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Guideline

Guidelines on general surgical emergencies in pregnancy

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Introduction

Elective non-obstetric surgery is usually avoided during pregnancy and in the immediate postpartum phase. A small proportion of pregnant people present with acute surgical pathology requiring emergency surgical intervention. Up to 2% of pregnancies require emergency non-obstetric surgery[1], and between 1 in 500 and 1 in 700 pregnant people develop an acute abdomen during pregnancy[2].

The condition of pregnancy can increase the likelihood of some surgical diseases. For example, the change in levels of progesterone and oestrogen has been shown to lead to increased biliary sludge and gallstone formation[3], whereas the physical changes of pregnancy may lead to complications such as umbilical hernias. However, appendicectomy is consistently reported as the commonest non-obstetric operation performed during pregnancy[4].

The devastating historical legacy of the use of medications such as thalidomide and diethylstilbesterol in pregnancy have raised vigilance regarding the safety to the fetus of all drugs, including anaesthetics and contrast agents[5]. Radiation used in imaging has an impact on rapidly dividing cells and therefore has an impact on the fetus, making the diagnosis of surgical disease challenging. Pregnancy is often listed as an exclusion criterion for many research studies, contributing to uncertainties in optimal management of these patients.

The purpose of these guidelines is to bring together the available evidence in supporting decision-making for the general surgeon covering emergency care of pregnant people, in their investigative and operative approach. It does not cover pre-existing conditions, or the specialist management of conditions such as cancer or inflammatory bowel disease. These guidelines do not cover anaesthetic considerations in pregnancy, or major trauma.

Methods

Guideline group

Members of the Association of Surgeons of Great Britain and Ireland were invited to form a steering group for Emergency General Surgery Guideline formation. Related associations and societies were contacted and the Upper Gastrointestinal Surgery Society, the British Hernia Society, the Obstetric Anaesthetists' Association, and Managing Medical Obstetric Emergencies and Trauma accepted the invitation to provide a consultant with an expert interest in this topic to support the guideline development process. A consultant radiologist provided advice and guidance regarding the radiological aspects of the guidelines. A list of the members of the group and their responsibilities is available in the acknowledgements.

The guidelines were developed for an international audience with a high-income health system.

Methodology

The guideline formation followed the AGREE II methodology[6]. The subject was divided into seven surgical sub-subspecialty areas with a lead surgeon for each. An overview of the literature for each subspeciality was presented by the lead surgeon at a virtual meeting, and specific questions were formulated using the PICO (Population, Intervention, Comparison, Outcome) model structure for each area of interest.

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Every research question was reviewed and reported according to PRISMA guidance[7]. The search questions used are recorded in *Appendix S1*. A systematic literature review was performed by the lead surgeon in March and April 2023 of English language publications using the PubMed database and the Cochrane Database of Systematic Reviews, and manual searches of relevant articles. If up-to-date meta-analysis or systematic reviews were available, conclusions from those were used. However, these were not available for many of the questions, and case series, case reports, and expert opinions were used in the analysis in such instances. For each question, recommendations were made, and the level of evidence graded using the Oxford Centre for Evidence-Based medicine 2011 Levels of Evidence[8].

During the PICO meetings, three further areas of interest were identified to help the reader understand the topic fully. For two of these topics—general obstetric considerations for surgeons, and imaging in pregnancy—a general overview of the literature was written by a surgeon and specialist together. Location of delivery of care for a patient with surgical disease was also considered, and a PICO question was developed. For this question, the grey literature was also searched using Google and Google Advanced, with the first 20 results selected.

Timeline and meetings

The protocol was agreed at an initial virtual meeting with all involved in October 2022. Three subsequent virtual meetings were held to agree the PICO questions for each topic. Systematic reviews were completed in March 2023 by the lead surgeon of the topic. Two virtual consensus meetings were held in March and April 2023 with all relevant specialists. The systematic reviews were presented, and recommendations were developed by those in attendance to answer each question. Following the virtual meetings, attendees were given access to the publications used to answer the questions and a summary of the discussion. The SurveyMonkey Inc (San Mateo, CA, USA) online voting platform was used to create a survey to agree the recommendations. A Likert scale from 1 (strongly disagree) to 5 (strongly agree) was used. Only recommendations scoring over 80% scores 4 and 5 were included. Questions that scored less than this were rephrased using the comments made and a second round of voting took place. After this, all recommendations reached consensus.

Results

General obstetric considerations for surgeons managing pregnant patients

Acute abdominal complaints during pregnancy can be challenging to diagnose and manage. Difficulties are encountered undertaking and interpreting investigations throughout pregnancy. Adjustments must be made to surgical interventions to accommodate the gravid uterus and consideration must be given to the developing fetus. Sepsis and abdominal surgery are both known to increase the risks of miscarriage and preterm labour[9,10]. It is vital that these risks are explained to the patient and form part of the shared decision-making process. There are certain additional aspects of care that are important to consider when managing pregnant patients, and it is important that these are discussed with the patient and the wider multidisciplinary team, including the obstetric team.

Modified early warning scores

Evolving morbidity can be difficult to identify in the obstetric population, and delays in intervention and treatment are known to be associated with poorer outcomes[11]. Owing to the physiological changes in pregnancy, a Modified Early Warning Score (MEWS) chart has been developed by the National Health Service (NHS) England National Patient Safety Team to allow for different trigger thresholds during pregnancy and the immediate postnatal phase. It is used to identify clinical deterioration and to instigate early intervention. When used, it has been shown to reduce morbidity and mortality, so is now a key recommendation as part of the latest MBRRACE-UK report[11,12]. It should be used for any pregnant patient in an inpatient setting during pregnancy and until 6 weeks postnatally[11].

Early delivery

Depending on the gestation of the pregnancy, early delivery may need to be considered to expedite and facilitate correct diagnosis and treatment. Depending on the obstetric history, gestation, and maternal well-being, induction of labour may be considered by the obstetric team aiming for vaginal delivery or caesarean section, if appropriate. This would most likely be in the context of a late third-trimester pregnancy, particularly if already beyond 37 weeks (which would be considered a term pregnancy). Early delivery is not without risks, namely the risks of prematurity to the baby (including breathing difficulties, visual impairment, poor thermoregulation, impaired immunity, gastrointestinal complications, and longer-term impact on growth and the central nervous system), and risks of intervention for the mother[13]. A careful consideration and discussion of the risks and benefits of early delivery should be made on an individual basis. Ultimately, maternal well-being must always be prioritized, as maternal well-being is essential to protect the well-being of the fetus. However, fetal well-being should be taken into consideration and will usually be the parents' main concern.

In utero *transfers*

If preterm delivery is expected or suspected, particularly extreme preterm delivery, defined as birth before 28 completed weeks of gestation, consideration should be given to the location of the birth to optimize neonatal outcomes. The British Association of Perinatal Medicine[14] has published a clear framework for perinatal management in the event of extreme preterm birth, which outlines the benefits of delivering in a hospital that can offer neonatal intensive care. Depending on the clinical picture, the likelihood of requiring intervention, the risk of preterm delivery, the gestation, and the level of neonatal care that can be provided locally, a multidisciplinary discussion involving the expectant parent(s) should take place to decide whether to transfer the mother with the fetus *in utero* to a hospital with a higher level of neonatal intensive care before ongoing surgical care.

Steroids

Antenatal corticosteroids, in the form of intramuscular betamethasone or dexamethasone, are known to reduce perinatal and neonatal mortality, as well as respiratory distress syndrome (RDS) in the neonate, so should be offered in the context of preterm delivery[15,16]. Evidence supports antenatal corticosteroid administration for all pregnancies where delivery is expected or threatened between 24 and 34 + 6 weeks' gestation[15,17,18]. There is immediate benefit from steroid injections; however, the optimum timing for reducing morbidity and mortality of the neonate is from 48 h of the first dose and up to 7 days. It is administered as 24 mg in two divided doses 24 h apart or four divided doses within a 24-h interval[15]. Beyond 34 weeks and up to 37 weeks, although there is still evidence that antenatal corticosteroids reduce RDS[19], there

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is also an associated risk of neonatal hypoglycaemia[15], and there is emerging evidence regarding the longer-term impact, particularly in relation to neurocognitive disorders[20–22]. As a result, a balanced discussion about the risks and benefits of the administration of antenatal corticosteroids, as well as the likelihood of preterm delivery in the context of the clinical picture, should be had with the expectant parents and the wider multidisciplinary team.

Magnesium sulphate

For deliveries below 32 weeks of gestation, intravenous magnesium sulphate has been found to confer some neuroprotective benefits to the fetus[23]. It should be considered for any pregnancy where there is a risk of delivering before 34 weeks' gestation. It is administered as a loading dose of 4 g, ideally starting approximately 4 h before the planned delivery, followed by a 1-g/h maintenance infusion[23,24] continued until the birth of the baby or for 24 h, whichever occurs sooner. A meta-analysis[25] of RCTs has shown that magnesium sulphate reduces rates of cerebral palsy and motor dysfunction. It can be challenging to commence the loading dose at the appropriate time, given that delivery does not always ensue in the event of threatened preterm labour. It is not harmful to start magnesium sulphate administration, and it can be stopped if the clinical picture changes.

Ultimately, these discussions and interventions should be carried out by the multidisciplinary team on an individual basis, and should not delay investigation and urgent treatment of the mother.

Imaging for the emergency surgical patient in pregnancy

Radiological investigations play a vital role in the diagnostic evaluation of the acute surgical abdomen. Imaging in pregnancy is more complex; conventional imaging techniques may be limited because of the risks of fetal harm. Although imaging techniques that avoid ionizing radiation are preferred, there remain misconceptions regarding the risks, safety, and appropriate use of imaging in pregnancy. This can lead to delayed diagnosis and potential harm to both mother and fetus.

This section reviews the available literature on the use of ultrasound imaging, CT, MRI, and contrast media during pregnancy for acute non-traumatic emergencies in general surgery. This evidence is based on a guidelines published by American College of Obstetricians and Gynecologists[26], Royal College of Radiologists[27], a recent review[28] based on UK and international guidelines from radiological and obstetric and gynaecological societies, and guidelines[29] from the American College of Radiology Committee on drugs and contrast media use in pregnancy.

Potential risk to fetus from imaging in pregnancy

Ultrasonography is considered lower-risk or safe in pregnancy[28]. MRI is also considered safe, although little is known about the effects of strong magnetic fields on the growth and development of a fetus; however, at the standard dose, MRI in the first trimester of pregnancy appeared to be safe in a population-based study[30] with follow-up to 4 years postpartum. There is a small risk from gadolinium contrast, which can be used in MRI, but this is not required routinely for diagnosing intra-abdominal pathology[31]. CT, however, involves ionizing radiation, which is associated with risks of teratogenicity and carcinogenesis. *Table 1* shows the relationship between gestational age, radiation dose, and radiation-induced teratogenic effects.

The radiation doses used in diagnostic imaging are usually well below these thresholds and so teratogenic effects are not typically a relevant consideration during diagnostic imaging in pregnancy. A more relevant consideration in diagnostic imaging relates to the carcinogenic effects of ionizing radiation (*Table 2*). Although carcinogenesis can theoretically occur at any dose, its risk increases with dose and varies with body area imaged[27].

Table 1 Effect of gestational age and radiation dose on radiation-induced teratogenesis (modified from American College of Obstetricians and Gynecologists guidelines[26])

Gestational age (weeks)	Estimated threshold dose (mGy)	Effects
0–2	50–100	Death of embryo or no consequence (all or none)
2–8	200	Skeleton, eye and genital anomalies
	200–250	Growth restriction
8–15	60–310	Severe intellectual disability (high risk)
	200	Microcephaly
16–25	250–280	Severe intellectual disability (low risk)

Table 2 Typical fetal radiation doses and risks of childhood cancer for selected imaging modalities relevant to the surgical patient (adapted from Wiles *et al.*[28])

	Typical fetal dose (mGy)	Risk of childhood cancer per examination
Natural background risk of childhood cancer	–	1 in 500
X-ray		
Chest	0.001–0.01	< 1 in 1 000 000
Abdomen or pelvis	0.1–1	1 in 100 000 to 1 in 10 000
CT		
CT pulmonary angiography	0.01–0.1	1 in 1 000 000 to 1 in 100 000
CT kidneys, ureters and bladder	2–5	1 in 10 000 to 1 in 5000
CT abdomen and pelvis	10–50	1 in 1000 to 1 in 200

Investigation modalities used to assess the acute abdomen

Typical investigations for suspected pathology in the acute abdomen are abdominal X-ray, ultrasound imaging, CT of the abdomen and pelvis with contrast, and MRI. Non-contrast-enhanced CT of the abdomen and pelvis seldom gives enough information, and contrast-enhanced MRI is not routinely necessary in the diagnosis of acute abdominal pathology[32].

Ultrasonography is safe, non-invasive, and quick, making it highly useful as the primary imaging modality of choice in the acute abdomen during pregnancy. Should ultrasound examination be non-diagnostic or equivocal, MRI (without contrast) can be considered as the next line of investigation, with an increasing volume of evidence supporting its safe use during pregnancy[33]. If MRI is not available or not deemed appropriate to answer the clinical question, CT can be carried out, but careful consideration should be taken, with discussion between surgeons, radiologist, and obstetrician, bearing in mind the clinical picture and differential diagnosis[33].

Iodinated contrast seems safe to use in pregnancy with no teratogenic risk[29] and only a potential postpartum risk of hypothyroidism. Intravenous gadolinium is unlikely to be required

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for diagnostic purposes in the acute abdomen during pregnancy, and should not be administered unless indicated specifically.

Risks and benefits of any imaging modality in pregnancy should always be considered and discussed with patients.

Appendicitis in pregnancy

Appendicitis is the most common general surgical emergency worldwide. Even in non-pregnant women, the diagnosis can be challenging as the spectrum of differential diagnoses for right iliac fossa pain is wider than for men. Appendicitis occurs in approximately 1 in 1000 pregnancies[34]. Physiological and anatomical changes associated with pregnancy can make the diagnosis particularly challenging. The gravid uterus can alter the position of the appendix in the second and third trimesters, giving rise to pain in the right upper quadrant.

Appendicitis scoring systems in pregnancy

Several scoring systems have been developed to aid the diagnosis of appendicitis. These include a variety of clinical, biochemical, and radiological parameters to give a score to predict the likelihood of the disease. They are based on the non-pregnant adult population. Their accuracy in pregnancy has not been fully assessed. There is currently no consensus on whether these scoring systems can be used in pregnant women, or on which one to use.

A systematic literature review evaluating scoring systems for appendicitis in pregnancy, and comparing the diagnostic accuracy in pregnant and non-pregnant women, identified two retrospective studies comparing multiple scoring systems: one retrospective study that evaluated a single scoring system, and one that evaluated a novel scoring system and compared it with existing scoring systems. A single-centre retrospective study[35] assessed nine clinical scoring systems (Alvarado, Eskelinen, Ohmann, Appendicitis Inflamatory Response Score (AIR), RIPASA, Tzanakis, Lintula, Fenyo-Lindberg, and Karaman systems) using 79 pregnant patients and a control group of 79 non-pregnant patients, all of whom underwent appendicectomy. The RIPASA score was the most accurate scoring system in pregnant patients. The positive predictive value (PPV) was 94%, the negative predictive value (NPV) was 44%, and the sensitivity and specificity were 78 and 79% respectively. The Tzanakis scoring system was best for both pregnant and non-pregnant patients, with PPV, sensitivity, and specificity of 97, 52, and 93% respectively when pregnant.

An evaluation[36] of the performance of the Alvarado, Ohmann, and Tzanakis scores in the diagnosis of appendicitis in 35 pregnant and 140 non-pregnant women showed that the Tzanakis scoring system was the most accurate. In the pregnant group, the sensitivity was 92%, specificity 88%, PPV 99%, and NPV 39%. Comparison of the Delta Neutrophil Index (DNI), the fraction of circulating immature granulocytes, between groups revealed significantly higher values in pregnant patients ($P = 0.012$). When the Tzanakis scoring system was modified with the DNI, the sensitivity, accuracy, and NPV were significantly increased (94, 94, and 50% *versus* 95, 94, and 50% respectively). Comparable efficacy of the Alvardo score at diagnosing appendicitis in pregnant and non-pregnant patients has been reported. In a small single-centre analysis, Tatli *et al.*[37] evaluated the efficacy in 48 pregnant and 53 non-pregnant patients. In the pregnant group, the sensitivity, specificity, PPV, and NPV of the Alvarado score were 79, 80, 94, and 21% respectively. When the pregnant group was subanalysed on the basis of trimester, the Alvarado score was most accurate in the first trimester (88%) and least in the second trimester (70%).

All the clinical scoring systems were designed on data from non-pregnant adults. Augustin *et al.*[38] developed the Appendicitis TriMOdal Score (ATMOS), specifically for use in pregnancy. It includes clinical, laboratory, and ultrasound parameters, with scores ranging from 0 to 10. In a cohort of 59 pregnant patients, 94% of patients with an ATMOS greater than 4 had appendicitis, compared with less than 13% of those with an ATMOS of 4 or less. Further studies are needed to assess the accuracy of ATMOS.

In conclusion, the data suggest similar accuracy in pregnant and non-pregnant patients.

Key Question 1.1: In a pregnant patient with suspected appendicitis, are risk stratification tools equally effective at diagnosis as in non-pregnant patients?

Recommendation: If appendicitis scoring systems are part of your usual practice, there is evidence to suggest that these are equally effective in the pregnant patient. However, if there is concern regarding the diagnosis, there should be a low threshold to proceed to imaging.

Level of evidence: III

Grade of recommendation: B

Strongly agree 56%, agree 33%

Imaging of appendicitis in pregnancy

Prompt identification of appendicitis in pregnancy is imperative to optimize outcomes for both mother and fetus. Imaging is required to confirm the diagnosis and is preferred over diagnostic laparoscopy; however, this should still be considered when imaging is inconclusive[39]. Timely access to imaging is important and absence of radiation exposure to the fetus is preferred. A literature review evaluating imaging modalities used in the diagnosis of appendicitis in pregnancy yielded two systematic reviews evaluating the role of ultrasonography, three systematic reviews evaluating the role of MRI, one review comparing imaging modalities, two single-centre studies comparing imaging modalities, and one review evaluating the efficacy of ultrasound imaging in each trimester of pregnancy.

Ultrasonography is often considered the first-line imaging modality to investigate suspected appendicitis in pregnancy owing to ease of access and lack of radiation exposure to the fetus. Two systematic reviews evaluated the accuracy of ultrasound imaging in pregnancy. Moghadam *et al.*[40] analysed a total of 8 studies consisting of 1593 patients. The overall sensitivity and specificity were 78 and 75% respectively. The sensitivity in the first, second, and third trimesters of pregnancy was 69, 63, and 51% respectively. The corresponding figures for specificity were 85, 85, and 65%. Li and Li[41] reported a similarly moderate sensitivity of 62% (95% c.i. 43 to 78%), but higher specificity of 91% (74 to 97%) in an analysis of 521 patients. Overall, ultrasonography has a relatively low diagnostic accuracy for appendicitis in pregnant women.

The accuracy of MRI in diagnosing appendicitis was evaluated in three systematic reviews and meta-analyses. In an analysis[42] of 26 studies with 2886 patients, the pooled sensitivity and specificity of MRI were 92% (95% c.i. 88 to 95%) and 98% (97 to 98%) respectively. Similarly, Kave *et al.*[43] included 19 studies with 2400 patients, and reported a sensitivity and specificity of 92 and 98% respectively. Finally, D'Souza *et al.*[44] analysed 2282 pregnant women, and found the sensitivity and specificity of MRI to be 96 and 97% respectively. Overall, all analyses demonstrated MRI to be an accurate and safe method of diagnosing appendicitis in pregnancy.

One systematic review compared the accuracy of multiple imaging modalities in diagnosing appendicitis in pregnancy. Dahabreh *et al.*[45] performed a subgroup analysis of pregnant women from a larger cohort of patients, and found similar specificity with CT, MRI, and ultrasound imaging (91, 98, and 95% respectively), but higher sensitivity for CT and MRI compared with ultrasonography (99, 98,

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and 72% respectively). Radiation exposure to the fetus is a concern with CT, so ultrasonography and MRI are preferred in pregnancy. Nonetheless, timely diagnosis is essential for the well-being of both mother and fetus, and CT may be necessary when ultrasonography is inconclusive and MRI is not available or contraindicated.

Two small single-centre studies compared the accuracy of ultrasonography and MRI in diagnosing appendicitis in pregnancy. Konrad *et al.*[46] evaluated 140 pregnant patients with suspected appendicitis. The appendix was visualized in only 7% of ultrasound and in 80% of MRI examinations. MRI had a higher diagnostic accuracy, with a sensitivity and specificity of 100 and 98%, compared with 18 and 99% for ultrasonography. Similarly, Ramalingam *et al.*[47] evaluated 127 patients who all initially underwent ultrasound imaging, followed by MRI if the ultrasonography was negative or equivocal. CT was reserved for patients with inconclusive ultrasound and MRI results. Of 127 patients, 125 (98.4%) had an inconclusive ultrasound examination. The sensitivity and specificity were 13 and 99%, compared with 100 and 94% with MRI.

These data suggest that MRI or ultrasonography should be the initial imaging modality used in patients with suspected appendicitis during pregnancy. CT should be reserved for when ultrasonography or MRI is inconclusive or not available. The relatively low diagnostic accuracy of ultrasound imaging must be considered, however; if it is used as first-line imaging modality, it should not delay a definitive diagnosis with MRI or CT if necessary.

Key Question 1.2: In a pregnant patient with right iliac fossa pain, what is the optimum imaging modality in the first, second and third trimester to diagnose appendicitis?

Recommendation: Ultrasound imaging or non-contrast MRI should be the initial imaging modality of choice in pregnant patients with suspected appendicitis, regardless of trimester. However, care should be taken to avoid delay to diagnosis because, once perforation occurs, the outcome for the fetus is much worse. CT should be used for when MRI or ultrasonography is inconclusive or not available.

Level of evidence: II
Grade of recommendation: A
Strongly agree 67%, agree 33%

Treatment of appendicitis in pregnancy

Appendicitis in the non-pregnant adult population can be managed successfully with non-operative management (NOM)[47]. In pregnancy, this could avoid the risks of anaesthesia and surgery to mother and fetus in terms of spontaneous preterm delivery. However attractive this strategy may be, the greatest challenge is to avoid failure of NOM and the subsequent risk of sepsis to both mother and fetus.

A systematic review identified three retrospective studies reporting rates of fetal loss with operative treatment and NOM of appendicitis. A national registry study[48] of 169 patients, of whom 113 (66.8%) underwent NOM, reported a fetal loss rate of 5% in the operative group and 4% in the NOM group. The proportion of patients with complicated appendicitis was unsurprisingly higher in the operative group (41 *versus* 6%). Liu *et al.*[49] reported comparable rates of fetal loss with surgery and NOM. Of 54 patients with acute uncomplicated appendicitis, 63% were managed conservatively. The rate of fetal loss was 3% in the NOM group compared with 5% in the operative group. In contrast, a population-based study[50] of 859 pregnant women found that operative management was associated with better outcomes. Most patients (781, 90.9%) underwent appendicectomy. The fetal loss rate was 5.6% in the operative group compared with 11% in the NOM group. Overall, these studies reported equivalent or better outcomes with surgery. Two of these studies also reported rates of preterm delivery, and found equivalent rates with surgery and NOM. In the study by Cheng *et al.*[50], the rate of preterm delivery was 10% in both the NOM and operative groups. Liu *et al.*[49] reported a preterm delivery rate of 9% with NOM and 10% with surgery.

One study, only available in abstract form[51], evaluated the management of patients with uncomplicated appendicitis. Of 3600 patients studied, 2088 (58.0%) had immediate surgery and 1512 (42.0%) were managed conservatively. NOM failed in 1043 patients (69.0%). There was no difference in outcomes between surgery and successful NOM, but unsuccessful NOM and delayed surgery were associated with a significantly increased risk of fetal complications (OR 2.62, 95% c.i. 1.17 to 4.00; $P < 0.001$). Similar findings were observed in a registry-based study[52] that evaluated the management of pregnant patients with complicated appendicitis. Among 8087 pregnant patients with complicated appendicitis, 4487 (55.5%) underwent immediate surgery. The remainder were managed conservatively. Of those, NOM was successful in 954 patients (26.5%), and failed in 2646 (73.5%) who underwent delayed surgery. There was no significant difference in preterm delivery, preterm labour or miscarriage between successful NOM and immediate surgery. If NOM was unsuccessful, however, delayed surgery was associated with a higher risk of preterm delivery, preterm labour, or miscarriage compared with immediate surgery (OR 1.45, 95% c.i. 1.24 to 1.68; $P < 0.001$).

In conclusion, the data suggest that immediate surgery and successful NOM are associated with similar outcomes in terms of fetal loss and preterm delivery. However, there is a relatively high risk of failure with NOM (particularly with complicated appendicitis), and unsuccessful NOM and delayed surgery are associated with worse outcomes.

Key Question 1.3: In a pregnant person with appendicitis, is operative or non-operative treatment better to prevent fetal loss or preterm delivery?

Recommendation: In a pregnant person with appendicitis, operative intervention is recommended over non-operative intervention, because, although the outcome is similar between operative and successful non-operative treatment, if NOM fails, delayed surgery is associated with increased preterm delivery and fetal loss compared with immediate surgery. The risks and benefits of surgical intervention should be discussed with the mother. Specialist input from the obstetrician, neonatologist, and obstetric anaesthetist is required to ensure patient management in an appropriate hospital setting.

Level of evidence: III
Grade of recommendation: B
Strongly agree 89%, agree 11%

Gallstone disease in pregnancy

Gallstone disease is common, and present in about 15% of the general adult population[53,54]. Approximately 80% of individuals with cholelithiasis remain asymptomatic, whereas in the remainder gallstones can cause uncomplicated (biliary colic) or complicated (cholecystitis, obstructive jaundice, cholangitis and pancreatitis) disease[55].

The reported incidence of gallstone disease in pregnancy depends on the imaging used and frequency of these investigations[56–58]. An increased oestrogen level, which raises cholesterol secretion making bile supersaturated, and an increased progesterone concentration, which reduces bile acid secretion increasing bile supersaturation and reducing gallbladder emptying leading to

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stasis, are the key factors leading to increased gallstone formation[59,60]. These changes normalize approximately 2 months after delivery. Symptomatic gallstones are associated with a risk of maternal and fetal morbidity during pregnancy[61,62].

Prospective studies[3,63,64] have shown that up to 31% of recently pregnant patients have gallstone sludge in the early postpartum phase and up to 2% develop stones, many of which are symptomatic. However, in many of these patients, especially those with smaller stones and sludge, these resolve spontaneously. Risk factors for development of gallstones during pregnancy are the same as those of non-pregnant patients[3]. Multiparity and prepregnancy obesity are independent risk factors[65,66].

As in the non-pregnant patient, complicated gallstone disease in pregnancy, such as cholecystitis, gallstone pancreatitis, and choledocolithiasis, is associated with a high recurrence rate[67,68]. Relapses are often more severe, and can lead to miscarriage and preterm delivery[69].

Cholecystitis in pregnancy

Acute cholecystitis is the second most common non-obstetric abdominal emergency during pregnancy[70]. It has been demonstrated to have a higher rate of preoperative systemic infection and systemic inflammatory response syndrome compared with cholecystitis in non-pregnant patients[71]. Recurrent episodes of acute cholecystitis occur during pregnancy in about 10% of patients managed with antibiotics, leading to a miscarriage rate in 10–20% of the patients[72].

A literature review evaluating the management of acute cholecystitis in pregnancy yielded two recent national cohort studies from the USA, two systematic reviews, and two guidelines.

A large prospective cohort study[73], evaluating 23 939 pregnant patients in the USA with acute cholecystitis between January 2003 and September 2015, reported that 60% were managed with laparoscopic cholecystectomy (LC). LC was more commonly performed after 2007, and time to surgery from admission was significantly shorter during the second half of the study. There were lower rates of preterm delivery, labour, or miscarriage in the LC group, compared with the non-operative group. Each day delay in surgery for acute cholecystitis was associated with an increased risk of fetal complications (OR 1.17; $P < 0.001$).

Another large prospective cohort study[74] looked at another national database in the USA between 2010 and 2015, involving 6390 pregnant patients with acute cholecystitis. Of these, 38% underwent LC, with a higher proportion being performed during the second trimester (59%) compared with the first (44%) and third (34%) trimesters ($P < 0.01$). NOM was associated with significantly increased maternal–fetal complications during the index admission (27.6 *versus* 8%; $P < 0.01$) and 30-day readmissions (7.9 *versus* 3.7%; $P < 0.01$).

A systematic review and meta-analysis[75] comparing 10 632 patients undergoing either LC (9413) or open cholecystectomy (1219) in pregnancy suggested that LC was associated with fewer maternal and fetal complications than open cholecystectomy during pregnancy. Some 91% of all patients were in the first or second trimester at the time of surgery. Another systematic review[76] involving 51 studies and 590 patients reported intraoperative complications in 3.5% with 0.4% fetal loss and 5.7% preterm delivery; 70% of the procedures were performed in the second trimester.

Some studies have recommended that LC can be performed safely in any trimester, but that deferring the surgery to after delivery may be appropriate for patients in the third trimester[77]. Cholecystectomy during the third trimester has been associated with higher rates of preterm delivery, readmissions, and longer duration of hospital stay[78–80].

Current guidelines from the American College of Obstetricians and Gynecologists[81] and the Society of American Gastrointestinal and Endoscopic Surgeons[39] recommend that LC can be performed for acute cholecystitis during any trimester. The studies identified[75,82–84], although retrospective, have supported LC for acute cholecystitis during pregnancy.

Key Question 2.1: In a patient presenting with acute cholecystitis, regardless of trimester, which is the best treatment, LC or antibiotics?

Recommendation: In a pregnant patient with acute cholecystitis, LC is recommended as soon as possible and within 7 days of onset of symptoms if a surgeon with experience of performing surgery in this setting is available. LC can be very challenging in the third trimester owing to lack of intra-abdominal space caused by the gravid uterus, especially when there is ileus associated with infection, so the benefits of surgery are reduced. The risks and benefits of surgical intervention should be discussed with the mother in detail. Specialist input from the obstetrician, neonatologist, and obstetric anaesthetist is required to ensure patient management in an appropriate hospital setting.

Level of evidence: III

Grade of recommendation: B

Strongly agree 33%, agree 56%

Choledocholithiasis in pregnancy

A literature review identified a systematic review[85] of endoscopic retrograde cholangiopancreatography (ERCP) in pregnancy reporting on 27 retrospective studies, and a small retrospective case series with an associated systematic review of case reports[86] for laparoscopic common bile duct (CBD) surgery.

ERCP with sphincterotomy can be performed during any trimester of pregnancy, but there is concern regarding the radiation produced during fluoroscopy in conventional ERCP. This can be managed either by shielding the fetus[87–90], or by using non-radiation ERCP, such as transabdominal ultrasound imaging, endoscopic ultrasound imaging, or cholangioscopy[91]. The systematic review and meta-analysis[85] included 1307 pregnant patients undergoing ERCP during pregnancy, although no data were included on the indication for ERCP. There was one maternal death, and the fetal event rate was approximately 5%. Outcomes of radiation *versus* non-radiation ERCP in pregnancy were compared. There was no significant difference in fetal adverse outcomes and maternal pregnancy-related outcomes; however, radiation-free ERCP had a reduced rate of non-pregnancy-related complications (7.6 *versus* 14.9%).

Laparoscopic CBD exploration is not undertaken routinely in all centres, even in the non-pregnant patient. A recent case series[86] from five institutions that routinely perform this procedure described eight retrospectively identified cases and a further seven from a systematic review of the literature. In most patients, the CBD was accessed via the transcystic approach. Successful CBD clearance was achieved in 14 of 15 patients. The advantage of this procedure is simultaneous cholecystectomy, which reduces the risk of further admissions with gallstone complications during the pregnancy.

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Key Question 2.2: In a pregnant patient with a stone obstructing the CBD, which is the optimum treatment: ERCP or laparoscopic CBD exploration?

Recommendation: In a pregnant patient with a CBD stone, the management is dependent on the skill set available. ERCP is appropriate and safe, with consideration of LC in the postpartum phase.
Level of evidence: IV
Grade of recommendation: C
Strongly agree 67%, agree 33%

Gallstone pancreatitis in pregnancy

Gallstone pancreatitis is less common in pregnancy, and is most often reported in the third trimester and postpartum phase[92–94]. However, recurrences necessitating readmission can occur in up to 50% of pregnant patients with gallstone pancreatitis, and can lead to miscarriage in 10–20% during each episode[72].

In the non-pregnant patient, guidelines suggest that cholecystectomy should be offered at the index admission[95], or within 2 weeks[96] for mild pancreatitis. In pregnancy, offering LC within 48 h of admission for mild pancreatitis in the second trimester has been recommended, as the risk to the fetus is minimal during this period[96].

Although cholecystectomy can be performed in any trimester for gallstone pancreatitis[97,98], surgery is often avoided in the first trimester as the fetus is most susceptible to teratogenic effects of medications at this time[99], and cholecystectomy in the third trimester can be associated with increased obstetric complications[78,80,100–103]. No difference has been reported in maternal mortality in pregnant patients with gallstone pancreatitis managed conservatively *versus* surgically[104–106], but the fetal mortality rate was higher in the conservatively managed group[107].

Key Question 2.3: In a patient presenting with gallstone pancreatitis during the first trimester, is immediate surgery the better treatment, or should surgery be delayed until the second trimester?

Recommendation: In a patient presenting with gallstone pancreatitis, LC should be performed during pregnancy. However, delaying surgery to the second trimester can reduce risks to the fetus. The risks and benefits of surgical intervention should be discussed with the mother. Specialist input from the obstetrician, neonatologist, and obstetric anaesthetist is required.
Level of evidence: IV
Grade of recommendation: C
Strongly agree 67%, agree 33%

Small and large bowel complications in pregnancy

Adhesional small bowel obstruction in pregnancy

The third most common non-obstetric operation during pregnancy (after appendicitis and cholecystitis) is intervention for bowel obstruction[108]. Despite this, very little has been published on this topic. A literature review identified only case reports and small case series with literature reviews.

The commonest cause of small bowel obstruction (SBO) in pregnancy is adhesions[109]. The incidence of hernia causing SBO is comparatively lower in the pregnant population, especially groin hernia as the bowel is pushed up into the abdomen by the gravid uterus. The incidence of SBO in pregnancy increases with advancing gestational age; it is seen most in the second trimester as the gravid uterus becomes abdominal from a pelvic position. A higher incidence is also observed in the latter part of pregnancy when the fetal head engages, and also after delivery, because of the sudden alteration in the relationships between the uterus and associated bowel. The overall incidence of SBO ranges from 1 in 1500 to 1 in 66 500 pregnant women[110]. SBO poses significant risks to both the mother and the fetus. The rate of fetal loss can range between 17 and 26%[110], and the maternal mortality rate between 2% in the first trimester and 10–20% in the third trimester[111].

SBO can be difficult to diagnosis in pregnancy as classical symptoms and signs can be obscured by the pregnancy, in particular the symptom of abdominal distension. Constipation is common during pregnancy; however, absolute constipation is not. Although vomiting is common in early pregnancy, if this starts later in pregnancy, SBO should be considered. As with the non-pregnant patient, early confirmation of SBO with imaging is vital to identify patients who may benefit from emergency or early surgery[112]; more details of how to image such patients are presented in the section of these guidelines on imaging in pregnancy.

Indications for, and timing of, operative intervention are no different from those in the non-pregnant population. The published literature suggests that the success of conservative management is lower in the pregnant patient with adhesional SBO[111]; however, this may be related to publication bias.

The non-pregnant patient with adhesional SBO who does not require emergency surgery should be offered oral water-soluble contrast, both for therapeutic and prognostic purposes[112]. Gastrografin, the most common water-soluble contrast media used for this purpose, has not been evaluated formally in the pregnant patient, and some diatrizoate salts, the active ingredient, can cross the placenta. However, when it is given orally, only 3% is absorbed and animal studies do not indicate harmful effects on the fetus. A single case report[113] has described its use in a pregnant patient with successful outcome.

Key Question 3.1: In a pregnant patient with SBO, should oral Gastrografin be given as part of the management, or omitted?

Recommendation: A pregnant patient with SBO should be managed in the same way as a non-pregnant patient. Although there is no evidence for the safety of Gastrografin, there is low evidence of harm, so, after discussion of risks and benefits with the mother, it should be given when necessary. Routine abdominal radiography should not be used after Gastrografin. The absence of flatus and/or bowel movement should guide the decision to operate.
Level of evidence: IV
Grade of recommendation: GP
Strongly agree 36%, agree 55%

In non-pregnant adults, the Bologna guidelines[114] for management of adhesional SBO recommend that laparoscopic adhesiolyis might reduce morbidity in selected patients with adhesional SBO who require surgery. In the pregnant patient, it is recognized that laparoscopy can be more challenging as the gestational age advances. Only 7% of published cases requiring surgery for SBO were operated laparoscopically[109]. Guidelines from the Society of American Gastrointestinal and Endoscopic Surgeons[39] suggest that laparoscopic treatment of acute abdominal disease offers similar benefits to laparotomy in pregnant and non-pregnant patients. They recognize additional benefits of laparoscopy in pregnancy, such as reduced need for narcotics and the benefits of this on the fetus, reduced

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thromboembolic events, and that the improved visualization in laparoscopy reduces the need for uterine manipulation which may reduce the risk of fetal complications. The decision between laparoscopic and open routes of surgery should be based on the available expertise, infrastructure, background history, gestation, and the woman's preference[84].

Key Question 3.2: In a pregnant patient with adhesional bowel obstruction, does laparoscopic surgery improve fetal outcome compared with laparotomy?

Recommendation: A pregnant patient with adhesional SBO should be managed in the same way as a non-pregnant patient. If the skill is available to offer laparoscopic surgery, although the evidence is weak, it is probably safe to start laparoscopically, considering the trimester of pregnancy. The risks and benefits of surgical intervention should be discussed with the mother in detail. Specialist input from the obstetrician, neonatologist, and obstetric anaesthetist is required to ensure patient management in an appropriate hospital setting.

Level of evidence: IV
Grade of recommendation: GP
Strongly agree 55%, agree 27%

Meckel's diverticulum in pregnancy

A recent systematic review[115] identified 27 case reports of Meckel's diverticulum in pregnancy. The presenting symptoms were very heterogeneous as would be found in non-pregnant patients, and the majority were diagnosed during surgery. However, the authors acknowledged that a higher proportion of the patients had a perforated Meckel's diverticulum, which they postulated may reflect delays in diagnosis in the pregnant population, especially as all patients in this case series had failed an initial trial of NOM.

Sigmoid volvulus in pregnancy

The incidence of volvulus in pregnancy is rare; a literature review[116] published in 2016 identified 84 case reports. It is more common in multiparous women and increases with advancing gestational age. Recent guidance from the World Society of Emergency Surgery[117] recommends a trial of endoscopic decompression for sigmoid volvulus if there are no signs of intestinal necrosis. However, this is less likely to be effective than in the non-pregnant population, especially in the third trimester.

Diverticular disease in pregnancy

With diverticular disease appearing in increasingly younger people and older people becoming pregnant, diverticular disease is becoming more common in pregnancy. Nevertheless, it is still rare in pregnancy, and a recent systematic review[118] identified only 12 case reports. As with the non-pregnant patient, most pregnant patients with diverticulitis were managed successfully with intravenous antibiotics. However, three of the four patients managed operatively required an emergency caesarean section at the time of the laparotomy.

Perianal diseases in pregnancy

During pregnancy, physiological changes can lead to the development of perianal disease. The most common perianal diseases experienced during this time are haemorrhoids and fissures. Haemorrhoids are seen in 15–41% of pregnancies[119]. These occur mainly during the third trimester. Risk factors include constipation, a history of haemorrhoids or fissures, and newborns weighing over 3800 g[120].

Haemorrhoids in pregnancy

During pregnancy, physiological changes, such as increased blood volume and intra-abdominal pressure, augmented by hormonal changes, can cause venous stasis in the perianal region, leading to haemorrhoids[121]. Because of these physiological changes, the treatment differs from that for non-pregnant individuals. Haemorrhoids usually present with bleeding, pain, swelling, itching, or a burning sensation. After giving birth, many of these symptoms resolve spontaneously[122].

A Cochrane systematic review[122] from 2005 reported very limited RCT evidence of treatments for symptomatic haemorrhoids during pregnancy. Two trials were identified that used oral rutosoids, a herbal medicine used to treat chronic venous insufficiency; these included only 150 women. Although the trials demonstrated some symptom relief, this was felt to be inadequate to recommend that this treatment was safe in pregnancy.

Topical agents can be used to treat haemorrhoids in the non-pregnant population. Although care should always be taken when giving medication in pregnancy, especially in the first trimester, there is no definite evidence of harm from these medications. A prospective study showed that topical hydrocortisone is an effective treatment for haemorrhoids in the third trimester, and did not produce any adverse obstetric complications compared with a placebo[123,124]. To increase mucosal contact time, it should be used after a bowel movement and at bedtime.

Rubber band ligation of haemorrhoids is a low-risk option for controlling symptoms of grade I–III haemorrhoids. This treatment has been assessed in pregnancy in only one retrospective, controlled study[125] of 45 pregnant patients, with telephone follow-up for 12 months. Effective symptom relief was demonstrated in all patients within one or two treatment sessions, and the only complication reported in the pregnancy group was rectal pain in one patient, requiring band removal.

Key Question 4.1: In a pregnant patient with haemorrhoids, are lifestyle modifications more effective than other treatments in reducing symptoms?

Recommendation: Haemorrhoids are very common in pregnancy. Lifestyle modifications, including high-fibre diet, exercise, ice packs, and reduction in straining, can reduce the incidence. Operative intervention is rarely necessary and is discouraged during pregnancy as symptoms usually resolve postpartum.

Level of evidence: IV
Grade of recommendation: GP
Strongly agree 70%, agree 20%

Thrombosed haemorrhoids in pregnancy

Thrombosed haemorrhoids are very common during the postpartum phase, but also arise in the third trimester of pregnancy in association with constipation, with an incidence of 2–8%[126,127]. Treatment for thrombosed haemorrhoids in pregnancy is controversial owing to limited evidence, with options including conservative management or early surgical approaches. Guidelines from the European Society of Coloproctology[127] in 2020 recommend that early surgery can be performed in this patient group, although the guidance was based on a retrospective review of 25 patients from a single centre who underwent haemorrhoidectomy under local anaesthetic.

More recently, three further retrospective single-centre studies[128–130] have been published. First, a study from the USA,

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in an outpatient setting of early surgical treatment performed under local anaesthetic, reported no obstetric complications in a series of 40 patients. A further study from China assessed 35 patients who underwent Ligasure™ haemorrhoidectomy. It was demonstrated that patients who underwent Ligasure™ haemorrhoidectomy experienced quicker pain relief, shorter recovery time, lower recurrence rates, and greater satisfaction. This procedure had fewer postoperative complications, with no significant risk to the mother or fetus. Finally, a series of 13 pregnant patients with thrombosed haemorrhoids from Turkey managed operatively reported no obstetric complications. This growing body of evidence suggests that early surgery could be considered in the very symptomatic pregnant patient.

Key Question 4.2: In a pregnant patient with a thrombosed haemorrhoid, is surgical intervention safer than conservative management for fetal outcome?

Recommendation: In a pregnant patient with thrombosed or gangrenous haemorrhoids, surgical haemorrhoidectomy may reduce the duration of symptoms without compromising pregnancy outcome. The risks and benefits of surgical intervention should be discussed with the mother in detail. Specialist input from the obstetrician, neonatologist, and obstetric anaesthetist is required to ensure patient management in an appropriate hospital setting.

Level of evidence: III
Grade of recommendation: B
Strongly agree 36%, agree 55%

Anal fissure in pregnancy

Anal fissures are common during pregnancy, with incidence rates of up to 20%[131]. The primary cause of anal fissures is hard, bulky stool resulting from constipation or, in rare instances, chronic diarrhoea[132]. They are more common in the third trimester and postpartum. The treatment for acute anal fissures (defined as having a duration of less than 6 weeks) is usually a conservative approach, which includes dietary modifications such as increased water intake, the use of laxatives, diets high in fibre, and sitz baths[123].

Topical treatments, such as glyceryl trinitrate rectal ointment, or topical diltiazem or nifedipine, are recommended in the non-pregnant patient as first-line treatment for chronic fissures (duration more than 6 weeks) or fissures that do not respond to conservative treatments[133]. Although there are no published studies of these treatments in pregnancy, there is no evidence that they cause harm, especially when used topically, and their use in pregnancy is recommended by the American Society of Gastroenterology[123]. Intersphincteric botulinum toxin can also be used for anal fissures in the non-pregnant population, and there is some evidence for its safety in the pregnant population as well.

Hernias in pregnancy

The management of emergency complications of hernias forms a reasonably large part of the workload of the general surgeon on call. The anatomical and physiological changes of pregnancy are known to be associated with ventral and epigastric hernias. Despite this, the need for emergency repair of any type of hernia in pregnancy is extremely low[134]. There is no evidence to suggest that having an abdominal wall hernia in pregnancy will affect the mother being able to have a normal vaginal delivery[134,135].

Emergency surgery for umbilical and ventral hernia during pregnancy

A review of the literature regarding the management of umbilical and ventral hernias during pregnancy identified a systematic review[136] and recent guidelines[137] from the European and American hernia societies. However, these publications were based on case series and case reports only.

The largest case series[138] of hernia repair during pregnancy included 126 patients from the American College of Surgeons National Surgical Quality Improvement Program. Only 71 of these were for incarceration or strangulation; the remainder were concurrent with another procedure. Only three of the patients had an open repair with mesh, and five had a laparoscopic repair; the remainder had an open suture repair. There is evidence that women who undergo an open repair with mesh can suffer pain at the repair site in the subsequent pregnancy[137].

Key Question 5.1: If a pregnant patient presents with a tender or incarcerated hernia during pregnancy, should suture repair or mesh repair be recommended to reduce recurrence?

Recommendation: A pregnant patient with an incarcerated primary umbilical or ventral hernia should be managed in the same way as a non-pregnant patient. If surgical repair is indicated, open suture repair is the option of choice. Specialist input from the obstetrician, neonatologist, and obstetric anaesthetist is required to ensure patient management in appropriate hospital setting.

Level of evidence: III
Grading of recommendation: B
Strongly agree 63%, agree 18%

European hernia guidelines[137] suggest discussing the advantages and disadvantages of using mesh *versus* suture repair, but generally support sutured repair for ventral hernias in pregnant women

Key Question 5.2: If a pregnant patient presents with a tender hernia containing just omentum, does conservative or surgical management lead to the best outcome for the fetus?

Recommendation: In a pregnant patient with a tender hernia containing omentum only, the patient should be managed in the same way as a non-pregnant patient, and surgical intervention is likely to be indicated. The risks and benefits of surgical intervention should be discussed with the mother. Specialist input from the obstetrician, neonatologist, and obstetric anaesthetist is required to ensure patient management in the appropriate hospital setting.

Level of evidence: III
Grading of recommendation: B
Strongly agree 72%, agree 27%

Laparoscopic hernia repair in pregnancy

Laparoscopic repair of ventral hernias in the emergency setting is well described in non-pregnant patients, and may have benefits in terms of reduced surgical-site infections and reduced duration of hospital stay[139]. Although there has been some hesitancy in using laparoscopy during pregnancy, it is being used increasingly when required, frequently for procedures such as appendicectomy, cholecystectomy, and ovarian torsion[140]. The safety of laparoscopic procedures for both mother and fetus is well documented[141]. Laparoscopic repair of incarcerated hernias in pregnancy has been described in only one case report[142], with a

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successful outcome for mother and fetus. A further five cases were reported from the American College of Surgeons National Surgical Quality Improvement Program[138]. However, the success of laparoscopic repair depends on the patient's physiology, the trimester of pregnancy, and the surgeon's skill in fully utilizing its benefits, ensuring safety.

Key Question 5.3: If a patient presents with a tender or incarcerated hernia during pregnancy, should open or laparoscopic repair be recommended to reduce pregnancy complications?

Recommendation: If a pregnant patient presents with a tender or incarcerated hernia, a laparoscopic approach could be considered, taking into account the trimester and the skill and capability of the available surgeon. The risks and benefits of surgical intervention should be discussed with the mother in detail. Specialist input from the obstetrician, neonatologist, and obstetric anaesthetist is required to ensure patient management in an appropriate hospital setting.

Level of evidence: IV
Grade of recommendation: GP
Strongly agree 60%, agree 20%

Groin hernia in pregnancy

Groin hernias are uncommon in pregnancy as the uterus expands to cover the inguinal and femoral canals. However, an important consideration is the misdiagnosis of round ligament varicocele[143], which can present with very similar symptoms—a history of an intermittent lump that is worse with standing and towards the end of the day, which can become tender and irreducible. Round ligament varicocele is managed very differently from inguinal hernia; surgery is not indicated and all published cases resolved postpartum, although the recurrence rate is approximately 90% in subsequent pregnancies. It is therefore essential to consider imaging with ultrasonography in a pregnant patient who is referred with suspicion of an inguinal hernia.

Incisional hernias in pregnancy

Complications related to incisional hernia are rare in pregnancy, and only a small number of case reports have been published. They can be a rare cause of SBO and strangulation[144]. Consideration should also be given to uterine incarceration through either a Pfannenstiel or lower midline incision[145]. It is sometimes possible to reduce the hernia and manage it with an abdominal binder. Elective caesarean section is then recommended, and subsequent incisional hernia repair often with the use of mesh.

Upper gastrointestinal complications

Pregnancy has a direct impact on the upper gastrointestinal tract. Progesterone can lead to delayed gastric emptying. Gastrin, produced by the placenta, may increase gastric acidity[146].

Peptic ulcer disease in pregnancy

Because of the physiological changes in pregnancy, it is very common for women to develop worsening symptoms of reflux throughout pregnancy. Despite this, the incidence of peptic ulcers and their complications is remarkably low. In a large cohort study[147] of over 13 million births in the USA, the incidence of peptic ulcer disease in pregnancy was 7 per 100 000 births.

The incidence of surgical complications of peptic ulcer disease is even rarer. A literature review in 2022 identified only six case reports of perforated peptic ulcers during pregnancy in the past 40 years, one of which was related to previous bariatric surgery[148]. Five of these cases developed in the third trimester, and the site of perforation was in either the first or second part of the duodenum.

There have been numerous case reports of perforated peptic ulcers in the immediate postpartum phase, suggesting that the reduced incidence during pregnancy might be a direct result of the pregnancy rather than modifications to lifestyle associated with pregnancy.

There have been no case reports of surgery for bleeding peptic ulcers during pregnancy.

Boerhaave's syndrome in pregnancy

Boerhaave's syndrome comprises rupture of the oesophagus due to forceful vomiting. It has a high mortality rate of up to 40% if not identified early[149]. Pregnancy is a time of increased vomiting, especially among those suffering from hyperemesis gravidarum, yet, despite this, Boerhaave's is very rare in pregnancy. A small number of case reports have described this phenomenon in pregnancy, all in the first trimester[150,151]. It should be suspected in a patient with hyperemesis who develops surgical emphysema or severe pain radiating to the back. Each of the reported patients was managed without surgery, although one required a period of parenteral nutrition.

Complications of bariatric surgery in pregnancy

Bariatric surgery is increasingly being undertaken in patients of childbearing age[152]. Late complications of this type of surgery are not uncommon, depending on the procedure undertaken; for example, up to 50% of patients with a laparoscopic adjustable gastric band (LAGB), and up to 20% of those with a Roux-en-Y gastric bypass (RYGB), may require revisional surgery in the long term[153]. The number of pregnant patients being referred to the general surgeon on call after bariatric surgery is increasing. However, pregnancy itself does not seem to increase the incidence of bariatric complications[154].

In a nationwide survey[155] of bariatric units in the Netherlands, 7 of 18 had seen at least 1 pregnant patient following bariatric surgery who presented with abdominal pain and severe morbidity; although no maternal deaths were reported, 1 fetus had died.

Internal hernia after Roux-en-Y gastric bypass during pregnancy

An internal hernia is a severe life-threatening complication that can occur after RYGB. Only case reports and small case series have been published on this presentation in pregnancy. A systematic review and case series[156] in 2016 identified 52 cases between 2004 and 2015. Most patients presented in the late second or third trimester with abdominal pain, and one-third also had nausea or vomiting. Patients underwent a range of imaging, including ultrasonography, CT, and MRI. None of these modalities had good diagnostic accuracy; CT was the most accurate. However, several patients were taken to theatre on clinical suspicion alone. Approximately half of the patients underwent laparotomy from the start, and operations in a further 10% were converted from laparoscopy to laparotomy. Delay of over 48 h from presentation was strongly associated with the need for laparotomy and need for bowel resection, and there were two maternal deaths in this group (9%) and three fetal deaths (14%).

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Key Question 6.1: Should a pregnant patient with a history of laparoscopic Roux-en-Y gastric bypass surgery, who has a suspected internal hernia, be transferred to a specialist bariatric surgeon or treated by the emergency general surgeon on call?

Recommendation 6.1: In a pregnant patient with unexplained upper abdominal pain and a history of laparoscopic Roux-en-Y gastric bypass surgery, ultrasound imaging and upper gastrointestinal endoscopy should be used to rule out other causes. MRI, or, if this is not available, CT with oral contrast can be used to diagnose an internal hernia. If there is suspicion of internal hernia and specialist bariatric support is not readily available, urgent laparoscopy or laparotomy by an emergency general surgeon should be considered. The risks and benefits of surgical intervention should be discussed with the mother. Specialist input from the obstetrician, neonatologist, and obstetric anaesthetist is required to ensure patient management in appropriate hospital setting.

Level of evidence: IV
Grade of recommendation: C
Strongly agree 56%, agree 44%

Gastric band complications in pregnancy

LAGB was previously one of the most common bariatric procedures performed. However, its popularity has declined owing to the high complication rate, and now, although LAGBs constitute a small proportion of bariatric operations, many women still have gastric bands in place. Band slippage can occur during pregnancy, especially in the second trimester, causing gastric outflow obstruction, and if there has been a shorter time interval between placement and pregnancy[157]. In a case series of 81 pregnancies after LAGB, 2 patients developed bland slippage requiring band removal. There has also been a case report[158] of gastric perforation in the third trimester in a patient with a LAGB.

A pregnant patient referred to the general surgeon on call with abdominal pain or vomiting after LAGB should be treated as any patient with a history of a gastric band. Consideration should be made to removing the fluid from the band with a Huber needle or spinal needle under ultrasound guidance if necessary, and an opinion should be sought from a bariatric surgeon[159]. However, just as in a non-pregnant patient, emergency surgical intervention may be required if the patient is acutely unwell.

Splenic artery aneurysm rupture and other causes of haemoperitoneum in pregnancy

Spontaneous haemoperitoneum in pregnancy (SHiP) is defined as acute intraperitoneal haemorrhage during pregnancy or up to 42 days postpartum, excluding trauma, uterine rupture, or ectopic pregnancy[160]. Although very rare, this complication of pregnancy involving the general surgeon on call has the highest mortality rate of both mother (3%) and fetus (25%). SHiP presents most commonly in the third trimester, and is associated with advanced maternal age and artificial reproductive technologies[161].

SHiP has an incidence of 0.04–0.1 per 1000 births[160,162]. Patients present with abdominal pain and hypovolaemic shock. It is often misdiagnosed as placental abruption, so the diagnosis is often made after emergency caesarean section. Median volume of hemoperitoneum reported was 1600 ml.

The commonest location of intraperitoneal haemorrhage in pregnancy is the pelvis, such as uterine wall, broad ligament, and adenexa. Rupture of a splenic artery aneurysm (SAA) is the commonest non-pelvic cause, but other causes of splenic bleeding are also seen, such as spontaneous splenic rupture and splenic vein rupture, as well as hepatic rupture and iliac artery aneurysm rupture. More recently, endometriosis, especially when combined with fertility treatment, has become prevalent as a cause of SHiP[163]. In approximately one-third of cases, no cause of the bleeding is identified.

For the general surgeon called to the obstetric theatre for haemoperitoneum, conversion to a midline laparotomy and formal damage control laparotomy with four-quadrant packing may be a lifesaving manoeuvre. Alternatively, if the volume of haemoperitoneum is not excessive and the patient remains stable, morbidity may be reduced by closing the Pfannenstiel incision and proceeding to CT angiography to identify the source of bleeding, and managing it endovascularly if necessary.

Key Question 7.1: In a pregnant mother with haemoperitoneum diagnosed at caesarean section, should the patient be transferred for imaging or proceed to full-length midline laparotomy?

Recommendation: When called to the obstetric theatre for a mother with haemoperitoneum, who had been taken for caesarean section with an initial diagnosis of placental abruption, the most common source of bleeding is either pelvic, or no source can be found. If there are no signs of ongoing bleeding, consider closing and proceeding to imaging with CT angiography because, if an extrapelvic source is subsequently identified, embolization can be used if necessary. However, if the patient shows signs of ongoing bleeding, a midline laparotomy should be performed to identify extrapelvic sources of bleeding, most likely from the liver or spleen.

Level of evidence: III
Grade of recommendation: B
Strongly agree 55%, agree 45%

Splenic artery aneurysms in pregnancy

SAA is the most common visceral artery aneurysm. The development of this type of aneurysm is thought to be related to the pathophysiological changes of pregnancy rather than to atherosclerosis. It has a prevalence in the population of 0.1–0.2% in autopsy series; however, it is four times more common in women, especially multiparous women[164].

A recent systematic review[165] of SAAs in pregnancy identified only 84 cases, of which 89.3% were ruptured at presentation. Of the 241 maternal deaths reviewed in the 2019–2021 UK maternal, newborn and infant clinical outcome review programme[166], 4 patients had died from a ruptured SAA. Common presenting features for splenic artery rupture were upper abdominal pain, often associated with shoulder-tip pain, nausea, and chest pain with collapse and hypovolaemic shock, although atypical presentations and misdiagnosis as either placental abruption or pulmonary embolism were common. The double-rupture phenomenon was found in 15% of patients with SAA rupture: initially the blood is contained in the lesser sac with minimal symptoms, before generalized rupture and circulatory collapse, usually within 48 h[167].

The diagnosis is often made at laparotomy after emergency caesarean section. However, a focused assessment with sonography for trauma scan has been recommended to diagnose haemoperitoneum and enable early involvement of the general surgical team[168]. If there is time, ultrasound imaging or, more rarely, CT has been used for diagnosis.

For the initially stable patient, successful endovascular management has been described when available[163]; however, this must not delay repair because the mortality rate is high when free rupture occurs.

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Location of delivery of care of pregnant patients with surgical disease

Recommendations have consistently reinforced the advice that optimum treatment of the mother leads to the optimum outcome for mother and fetus.

A common dilemma when a patient has been referred to the general surgeon on call is where the patient should be cared for—on the surgical ward or the gynaecology or obstetric ward? A systematic review to find answers to this question did not identify any publications that addressed this question directly. However, an Acute Care Toolkit is available from the Royal College of Physicians[169]. They recognize the importance of using MEWS (see section on general guidance for surgeons managing pregnant patients) and that 'local inpatient shared care pathways and services [should be] in place for pregnant women presenting with acute medical problems, including where they should be cared for'.

To provide optimum surgical care, benefits can be seen from being cared for on a surgical ward with nurses and doctors and other members of the team familiar with management of the surgical disease. However, it should be recognized that pregnancy itself and complications of the pregnancy may mimic surgical disease, and these patients may be best treated by midwives and gynaecologists and obstetricians, so, pending confirmation of the diagnosis, the pregnant patient may best be managed on a gynaecology or obstetric ward.

Key Question 8.1: Should a pregnant patient referred to the general surgery team be cared for on a surgical ward or an obstetric ward?

Recommendation: A pregnant patient referred with confirmed general surgical pathology may best be treated on the surgical ward under the care of the surgeon. There should be regular review from the obstetric team, with fetal monitoring as advised by the obstetric team. Medical and nursing staff responsible for the patient should be aware of the modified parameters for early warning of deterioration in a pregnant patient. If the clinical diagnosis is unclear, the patient should be managed on the obstetric or gynaecology ward, under the care of the gynaecologist and obstetrician. There should be regular review by the surgical team until the diagnosis is clarified.

Level of evidence: IV
Grading of recommendation: GP
Strongly agree 45%, agree 35%

Conclusions

The importance of providing optimum care to the mother to improve the outcome of the fetus has been stressed throughout these guidelines. The strength of the guidelines is limited by the small number of published papers and the low level of evidence in the patient groups studied.

It has also been identified that open communication and explanation of risks should be prioritized with the patient and relatives. Timely communication between senior members of all disciplines involved in the care of these patients is essential. Treatment should be undertaken in centres that can also provide neonatal intensive care when necessary. When pregnant patients are cared for on a general ward, maternal early warning scores should be used.

General surgery colleagues engaged in the shared management of this patient group will be supported and informed by this extensive review of the evidence and expert recommendations. However, this guidelines process has identified that more research is needed in this overlooked population.

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Disclosure

The authors declare no conflict of interest.

Data availability

This guideline did not involve the collection of any data. As a result, no data were collected, generated, or stored during the development of this guideline. The guideline relies on existing knowledge, data, and information that have been published previously and are available through publicly accessible sources. The authors have reviewed and critically analysed existing data to provide the recommendations and best practices outlined in this guideline. The results of voting and minutes of the PICO and consensus meetings are available from the corresponding author on reasonable request.

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