoses are made with, or at least supported by, cross-sectional imaging. However, providers are often hesitant to order imaging with ionizing radiation for pregnant patients owing to concerns that it may affect fetal development.[9–11] Perhaps because of these factors diagnostic delay is common in pregnant patients, which can have significant harmful effects on the patient and fetus.[12–14] In fact, pregnant patients with appendicitis, cholecystitis, or bowel obstructions tend to have worse outcomes than nonpregnant patients with these conditions.[5,10,15–19]

Even once the diagnosis is established, management decisions are not straightforward. Prescribing must be done carefully, with the goal to avoid medications that are harmful to the developing fetus when possible. Determining whether to offer operative intervention requires thoughtful comparison of the risks of surgical and nonsurgical management. Surgery during pregnancy has been associated with premature birth, low birth weight, neonatal complications, and longer hospital stays.[20–23] However, diseases that commonly prompt surgery, including appendicitis and cholecystitis, also increase the risk of adverse pregnancy outcomes,[24–26] so establishing causality is challenging. Nonoperative or delayed operative management is often far riskier to the pregnant patient and fetus.[14,18,27–36] Ultimately, the decision to operate must be made thoughtfully by surgeons, obstetricians, maternal-fetal medicine specialists, and patients in a shared decision-making process.

The literature guiding decision-making practices in pregnant patients with surgical disease comprises mostly small, retrospective studies. Still, it is incumbent on surgeons who care for this high-risk population to use the best available evidence and guidelines to provide the highest-quality care. As such, we sought to compile a summary of relevant studies and guidelines for the management of pregnant patients with emergency general surgery (EGS) conditions.

Methods

We performed a scoping review using an OVID Medline search, as outlined in Appendix 1, available at www.canjsurg.ca/lookup/doi/10.1503/cjs.001124/tab-related-content. This process identified 8199 articles. Duplicates were removed. Four of us (G.S.-G., A.N., D.H., and L.R.) performed title and abstract screening. Studies were included if they were published after 2000; were composed in English; and assessed the diagnosis or management of acute appendicitis, benign biliary disease, or small/large bowel obstruction in pregnant patients. We selected the year 2000 as a cut-off point given the emergence of laparoscopic treatment for many of the diseases around that time. The same 4 authors performed full-text review of 758 studies. We excluded 311 studies as outlined in Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), leaving 447 articles included in the review (Appendix 1).

Results

General considerations for pregnant patients undergoing nonobstetrical surgery

There are several general considerations when caring for pregnant patients with surgical disease. General considerations are summarized in this section and in Figure 1, and we summarize the latest literature guiding surgical management of the most common EGS diseases — appendicitis, benign biliary disease, bowel obstruction, and hemorrhoids — in the sections that follow.

Imaging

Owing to the risks of ionizing radiation on the developing fetus, the choice of imaging modality for pregnant patients should be considered carefully.[9,24,25,37] Ultrasonography and magnetic resonance imaging (MRI) without gadolinium should be used as first-line options.[9,38–49] If ionizing radiation studies are required, consideration should be given to the dose of radiation and the gestational age of the fetus.[9,50] In general, the dose of ionizing radiation from a single diagnostic imaging study is below that associated with fetal harm, as fetal risks (e.g., growth restriction, anomalies, intellectual disability) have not been associated with radiation exposures of less than 50 mGy.[10,11] Plain film abdominal radiography provides a fetal dose of 0.1–3.0 mGy of radiation.[11] If higher-dose examinations are required (e.g., abdominal or pelvic computed tomography [CT], which carry fetal doses of 1.3–35 mGy and 10–50 mGy, respectively), consultation with a radiologist is recommended, as low-dose protocols exist that can achieve adequate images to confirm the diagnosis while minimizing fetal radiation exposure.[11,50] Pregnant patients should not be denied medically indicated imaging because of concerns about radiation exposure.[9,51]

Preoperative planning

If nonobstetrical surgery is indicated, an obstetrical care provider should be included on the care team to

optimize the safety of the procedure for both the pregnant patient and fetus, particularly in the second and third trimesters.[25,52] In viable pregnancies (after 23–24 weeks' gestation), if obstetrical services are not available locally, providers should consider transfer on a case-by-case basis to a centre with obstetric or maternal-fetal medicine services. If transfer is not feasible, or if the associated delay in management is likely to harm the pregnant patient or the fetus, care should be provided locally with support from regional experts, as available.

Timing of surgery

Traditionally, early second trimester was considered the optimal time for surgical procedures for several reasons. The risk of preterm delivery was thought to be lowest, and the gravid uterus was not so large that it impaired the surgeon's visualization.[53,54] Additionally, avoiding surgery during the first trimester minimizes exposure of the fetus to anesthetic agents during organogenesis, although modern anesthetic agents are not thought to have teratogenic effects in humans.[10,24,55] Some evidence has linked surgery in the third trimester to a higher risk of preterm delivery and low-birth-weight infants.[56] However, modern series have shown that surgery can be performed safely in any trimester[24,57] and that maternal complications are rare.[58,59] Thus, elective surgery should be deferred to the postpartum period whenever possible, but urgent and emergent surgery should not be delayed, regardless of gestational age.[24,25,60]

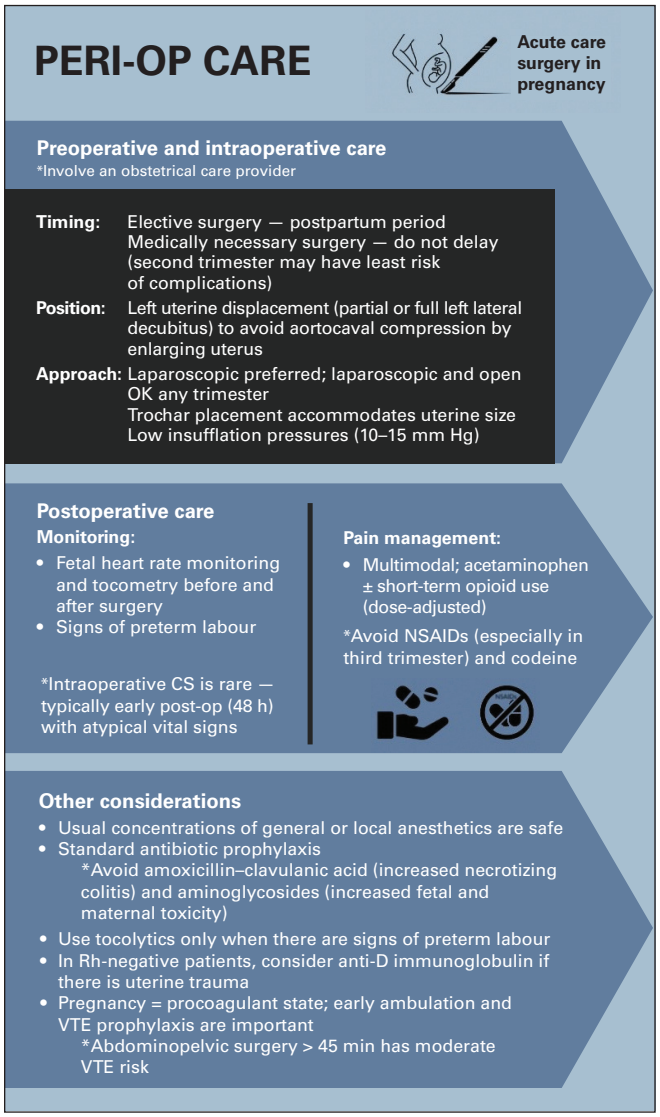

Fig. 1. Summary of recommendations for perioperative and intraoperative care of pregnant patients with nonobstetrical surgical disease. CS = Cesarean section; NSAIDs = nonsteroidal anti-inflammatory drugs; peri-op = perioperative; post-op = postoperative; VTE = venous thromboembolism.

Anesthesia

When a general anesthetic is required, considerations should include an airway assessment, premedication for aspiration prophylaxis, optimization of patient position, preoxygenation, and a structured approach to securing the airway.[55] Notably, the likelihood of difficult endotracheal tube placement is substantially increased during pregnancy; Mallampati scores, which are used to predict difficulty of intubation, increase as pregnancy progresses.[61,62] Further, the risk of failed intubation is 8-fold higher in pregnant patients than in the general population.[63]

There is no evidence that commonly used anesthetic agents, including barbiturates, propofol, benzodiazepines, opioids, and ketamine, have a teratogenic effect at usual concentrations; therefore, the type of anesthetic agent should be chosen based on usual indications.[10,55] Use of both volatile halogenated agents with minimum alveolar concentration (< 1%) and local anesthetics at usual concentrations are considered safe.[55] Additional in-depth considerations of anesthetic management and techniques in pregnant patients have been described.[55]

Surgical approach and positioning

When feasible, a laparoscopic approach is preferred in pregnant patients requiring abdominal surgery,[24,64–66] as it is associated with shorter length of stay, less postoperative pain, reduced narcotic requirements, and fewer complications (including blood transfusion, wound complications, and thromboembolic events).[24,67,68] According to the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), laparoscopy can be performed safely in any trimester without increased maternal or fetal risks.[24] Some studies contradict this position, and are summarized in the sections that follow. Notably, laparoscopy may not be feasible in the third trimester owing to the size of the gravid uterus.[24,25]

As gestation progresses beyond the first trimester, the enlarging uterus can compress the inferior vena cava when the patient is supine, which can reduce venous return, cardiac output, and placental perfusion. Left uterine displacement should occur in the supine position, or a wedge

under the patient's right hip (partial or full left lateral decubitus position) can be used to avoid aortocaval compression where suitable for the associated procedure.[24,69–71] Additionally, trochar placement should be adjusted to accommodate uterine size. Intraperitoneal insufflation pressures should be as low as possible (target 10–15 mmHg) to balance worsening maternal respiratory physiology with adequate surgical visualization.[24,70] Fetal acidosis secondary to CO_2 pneumoperitoneum has been noted in animal studies, and maternal CO_2 monitoring with end-tidal carbon dioxide is recommended.[24] Hemodynamic changes during laparoscopy, such as decreased cardiac output, are similar in pregnant and nonpregnant patients.[72]

Fetal monitoring

In pre-viable pregnancies, typically before 23–24 weeks of gestational age, fetal viability should be confirmed and documented with fetal Doppler ultrasonography before and after the nonobstetrical surgery procedure.[24] In viable pregnancies, fetal heart rate (FHR) monitoring with tocometry performed before and after the procedure is considered the current standard of care.[24] Continuous intraoperative FHR monitoring in viable fetuses is recommended by the American College of Obstetricians and Gynecologists,[25] but in practice is controversial for numerous reasons.[73] First, it can be technically challenging to perform the procedure with an appropriately placed fetal ultrasound transducer. In addition, interpretation of the FHR requires expertise in maternal general anesthesia, as adverse patterns in labour and delivery (including loss of beat-to-beat variability) can be expected and could be inappropriately interpreted as abnormal.[73] When proceeding with intraoperative continuous FHR monitoring, multidisciplinary planning with the surgeon, obstetrician, and anesthesiologist should occur. Intraoperative FHR monitoring should be performed only with a viable fetus in situations when the primary procedure can be interrupted for delivery, and when an obstetric care provider is available to perform an emergency cesarean section (CS) in response to an abnormal FHR tracing. Appropriate patient consent is essential. Intraoperative CS is rarely performed unless the patient is in extremis, as the fetus will be in distress as well. Typically, if delivery is indicated, it is performed within the early postoperative period (within 48 hours) or in patients with abnormal vital signs.[74]

Antenatal corticosteroids and tocolytics

Patients should be monitored for signs and symptoms of preterm labour, and FHR monitoring and tocometry should be performed before and after the procedure. After appropriate counselling, administration of antenatal corticosteroids should be considered in patients with a viable fetus (approximately 23–24 weeks' gestation) until 33 weeks plus 6 days' gestation, if there is high risk of preterm birth in the next 1–7 days.[25,75] Antenatal corticosteroids are associated with reduced perinatal morbidity and mortality in infants born preterm, particularly in those born earlier than 34 weeks' gestation. However, the benefits of administration in late preterm infants must be balanced with the risk of neonatal hypoglycemia and potential impact on neurodevelopmental outcomes.[75] Tocolytics should not be used prophylactically, but should be administered in patients with signs of preterm labour.[24]

Antibiotics

Antibiotic surgical prophylaxis and treatment should be given when recommended for usual indications, with consideration of antibiotic safety in pregnancy.[76] Standard antimicrobial prophylaxis (cephalosporins, penicillins, macrolides) can be used safely.[77] Amoxicillin–clavulanic acid should be avoided owing to the increased risk of necrotizing enterocolitis.[78] Aminoglycosides are associated with a risk of fetal and maternal ototoxicity and nephrotoxicity, but are considered relatively safe and are used when indicated.[79] Table 1 summarizes commonly prescribed medications by general surgeons and their safety during pregnancy.

Pain control

As in the nonpregnant population, multimodal analgesic strategies are essential for pregnant patients with surgical disease.[80] Acetaminophen in the usual dose should be used as the first-line agent for acute postoperative pain control in pregnant patients at any gestational age.[81] Nonsteroidal anti-inflammatory drugs (NSAIDs) should be avoided, particularly in patients of advanced gestational age, owing to the risk of oligohydramnios, premature closure of the ductus arteriosus, and necrotizing enterocolitis.[82,83]

Short-term use of opioids is generally considered acceptable, although multimodal strategies are essential to reduce opioid requirements.[84] Opioid use during pregnancy is common, with more than 20% of pregnant patients filling a prescription.[85] Opioids readily cross the placenta,[86] and in utero exposure has been associated with fetal–neonatal respiratory depression, increased rates of neonatal hospitalization and health care utilization, decreased executive function, and behavioural problems.[87–89]

Table 1. Summary of commonly prescribed medications in general surgery and their safety in pregnancy

Medication	Safe in pregnancy	Avoid in pregnancy
Analgesia	Acetaminophen, opioids*	NSAIDs, codeine†
Antibiotics	Cephalosporins, penicillins, macrolides, aminoglycosides	Amoxicillin–clavulanic acid, doxycycline
Anticoagulants	LMWH	Warfarin, DOACs
Antiemetics	Dimenhydrinate, ondansetron	

DOAC = direct oral anticoagulant; LMWH = low-molecular-weight heparin; NSAID = nonsteroidal anti-inflammatory drug.
*Ideally used only in the short term.
†Avoid in late pregnancy.

Codeine is typically avoided in late pregnancy and the postpartum period owing to concerns regarding metabolism in neonates, although recent studies suggest that it can be prescribed safely.[90,91] Importantly, opioid metabolism may be increased by metabolic changes in pregnancy; thus, pregnant patients may require increased dose or frequency.[92]

The American College of Obstetricians and Gynecologists recommends universal screening for opioid use disorder (OUD), minimizing the use of opioids with alternative strategies, prescribing opioid agonist pharmacotherapy for pregnant patients with OUD, and continuing this therapy during breastfeeding.[84] They also recommend monitoring infants for neonatal abstinence syndrome, a withdrawal syndrome experienced by opioid-exposed neonates that may present with irritability, exaggerated reflexes, sleep disturbances, poor feeding, or respiratory distress.[84,93]

Venous thromboembolic prophylaxis

Given the pro-coagulant state attributable to pregnancy and the increased risk of deep vein thrombosis and pulmonary embolism, perioperative venous thromboembolic (VTE) prophylaxis should be considered.[24,94,95] Use of intraoperative and postoperative pneumatic compression devices along with early ambulation is recommended,[24,70] and pharmacologic prophylaxis should be individualized based on patient risk factors.[95] Abdominopelvic surgery (either laparotomy or laparoscopy) exceeding 45 minutes places pregnant patients at moderate risk for VTE (Caprini Risk Score of 3–4[96]), and pharmacologic prophylaxis is indicated.[95] Unfractionated or low-molecular-weight heparin (LMWH) are considered safe and the agents of choice during pregnancy.[24,97,98] Treatment with LMWH should be continued for a minimum of 3 months and for at least 6 weeks postpartum.[98] Warfarin is generally avoided during pregnancy as it crosses the placenta and is a known teratogen.[99] As such, it can cause major congenital malformations and increase the risk of spontaneous pregnancy loss.[99] Data regarding the use of direct oral anticoagulants (DOACs) during pregnancy are relatively scarce. Inadvertent DOAC exposure has been associated with a 1%–2% risk of embryopathy,[100,101] so pregnant patients should avoid DOACs.[98,99]

Rhesus blood type

Rhesus (Rh) D–negative individuals are at risk for developing anti-D antibodies if they become exposed to D-positive red blood cells.[102] Subsequent RhD-positive fetuses/neonates are then at risk for hemolytic disease, which can cause serious morbidity or death.[102] Any surgery involving risk of uterine trauma should include consideration of anti-D immune globulin if the patient is Rh negative.[103]

Iatrogenic injury

Intraoperative injury to the gravid uterus is a rare complication and should be managed on a case-by-case basis with intraoperative obstetrical and/or maternal-fetal medicine consultation. The literature on uterine injury consists mostly of case reports,[104–106] but can be extrapolated from operative fetoscopy procedures. Risks can include preterm prelabour rupture of membranes (pPROM), preterm delivery, fetal injury, and fetal loss.[105] In general, uterine lacerations should be managed conservatively and should be sutured only to obtain hemostasis. Postoperatively, patients should undergo ultrasonography to confirm fetal viability and assess for fetal injuries and amniotic fluid volume, and they should be monitored carefully for postoperative complications.[104] Major uterine bleeding is rare but may require conversion to laparotomy for control.[107]

Appendicitis

Acute appendicitis is the most common surgical emergency during pregnancy, with an incidence estimated between 1 in 500 and 1 in 2000 pregnancies.[1,2,52,108–116] Appendicitis is diagnosed most frequently in the second trimester and less commonly in the third trimester.[2,109,117–119] Similar in pregnant and nonpregnant patients, the pathophysiology of appendicitis involves appendiceal lumen obstruction by a fecalith, lymphatic hypertrophy, or malignancy, leading to bacterial overgrowth and acute inflammation.[1,120] Occasionally, ectopic endometrial tissue can cause a similar obstruction during decidualization, leading to appendicitis.[121–125] A few simultaneous cases of acute appendicitis and ectopic pregnancy have been reported, although no causal link has been identified.[126–132] Important considerations in pregnant patients are summarized in Figure 2.

Diagnosis

Diagnosing appendicitis can be very challenging in pregnant patients,[2,133–142] as they frequently experience lower abdominal pain,[143] which has a broad differential diagnosis.[1] In pregnancy, pain associated with appendicitis most often localizes to the right lower quadrant,[144,145] although it can manifest anywhere in the abdomen.[146–148]

The gravid uterus may displace the inflamed appendix, and most studies report that the appendix is found less frequently in the right lower quadrant as pregnancy progresses.[7,149–153] One study found no change in appendix position.[154] Fever is not reliably associated with infection in pregnant patients.[147,155] Thus, history and physical exam findings may not be classic in pregnant patients with appendicitis.

Blood work is another important part of the evaluation of pregnant patients with abdominal pain. Elevated white blood cell (WBC) count, neutrophil:lymphocyte ratio, platelet:lymphocyte ratio, and bilirubin have been associated with appendicitis in pregnancy.[156–161] However, leukocytosis as high as 16 000 cells/μL may be a normal finding in pregnancy, and values tend to increase in later trimesters.[8,147,162] Other inflammatory markers, such as C-reactive

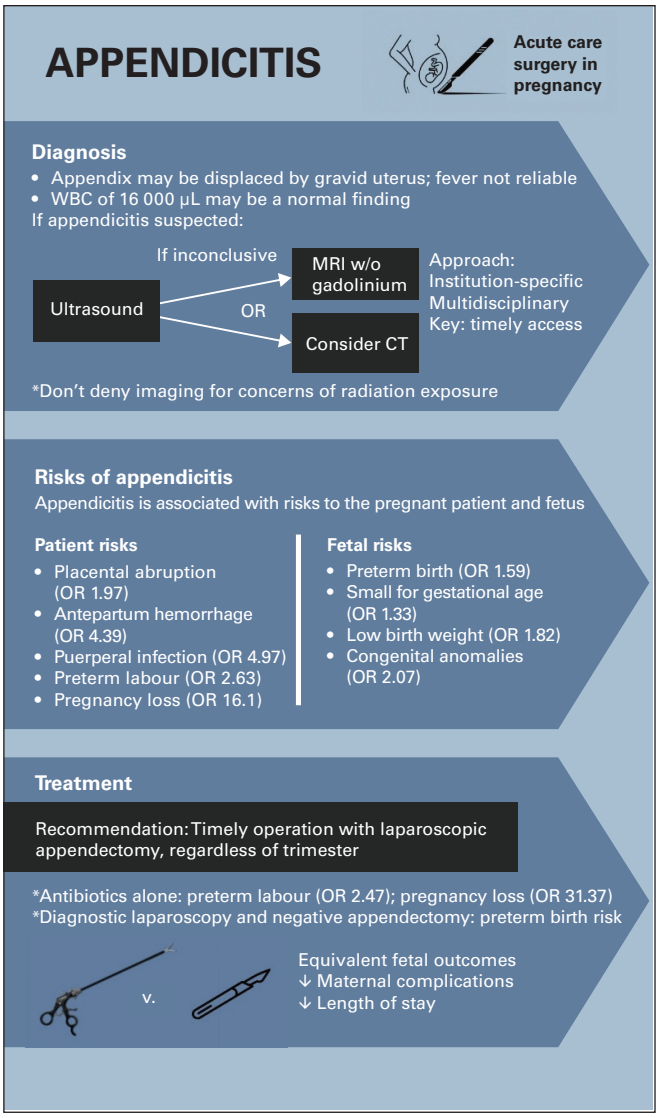

Fig. 2. Summary of recommendations for pregnant patients with appendicitis. CT = computed tomography; MRI = magnetic resonance imaging; OR = odds ratio; WBC = white blood cell count.

protein and platelet-related markers, have been investigated to aid in the diagnosis of acute appendicitis in pregnancy,[163–165] but currently do not have clearly established utility in making this diagnosis.

Clinical models have been developed to help clinicians predict whether a pregnant patient has appendicitis[166] and, if so, the likelihood of perforation.[167,168] The Alvarado score is accurate in pregnancy;[169] however, among all scoring systems, the Tzanakis scoring system has the highest positive predictive value.[170,171]

Imaging is another important adjunct for the diagnosis of appendicitis. When appendicitis is considered, the initial study should usually be ultrasonography with graded compression views of the right lower quadrant, starting at the point of maximal tenderness.[9,38,172–174] Ultrasonography is user dependent and often inconclusive when evaluating for appendicitis;[175,176] thus, some studies have advocated for use of MRI for all pregnant patients with a physical examination suggestive of appendicitis.[177–182] Ultrasonography has a sensitivity of 28%–100% and specificity of 33%–92%,[175,176,183–191] with decreasing sensitivity in later trimesters.[192] When inconclusive, additional imaging such as MRI without gadolinium[193–198] or, if MRI is not available, CT should be performed.[9,199–203] The sensitivity and specificity of CT and MRI for appendicitis in pregnancy approaches 100%[204–221] and identifies appendicitis in 8.6% of normal ultrasounds.[206] Abbreviated MRI protocols have demonstrated excellent diagnostic accuracy.[222] The routine use of MRI decreases the negative appendectomy rate by almost 50%.[223,224] Tagged WBC scans have not been shows to be effective at diagnosing appendicitis in pregnant patients.[225]

It is crucial that institutions have operational strategies when substantial suspicion for appendicitis remains, despite an inconclusive ultrasound.[226–228] In 1 study, pregnant patients with equivocal ultrasounds received MRI, followed by CT if the MRI was not definitive; this sequential multimodality imaging algorithm had a sensitivity of 100% and a specificity of 98% for the diagnosis of appendicitis.[229] Another group admitted and carefully observed pregnant patients with high suspicion for appendicitis.[230] If the patients deteriorated clinically or biochemically, they received diagnostic laparoscopy with appendectomy, if indicated. Stable patients underwent repeat ultrasonography after 12–24 hours. This strategy conferred no additional maternal or fetal morbidity in 225 patients.[230] The ideal strategic algorithm for managing pregnant patients with equivocal ultrasounds is likely highly specific to individual institutions and should consider the expertise and availability of local surgeons, obstetricians, and radiologists.

Lastly, patients should be informed that the diagnosis of appendicitis, regardless of management, carries risk for both the pregnant patient and fetus.[27] Pregnant patients with appendicitis are more likely to experience fetal loss (odds ratio [OR] 2.05) or to die (OR 4.04).[231] Another study demonstrated a 5-fold higher rate of pregnancy loss with appendicitis.[232] One population-level study showed that appendicitis increased the risk of preterm labour from 4.4% to 10.4% and that of spontaneous pregnancy loss from 0.4% to 6.2%.[18] The risk of preterm labour may be especially increased when appendicitis is diagnosed in the third trimester (OR 1.65).[233] Acute appendicitis is also associated with increased risk of low birth weight (OR 1.82), small for gestational age (OR 1.33), preterm birth (OR 1.59), and congenital anomalies (OR 2.07).[17] Patients with appendicitis may be more likely to require urgent CS.[234] Factors such as hypertension, anemia, and advanced age are associated with spontaneous pregnancy loss and increased risk of preterm labour among pregnant patients with appendicitis.[235] Despite these pregnancy risks, there do not seem to be long-term complications for the developing child.[236]

Treatment

As in the nonpregnant population, options for the definitive management of appendicitis in pregnancy include laparoscopic appendectomy, open appendectomy,[237,238] or antibiotics alone.[18,235,239–246] When open surgery is performed, an incision over the McBurney point will facilitate localization of the appendix.[247] There is a single case report of endoscopic management of appendicitis in a pregnant patient.[248] Over the past 20 years, there has been a substantial decrease in the number of open appendectomies performed on pregnant patients and a concomitant increase in the number of patients managed with antibiotics alone.[235] In fact, nonoperative management is more common in pregnant than nonpregnant patients.[249]

One study found similar rates of fetal loss between patients treated surgically or with antibiotics alone; thus, the authors concluded that nonoperative management with antibiotics was safe.[109] Another showed no difference in gestational age at delivery, mode of delivery, birth weight, or Apgar scores among the infants of patients treated with antibiotics compared with those of patients treated with surgery.[250] Multiple other studies refute this claim. In more than 33 000 pregnant patients, nonoperative management increased preterm labour (OR 3.1), with each day of delay associated with significantly increased rates (OR 1.2).[251] Similarly, another study showed that each day of delay to surgery was associated with an increase in the odds of preterm delivery, preterm labour or spontaneous pregnancy loss by 23%.[252] In more than 7000 pregnant patients with appendicitis, management with antibiotics alone was associated with increased risk of shock, peritonitis, and VTE.[27] Another study with more than 800 patients reported that antibiotics alone led to the highest rates of preterm labour (OR 2.47) and pregnancy loss (OR 31.37), with a miscarriage rate of 11.5%.[18] Based on this, timely operative management of appendicitis is recommended in multiple guidelines.[24,25,94,253]

The risk of appendiceal rupture increases with time from symptom onset,[13,246,254] and numerous studies have linked appendiceal perforation to fetal morbidity and mortality.[14,20,29,254,255] Among patients with a perforated appendix, preterm delivery was nearly 5-fold higher, and fetal demise was 25% compared with 1.7% in nonperforated appendicitis.[29,255,256] More than half of patients with perforated appendicitis experienced a perioperative issue such as preterm labour, wound infection, sepsis, or spontaneous pregnancy loss.[14] Of note, the incidence of perforation increases in later trimesters, perhaps owing to challenges in establishing the diagnosis.[257] The likelihood of perforation also increases with advanced gestational age.[258] Irrespective of perforation, time to surgical management is important, as postoperative complications increase (OR 4.8) when symptoms last longer than 48 hours before surgery.[259]

In nonpregnant patients, perforated appendicitis with phlegmon is treated with antibiotics and observation.[260] Abscesses are evaluated for percutaneous drainage if they are large enough and accessible.[260,261] Unstable pregnant patients, or those with diffuse peritonitis, require surgical treatment.[262] The literature guiding management of abscess and phlegmon in pregnant patients is sparse; thus, treatment decisions must be extrapolated from experience with nonpregnant patients.[1]

Negative appendectomy

Given that diagnostic uncertainty is common in pregnant patients, diagnostic laparoscopy is often recommended in cases of suspected appendicitis. The negative appendectomy rate is typically found to be higher than in the general population,[20,263–265] although a few studies found no difference.[266–269] A large, retrospective population-level study evaluated more than 3000 pregnant patients who underwent appendectomy between 1995 and 2002. Among the patients with a negative appendectomy (n = 725), the risk of fetal loss and early delivery doubled.[20] A more recent study evaluated 225 laparoscopic appendectomies in pregnant patients and found lower birth weights and higher risk of small-for-gestational-age infants associated with negative appendectomy.[21] A case series from Nigeria found increased preterm delivery and fetal loss in the negative appendectomy group.[270] These studies suggest that surgery and/or anesthesia may be harmful to patients who don't have appendicitis. They argue for more stringent diagnostic certainty before surgery, including the use of additional imaging, if necessary.[223,271]

Laparoscopic versus open appendectomy

Laparoscopic appendectomy has been recommended as the treatment of choice for acute appendicitis, regardless of trimester.[24,94] Some small observational studies initially raised concerns about the use of laparoscopic appendectomy in pregnancy.[20,272,273] Meta-analyses of studies from the 1990s and early 2000s found increased fetal loss in the laparoscopic group.[274–276] However, the majority of studies comparing laparoscopic versus open appendectomy during pregnancy report improved outcomes for pregnant patients, and at least equivalent outcomes for the fetus.[15,18,54,235,276–337] More recent meta-analyses reported that laparoscopic appendectomy decreased length of stay in hospital and wound infection rates and that rates of preterm delivery and other obstetrical complications were similar.[277,284,286] A large retrospective cohort study of more than 10 000 pregnant patients with appendicitis found that laparoscopic appendectomy decreased the risk of preterm labour (OR 0.6) compared with open appendectomy.[235] A similar study looking at more than 800 patients found a greater than 2-fold reduction in preterm labour among the laparoscopic appendectomy group as well as decreased length of stay in hospital (5.5 d v. 3.8 d).[18] Overall, meta-analysis has shown that laparoscopic appendectomy during pregnancy is associated with fewer complications and shorter hospital stays than open appendectomy.[338]

Benign biliary disease

Disorders of the biliary tract are the second most common cause of nonobstetrical surgery in pregnant patients, with an incidence of 0.05%–2.9%.[16,339–343] Biliary colic represents 76% of benign biliary disease diagnosed during pregnancy, while complicated biliary disease, such as acute cholecystitis, choledocholithiasis, and gallstone pancreatitis, makes up the remainder.[344] During pregnancy, increased estrogen and progesterone levels encourage gallbladder stasis and biliary cholesterol hypersecretion,[345] which contributes to the increased incidence of gallstone formation in pregnancy.[344–347] The incidence of gallstones in pregnancy is 2%–6%, with sludge present in 10%–31% of cases.[347,348] Patient factors associated with risk of developing gallstones or sludge include increasing body mass index (BMI),[348] high carbohydrate intake,[349] and increased parity.[345,350] Ethnicity also affects risk; for example, Indigenous people experience a significantly higher incidence of gallstones.[351] Interestingly, vigorous exercise may not decrease incidence of gallstones.[352]

Benign biliary disease is associated with adverse obstetrical outcomes such as preterm delivery (relative risk [RR] 1.3), pregnancy loss,[19,26,353] and neural tube defects.[354] Gallstone disease also increases risk of maternal morbidity (RR 1.6), and maternal readmission (RR 4.7).[19] Patients with complicated biliary disease have an even higher risk of adverse pregnancy outcomes than those with biliary colic (7.4% v. 2.3%).[355] These outcomes include sepsis (OR 1.4), deep vein thrombosis (OR 8.7), and even bowel obstruction (OR 1.3).[356] Unfortunately, there are no data that predict whether a pregnant patient with biliary colic will develop complicated biliary disease. In the general population with biliary colic, 20% ultimately develop acute cholecystitis,[357] 20% develop choledocholithiasis,[358] and 3%–8% are eventually diagnosed with gallstone pancreatitis.[359] General recommendations regarding benign biliary disease are summarized in Figure 3.

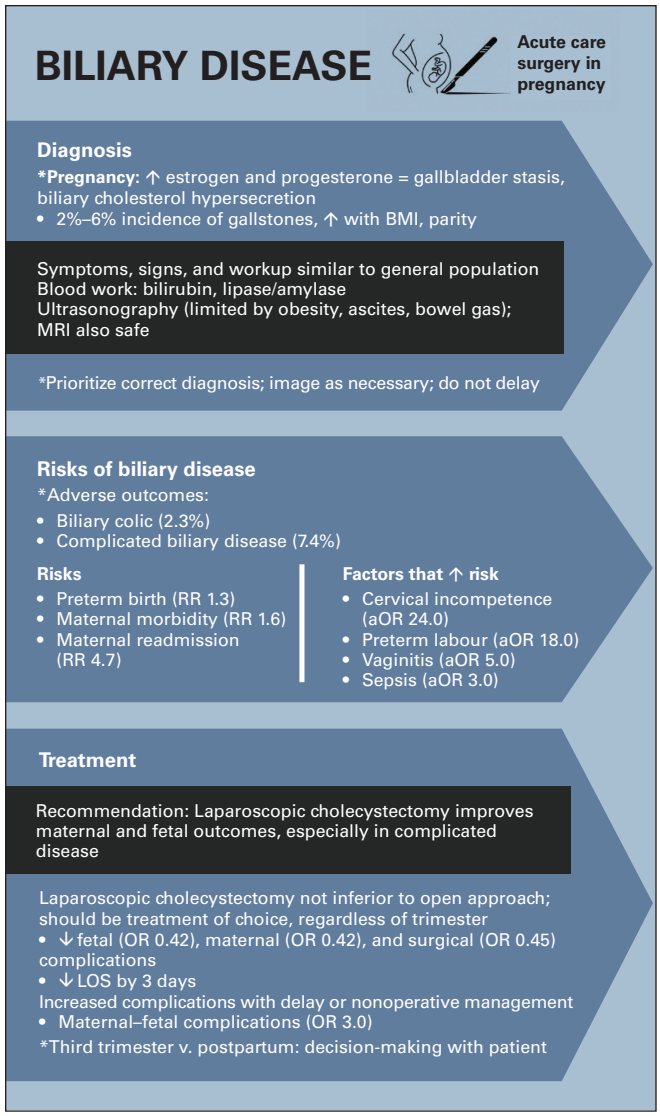

Fig. 3. Summary of recommendations for pregnant patients with benign biliary disease. aOR = adjusted odds ratio; BMI = body mass index; LOS = length of stay; MRI = magnetic resonance imaging; OR = odds ratio; RR = relative risk.

Diagnosis

The signs and symptoms of benign biliary disease in pregnancy are similar to those seen in the general population.[360,361] For example, intermittent postprandial right upper quadrant and/or epigastric pain is typical of biliary colic.[360] Fever, anorexia, and vomiting are more frequently seen with acute cholecystitis.[361]

Patients presenting with biliary symptoms require further investigation with laboratory studies and appropriate imaging. Total or direct bilirubin and γ-glutamyl transferase are used to identify bile duct obstruction, which occurs in choledocholithiasis among other diseases.[362] As in the general population, ultrasonography is the initial imaging modality of choice.[363,364] The sensitivity of ultrasonography is nearly 100% for gallstones and 95% for acute cholecystitis.[365] When an ultrasound is inconclusive, MRI can be used to diagnose benign biliary disease, although its sensitivity and specificity are unknown in pregnancy.[366,367] Endoscopic ultrasonography has also been described as a method of diagnosing choledocholithiasis in pregnant patients.[368]

Treatment

In the general population, benign biliary disease is treated with cholecystectomy in surgically fit patients.[369] One group demonstrated increased adverse birth outcomes (OR 3.46) with operative management; however, patients in that study who received an operation were more likely to have complicated biliary disease.[354] The vast majority of studies indicate that surgical management of benign biliary disease substantially improves maternal and fetal outcomes.[19,28,30–33,370,371]

Despite this, most biliary disease in pregnancy is managed nonoperatively, with only 7.5%–40% of patients receiving cholecystectomy.[28,30–33,372] Several reports have demonstrated that cholecystectomy is safe in pregnancy, and laparoscopic cholecystectomy is not associated with worse outcomes than open cholecystectomy.[34,308,373–379] A meta-analysis comparing laparoscopic and open cholecystectomy including more than 10 000 pregnant patients demonstrated that laparoscopic cholecystectomy decreased fetal (OR 0.42), maternal (OR 0.42), and surgical (OR 0.45) complications, and decreased length of stay by 3 days.[380] Notably, 1 study reported higher rates of surgical (19% v. 10%), maternal (9% v. 4%), and fetal (11% v. 5%) complications among pregnant patients with biliary disease treated laparoscopically.[16] However, the study included data from the 1990s, and important technical and anesthetic advances have been made since then. Additional treatment modalities, such as robotic cholecystectomy and appendectomy, may become feasible strategies in the coming years. However, currently there are no established data to support the safety or efficacy of robotic approaches for pregnant patients with benign biliary disease or other EGS conditions.

Cholecystectomy during the third trimester

Modern guidelines state that laparoscopic cholecystectomy is the treatment of choice in pregnant patients with symptomatic gallbladder disease, regardless of trimester.[24] Still, the role of laparoscopic cholecystectomy in the third trimester remains rigorously debated. Smaller series have suggested that it is a safe procedure;[224,374–378] yet, a study of 819 pregnant patients found that cholecystectomy in the third trimester was associated with a higher rate of preterm delivery (OR 7.20) and overall maternal and fetal complications (OR 2.78).[369] Two recent population-level retrospective studies sought to provide clarity to this discussion.

A statewide database study from California compared laparoscopic cholecystectomy performed in the third trimester (n = 403) to that performed in the 3 months immediately postpartum (n = 17 490).[380] Patients receiving their surgery during pregnancy were more likely to require hospitalization (85% v. 63%).[380] The risk of eclampsia, antepartum hemorrhage, or preterm delivery was increased (OR 1.88), as was the length of stay (3 d v. 1 d). The authors concluded that, whenever possible, laparoscopic cholecystectomy should be delayed until the postpartum period.[380]

A study conducted in New York during the same time frame also compared pregnant patients who underwent cholecystectomy in the third trimester (n = 82) to those who had surgery within 3 months of delivery (n = 5040).[381] This study reported no difference in outcomes including preterm delivery, hemorrhage, and CS, although there was an increased length of stay among pregnant patients. The authors concluded that laparoscopic cholecystectomy in the third trimester was safe, but encouraged discussion with patients.[381]

Delayed treatment

Many treatment algorithms have been proposed based on the trimester of diagnosis. One group advocates for delaying management of disease diagnosed in the first trimester to the second trimester, operating on patients diagnosed in the second trimester, and delaying surgery to the early postpartum period for those diagnosed in the third trimester.[382] However, maternal morbidity with delayed treatment of biliary disease is significant. Delayed operative management is common, and patients waiting for surgery are frequently symptomatic, often requiring hospital admission.[31–34] Nonoperative management is associated with a nearly 25% chance of readmission and double the risk of preterm delivery.[35] Conversely, timely operative management gains 2 quality pregnancy weeks per patient on average.[383]

Complicated biliary disease

Complicated biliary disease, including cholecystitis, choledocholithiasis, and pancreatitis, confers especially increased maternal and fetal risk when managed nonoperatively.[28,30,384] A retrospective analysis found that only 17.9% of patients with complicated disease had antepartum cholecystectomy. Among the others, 58.6% had recurrent symptoms, 35% of which presented within 1 month.[384]

A study of more than 6000 pregnant women with acute cholecystitis showed that the odds of maternal-fetal complications, including intrauterine death/stillbirth, poor fetal growth, pregnancy loss, and preterm delivery, were 3 times greater in pregnant patients treated nonoperatively.[30] A study of almost 24 000 pregnant patients with acute cholecystitis found that laparoscopic cholecystectomy lowered rates of preterm delivery, labour, and pregnancy loss by 60%. In fact, each day that surgery was delayed increased fetal complications by 20%.[28] In a series of 20 pregnant patients with acute cholecystitis, preterm labour was 28.5% in the group who received antibiotics alone compared with 0% in the group who received immediate surgery.[385]

Percutaneous cholecystostomy is an image-guided technique whereby a catheter is placed in the gallbladder with cholecystitis to allow for decompression.[386] This approach is generally not preferred in surgically fit patients; however, it results in resolution of cholecystitis approximately 90% of the time.[386] Percutaneous cholecystostomy has been safely used in pregnancy, including in the third trimester.[387–389] Laparoscopic common bile duct exploration has been performed in pregnant patients with choledocholithiasis with no fetal or maternal issues reported.[390–391] Endoscopic retrograde cholangiopancreatography (ERCP) has been performed safely in multiple studies of pregnant patients,[392–407] although the exact dose delivered to the fetus is unknown.[408,409] One series demonstrated adverse fetal outcomes in 3 of 5 patients treated with ERCP, possibly owing to radiation exposure.[410] However, several

studies have shown that ERCP can be done without radiation in pregnancy.[361,413–425] Percutaneous transhepatic common bile duct stone retrieval[426] and combined laparoscopic–endoscopic[427] approaches have also been described.

Pancreatitis

Pancreatitis occurs at similar rates in pregnant and nonpregnant patients, affecting 0.2 to 2.2 per 1000 pregnancies.[428–430] Of these, 0%–29% occur in the first trimester, 4.8%–63.6% in second trimester, and 27.3%–95.2% in the third trimester.[431,432] The most common cause of pancreatitis in pregnancy is gallstones, followed by hypertriglyceridemia.[429,433,434] Alcohol is a common cause of pancreatitis in the general population but is rare in pregnancy, with a prevalence of only 0%–16%.[434] Pancreatitis is associated with maternal risks including multiorgan failure, acute respiratory failure, VTE, disseminated intravascular coagulation, preeclampsia, postpartum hemorrhage, and death (0%–5.1%), as well as fetal risks including prematurity and fetal demise (3.6%–47%).[382,430,432–437] Maternal and fetal death are most common in the first trimester.[432]

In pregnancy, the presenting symptoms of pancreatitis — severe epigastric pain radiating to the back, nausea, and vomiting — are the same as in nonpregnant patients, but the differential diagnosis is broader.[431,436] Elevations of lipase or amylase of more than 3 times the upper limit of normal, with corresponding clinical symptoms or imaging findings, is diagnostic of pancreatitis.[436] Fortunately, these levels are not affected by pregnancy. To determine the etiology, liver enzymes, bilirubin, serum triglyceride levels, and abdominal ultrasonography are used.[436] If bilirubin is elevated, suggesting choledocholithiasis, magnetic resonance cholangiopancreatography (MRCP) or endoscopic ultrasonography (EUS) can be performed if the diagnosis is not made on initial abdominal ultrasound.[424,436–438] Typically, MRCP is preferred as EUS requires sedation and is not universally available.[431,436]

Pancreatitis in pregnancy should be managed initially with fluid resuscitation, correction of electrolyte disturbances, multimodal analgesia, and antiemetics.[431,436] Fetal monitoring and, if required, transfer to a facility with surgical, obstetrical, and intensive care support is recommended.[436] Early enteral nutrition should be prioritized; however, it is less commonly used in pregnant patients, who are often started on parenteral nutrition.[382,431,433]

As discussed, ERCP with biliary clearance and sphincterotomy can be performed if common bile duct stones are present. One study of pregnant patients suggested that recurrent symptoms of choledocholithiasis or gallstone pancreatitis were less likely (38.5% v. 75%) when treated with ERCP and sphincterotomy.[384] Therefore, ERCP and cholecystectomy can be discussed with pregnant patients with gallstone pancreatitis, although these procedures are typically performed only with evidence of choledocholithiasis. Undergoing cholecystectomy during pregnancy following acute pancreatitis has been shown to reduce 30-day readmission.[439]

Pancreatitis rarely requires further intervention, except in the setting of necrotizing pancreatitis, which is uncommon in pregnancy.[433] A case series reported several patients undergoing laparotomy or percutaneous-guided necrosectomy, but all the patients were postpartum at the time of the procedure.[440] In another series, 12% of patients underwent laparotomy and 35% required percutaneous drainage during pregnancy.[441] Given the paucity of data on the management of necrotizing pancreatitis in pregnancy, surgeons must extrapolate from nonpregnant patients. Vaginal delivery is preferred over CS, when possible, in the setting of necrotizing pancreatitis to prevent super-infection.[382] Laparoscopic cholecystectomy should be considered on the same admission as in the general population.[442]

Bowel obstruction

In adults, small bowel obstructions (SBOs) constitute up to 15% of surgical admissions for acute abdominal discomfort.[443] Small bowel obstructions in pregnancy are rare, with an incidence of 1 in 17 000 deliveries.[444] They are more commonly diagnosed later in pregnancy[445,446] and are associated with an increased risk of fetal loss (17%), preterm delivery (45%), and maternal complications including death (2%).[447,448] Especially when associated with perforation, SBO can be life threatening to the pregnant patient and fetus.[449] Postoperative adhesions are the most common cause of SBO in pregnant patients, making up about 70% of cases.[442,447,449–452] Other causes include small bowel volvulus,[453] uterine fibroids,[454] inflammatory bowel disease,[455] intussusception,[456] ovarian pathology,[457] incarcerated hernia,[458–460] Meckel diverticulum,[461,462] or the gravid uterus itself.[463] There are also case reports of ileostomy obstruction by the gravid uterus managed with ileostomy drainage.[464,465]

Several authors have reported SBO secondary to internal hernia in pregnant patients who have previously undergone bariatric surgery.[466–482] Bariatric surgery is common, with more than 100 000 procedures taking place annually in the United States, most of which are Roux-en-Y gastric bypass.[483] Approximately 80% of patients undergoing bariatric surgery are women.[483] It is typically recommended that pregnancy be delayed for 12–18 months after bariatric surgery to maximize weight loss.[483] A national cohort study of pregnant patients found that SBO was significantly more likely in those who had undergone bariatric surgery (OR 34.4).[484] Another study showed that the risk was highest in the second and third trimester.[485]

Diagnosis

Small bowel obstruction may present atypically in pregnancy.[447] The diagnosis is made using a combination of

clinical signs, symptoms, and cross-sectional imaging.[486] A thorough history should include past surgical and endoscopic procedures, previous delivery modalities, and personal and family history of inflammatory bowel disease or malignancy. In nonpregnant patients, preferred diagnostic studies for SBO include radiography and CT.[443] Water-soluble radiographic contrast has been used in nonpregnant patients to identify those likely to require operative management.[11,24,440] It may also provide a therapeutic effect.[443,487] Fortunately, oral contrast agents are not absorbed and thus do not confer risk to the fetus.[11] Still, ultrasonography and MRI are the preferred modalities to diagnose intra-abdominal pathology in pregnancy and should be used whenever possible to diagnose SBO.[11,447,444,488–493] Magnetic resonance imaging has a sensitivity of 67% (confidence interval [CI] 0.43–0.85) and a specificity of 67% (CI 0.13–0.90) for SBO.[492] Ultrasonography has comparable sensitivity and specificity to CT for the diagnosis of SBO.[494,495] Therefore, in settings where MRI is not readily available, ultrasonography should be the modality of choice, followed by CT.

Management

Initial management should involve establishment of intravenous access, fluid resuscitation, and decompression via nasogastric (NG) tube.[460] Emergent operative treatment should be offered to patients with peritonitis, bowel ischemia, or closed loop obstruction and should be strongly considered in patients with metabolic derangements or tachycardia.[489,496,497] Patients without such signs may be safely kept nil per os with intravenous fluid support and NG decompression.[440,496] They should be reassessed frequently, and surgery should be considered if oral contrast has not passed into the colon after 24–36 hours, NG outputs are greater than 500 mL/d after 3 days, or symptoms worsen or persist beyond 72 hours.[496] Successful vaginal delivery has been described in a patient simultaneously being managed conservatively for SBO.[486]

Early operative management in nonpregnant patients with a first episode of SBO has been shown to reduce mortality, likelihood of recurrence, and cost.[498–501] Patients with a first episode of SBO have a 20% probability of recurrence within 2 years.[498] Additionally, with each presentation, the likelihood of recurrence increases and the interval between episodes tends to decrease.[498] Two studies suggest that nonoperative management may fail at a higher rate in pregnant patients.[447]

Both laparoscopic[450,451] and open[445,502,503] approaches have been used to treat bowel obstruction in pregnancy. Laparoscopy may decrease morbidity, although the risk of bowel injury may be higher.[496] Of note, in the presence of bowel ischemia, significant abdominal distension, or difficult trocar placement, early conversion to laparotomy may reduce the incidence of bowel injury.[504] Treatment involves complete assessment of the bowel, resection of necrotic tissue, and addressing the underlying cause, such as closure of spaces for an internal hernia.[466] Finally, nutritional status should be carefully evaluated in pregnant patients admitted with SBO. In patients with a history of prolonged poor oral intake due to obstructive symptoms, or with nonresolving obstructions and protracted postoperative ileus, total parenteral nutrition should be considered within the first week of hospitalization.[505,506] Recommendations for SBO are summarized in Figure 4.

Sigmoid volvulus

Large bowel obstruction is less common than SBO in pregnancy,[507] with most reported cases caused by sigmoid volvulus.[507–509] It is postulated that pregnancy-related hormones cause relaxation of tissues including the sigmoid mesentery,

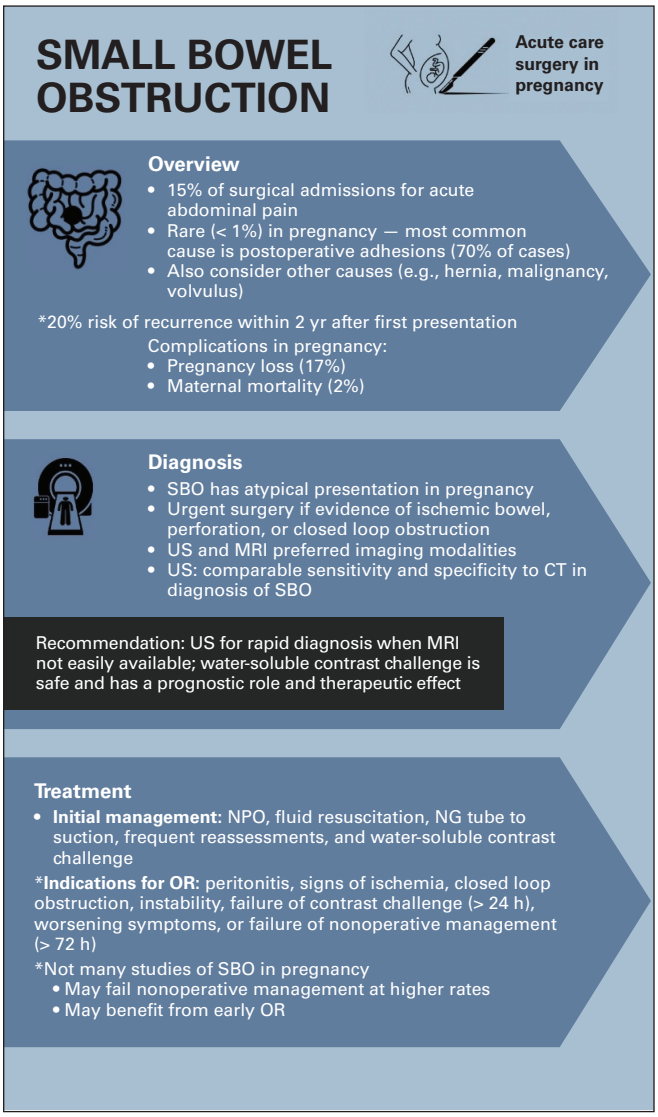

Fig. 4. Summary of recommendations for pregnant patients with small bowel obstruction. CT = computed tomography; MRI = magnetic resonance imaging; NG = nasogastric; NPO = nil per os; OR = operating room; SBO = small bowel obstruction; US = ultrasonography.

which increases the likelihood of volvulus.[509] Generally, treatment has required Hartmann resection,[507,509] although laparoscopic detorsion has been described.[510] Large bowel obstruction in pregnancy is also caused by ileosigmoid knotting, where the ileum wraps around the sigmoid colon or its mesentery. It is typically treated with small bowel resection and Hartmann resection.[511,512]

Hemorrhoids

Symptomatic hemorrhoids are caused by venous dilation and downward displacement of the anal cushions.[513] Hemorrhoids are common in pregnancy. Nearly half of pregnant patients experience symptoms,[514] most commonly in the third trimester and early postpartum period.[515,516] Normal physiologic changes of pregnancy, such as increased intra-abdominal pressure and circulating blood volume, may contribute to the development of hemorrhoids.[517] Additionally, many pregnant patients experience constipation, which is well known to provoke hemorrhoidal disease.[518,519] One randomized control trial demonstrated that dietary and behavioural interventions decrease the incidence of hemorrhoids in pregnancy.[520]

Internal hemorrhoids are graded based on the extent to which they protrude and their ability to be reduced.[521] Low-grade hemorrhoids often respond to lifestyle and dietary changes or topical treatments.[521] Laxatives, stool softeners, and fibre supplements have been shown to be safe in pregnancy; however, there is minimal evidence for the safety of topical agents.[522] Zinc-containing ointments and suppositories containing esculin are not considered safe in pregnancy.[516]

Higher-grade hemorrhoids may require procedures such as banding or sclerotherapy.[523] In 1 study evaluating more than 1 000 000 pregnancies, more than 90% of patients with hemorrhoids were treated with lifestyle management or topical agents, and less than 2% required surgery.[524] Thrombosed hemorrhoids affect 8% of pregnancies,[514] with most responding to conservative therapy. However, when presenting acutely, incision and drainage of thrombosed hemorrhoids has been performed safely in pregnancy.[525] Hemorrhoidectomy is generally reserved for failure of medical management, intractable bleeding, or strangulated/thrombosed hemorrhoids, and can be offered to pregnant patients.[522] No maternal or fetal complications were reported in a case series of 25 pregnant patients who underwent hemorrhoidectomy.[526] Another study of 35 patients reported no adverse pregnancy outcomes and improved patient satisfaction scores among the group receiving hemorrhoidectomy.[527]

Conclusion

This scoping review serves as a stand-alone resource, consolidating the best available evidence for the management of pregnant patients with acute nonobstetrical surgical emergencies. Despite the large number of studies compiled, limitations to the data exist. It is important to recognize that many of these studies involve small population cohorts, the majority were retrospective, and data from randomized controlled trials are scarce. This up-to-date resource will help clinicians to navigate the challenging and intimidating decisions associated with nonobstetrical surgical diseases in pregnancy.

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Competing interests: None declared.

Contributors: Graham Skelhorne-Gross, Melissa Walker, Jordan Nantais, Danielle Bischof, and Ashlie Nadler contributed to the study design. Graham Skelhorne-Gross, Luckshi Rajendran, Doulia Hamad, and Ashlie Nadler performed the literature search. Luckshi Rajendran and Doulia Hamad analyzed the results. Graham Skelhorne-Gross, Melissa Walker, Doulia Hamad, and Ashlie Nadler wrote the manuscript. All of the authors revised it critically for important intellectual content, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

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