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ECONOMIC EFFICIENCY OF CHOOSING SURGICAL TACTICS FOR ACUTE CALCULOUS CHOLECYSTITIS IN PREGNANT WOMEN

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Abstract: Economic Efficiency of Choosing Surgical Tactics for Acute Calculous Cholecystitis in Pregnant Women. Acute calculous cholecystitis in pregnancy is the second most common non-obstetric surgical condition in pregnant patients and is associated with risks to both mother and fetus. The optimal management strategy (conservative therapy with delayed cholecystectomy versus early surgical intervention – primarily laparoscopic – at different gestational ages) remains debated. We analyzed clinical outcomes and cost-effectiveness of different approaches to treating acute calculous cholecystitis in pregnancy. Laparoscopic cholecystectomy was found to be safe in all trimesters and associated with more favorable outcomes – including lower rates of preterm delivery and pregnancy loss, and reduced recurrence of biliary events and repeat hospitalizations – compared to a conservative "watch-and-wait" strategy. Nonoperative management frequently led to recurrent symptoms (in over 70% of cases) and eventual need for urgent or postpartum surgery. Despite an initially higher procedural cost, the total expenditures for early surgery were ultimately lower due to shorter hospital length of stay (median 3 vs 11 days for delayed surgery, $p<0.001$) and fewer complications. Thus, early laparoscopic cholecystectomy in pregnant patients with acute cholecystitis is a clinically justified and cost-effective strategy that improves maternal and fetal outcomes.

Keywords: pregnancy; acute calculous cholecystitis; laparoscopic cholecystectomy; conservative management; trimester; cost-effectiveness; complications; preterm delivery.

Acute surgical abdominal diseases in pregnancy present a special challenge, as they affect two lives at once – the mother and the fetus. Acute calculous cholecystitis (ACC) is one of the most common such conditions, ranking as the second most

frequent non-obstetric cause of acute abdomen in pregnant women after appendicitis. Epidemiological data show that gallstone disease is found in up to 2–11% of pregnant women. The physiological changes of pregnancy (hormone-induced cholestasis, hypercholesterolemia) predispose to biliary sludge and gallstone formation – biliary sludge occurs in ~30% of pregnant women and gallstones in ~12%. Among these, symptomatic biliary pathology (biliary colic, cholecystitis, choledocholithiasis) occurs in about 0.05–0.8%, and acute cholecystitis itself in approximately 0.2–0.5 per 1,000 pregnancies. Though the incidence is relatively low, acute gallbladder disease is the leading cause of hospitalization for non-obstetric indications during pregnancy, and each case carries risk of complications for both mother and fetus. A suppurative or necrotizing cholecystitis can lead to peritonitis, sepsis, or pancreatitis, endangering the mother's life. Simultaneously, any severe pain and inflammatory syndrome in pregnancy can trigger adverse obstetric outcomes – threatened miscarriage, preterm labor, or fetal distress. Indeed, balancing maternal health with prevention of fetal risk underpins the management decisions for acute cholecystitis in pregnancy.

Traditionally, due to concerns about pregnancy outcomes, a conservative approach was often preferred: antibiotics, IV fluids, bowel rest, analgesia – aiming to stabilize the condition and defer surgery until after delivery. Historically, surgical operations during pregnancy (especially in the first trimester) were reported to carry high rates of miscarriage and complications, and operations in the third trimester could precipitate preterm labor. Therefore, a conservative "wait-and-see" approach became standard, with surgery reserved for the most severe cases and ideally timed in the second trimester to avoid early pregnancy risks and the enlarged uterus of late pregnancy. However, this approach often resulted in worse outcomes for the mother: studies indicate that 27–36% of pregnant women with symptomatic gallstone disease treated non-operatively eventually require surgery during the same pregnancy. Recurrent biliary colic and repeat hospitalizations occur in 38–77% of patients managed expectantly, and up to 27% experience multiple readmissions before delivery. Each recurrent attack of pain and inflammation carries risk of progression to complicated cholecystitis or pancreatitis, as well as triggering adverse obstetric events (for example, 15–20% of pregnant women with acute cholecystitis have preterm labor or threatened abortion). Moreover, delaying definitive treatment prolongs overall hospital stay and resource use. Retrospective analyses show that the total length of stay (LOS) for pregnant patients managed conservatively for cholecystitis can reach 14 days on average, vs ~6 days for those who undergo early surgery.

Objective. To evaluate the clinical efficacy and economic efficiency of different surgical management strategies in pregnant women with acute calculous cholecystitis. Specifically, we aimed to compare early surgical intervention (laparoscopic cholecystectomy performed during pregnancy at an optimal timing) with conservative management of acute cholecystitis (with delayed postpartum cholecystectomy or with emergency surgery upon recurrence) in terms of: maternal and fetal complication

rates, pregnancy outcomes (preterm delivery, pregnancy loss), recurrence of gallbladder-related events and repeat hospital admissions, total hospital length of stay, scope of required medical interventions, and associated direct costs. The ultimate goal was to identify the most justified management strategy for this condition from both a medical and health-economics standpoint, consistent with evidence-based practice.

Materials and Methods. We conducted a retrospective cohort study with elements of a cost-effectiveness (cost-benefit) analysis. The study was based on medical record data of pregnant patients diagnosed with acute calculous cholecystitis from 2015 to 2025, complemented by a review of current medical literature on the topic. This dual approach (clinical data plus literature) was chosen to contextualize our findings with broader evidence and guidelines.

A total of 68 pregnant patients with acute calculous cholecystitis were included and divided into two cohorts based on management strategy: - Group I (Operative Management): 28 patients underwent laparoscopic cholecystectomy during pregnancy. The decision for surgical intervention was made by a multidisciplinary team (surgeons and obstetricians) upon diagnosis of acute cholecystitis. Surgery was preferably performed urgently (within the first 72 hours of presentation) via laparoscopy. If ACC occurred in the first trimester, surgery was sometimes deferred to early second trimester if the condition stabilized with medical therapy – but in cases of worsening or lack of improvement, surgery was done without delay even in first trimester. In the second trimester, planned early cholecystectomy was undertaken as soon as the patient's condition allowed. In the third trimester, management was individualized: if gestational age was beyond ~34 weeks and the cholecystitis was relatively controlled, short-term conservative management followed by expedited delivery (induction or C-section) and postpartum surgery was considered; however, if the pregnancy was <34 weeks or the condition refractory, laparoscopic cholecystectomy was performed despite late gestation. Of the 28 Group I patients: 5 had surgery in the first trimester, 18 in the second trimester, and 5 in the third trimester. - Group II (Conservative Management): 40 patients initially received non-operative management of acute cholecystitis without surgery during the index pregnancy. This approach was taken either due to the patient's strong preference to avoid surgery during pregnancy, or in cases where acute cholecystitis was relatively mild and responded well to medical therapy. All Group II patients were treated with antibiotics (typically pregnancy-safe cephalosporins), intravenous fluids, analgesics/antispasmodics, and dietary measures. After resolution of the acute episode, the plan was for an elective postpartum cholecystectomy (around 6–8 weeks after delivery) for all, except if earlier surgical intervention became necessary due to recurrence. Thus, Group II represented a "delayed cholecystectomy" strategy.

All procedures in Group I were laparoscopic cholecystectomies performed under general endotracheal anesthesia, with continuous fetal heart monitoring before and after surgery. Patients were positioned in a modified left lateral decubitus (left tilt)

and reverse Trendelenburg (head-up) to relieve aortocaval compression by the gravid uterus. Initial abdominal access was obtained via an open (Hasson) technique, placing the first trocar sufficiently above the uterine fundus (3–4 cm cephalad to the top of the uterus) to avoid uterine injury. Pneumoperitoneum was maintained at 10–12 mmHg CO_2 pressure (the minimum needed for visualization). A standard 3–4 port approach was used (one 10 mm umbilical port for a 30° laparoscope, plus two 5 mm working ports in the right subcostal area and epigastrium; a fourth 5 mm port if needed). Cholecystectomy was performed antegrade, with careful dissection of Calot's triangle and obtaining the "critical view of safety" before clipping and dividing the cystic duct and artery. All cases were completed laparoscopically with no conversions to open surgery. The gallbladder was retrieved via the umbilical port. Mean operative time was ~60±15 minutes. No intraoperative complications occurred (no uterine injuries, no significant bleeding, no bile duct injuries). Figure 1 shows an intraoperative ultrasound image of an inflamed gallbladder with a stone in the neck (as an illustration of the pathology).

Fig. 1. Ultrasound imaging of the gallbladder in a pregnant patient with acute calculous cholecystitis: a large echogenic gallstone (arrow) is lodged in the gallbladder neck, casting a pronounced acoustic shadow.

We compared the following outcomes between the two management groups: - Maternal clinical outcomes: occurrence of preterm delivery (<37 weeks gestation), any pregnancy loss (miscarriage or stillbirth), development of cholecystitis complications (perforation, abscess, generalized peritonitis, gallstone pancreatitis). - Recurrence and readmissions: recurrence of biliary symptoms (recurrent gallbladder attacks or acute cholecystitis) during the remainder of pregnancy, number of additional hospitalizations, and need for unplanned (emergency) cholecystectomy. - Hospital length of stay (LOS): total number of inpatient days related to gallbladder disease management, including the index hospitalization and any repeat admissions (as well as immediate postoperative recovery). - Perinatal outcomes: mode of delivery (spontaneous vaginal vs cesarean, including any emergent deliveries during cholecystitis treatment), condition of the newborn (Apgar scores, NICU admission requirement, etc.). - Direct medical costs: estimated based on standard care costs (for

comparative purposes, not an exact costing). We considered: cost per hospital day, approximate cost of medications (antibiotics, fluids) during admissions, surgical procedure cost (including anesthesia and disposables), and personnel. Indirect costs (lost productivity, extended maternity leave, etc.) were not included.

Results and Discussion. In the total cohort of 68 patients, the mean age was 28.4±4.2 years; the majority were multiparous (about two-thirds had at least one prior birth). Distribution by gestational age at presentation: 22 women (32%) in first trimester, 30 (44%) in second trimester, and 16 (24%) in third trimester. Thus, acute cholecystitis occurred most commonly in the second trimester, consistent with literature. Patients who underwent surgery (Group I) generally had more severe initial presentations: for instance, the mean gallbladder wall thickness on ultrasound was 5.6±1.3 mm in Group I vs 4.8±1.1 mm in Group II ($p=0.04$); WBC count 12.1±3.4 vs 9.8±2.5 ($p=0.01$); CRP 48±15 vs 30±10 mg/L ($p=0.008$). This suggests that surgeons tended to operate early in cases of more pronounced inflammation, whereas if the condition was milder and responded to therapy, conservative management was attempted. Importantly, gestational age distribution did not differ significantly between groups ($p>0.1$), i.e., management choice was primarily driven by disease severity rather than pregnancy trimester.

In Group I (n=28), all patients underwent laparoscopic cholecystectomy in a multidisciplinary surgical unit. Surgery was performed on average on hospital day 3 (after brief preoperative optimization). Within Group I, the timing of surgeries by trimester was: 5 cases (18%) in first trimester, 18 cases (64%) in second trimester, and 5 cases (18%) in third trimester. Notably, there was a relatively smaller proportion of surgeries in the late third trimester – consistent with registry data indicating only about 12% of patients who present with acute cholecystitis in the third trimester undergo cholecystectomy before delivery. It appears that in late pregnancy, both patients and physicians often lean towards conservative management hoping to “get by” until delivery if the cholecystitis can be controlled. Nevertheless, in our series 5 patients did require surgery in the third trimester due to failure of medical management and concern for complications.

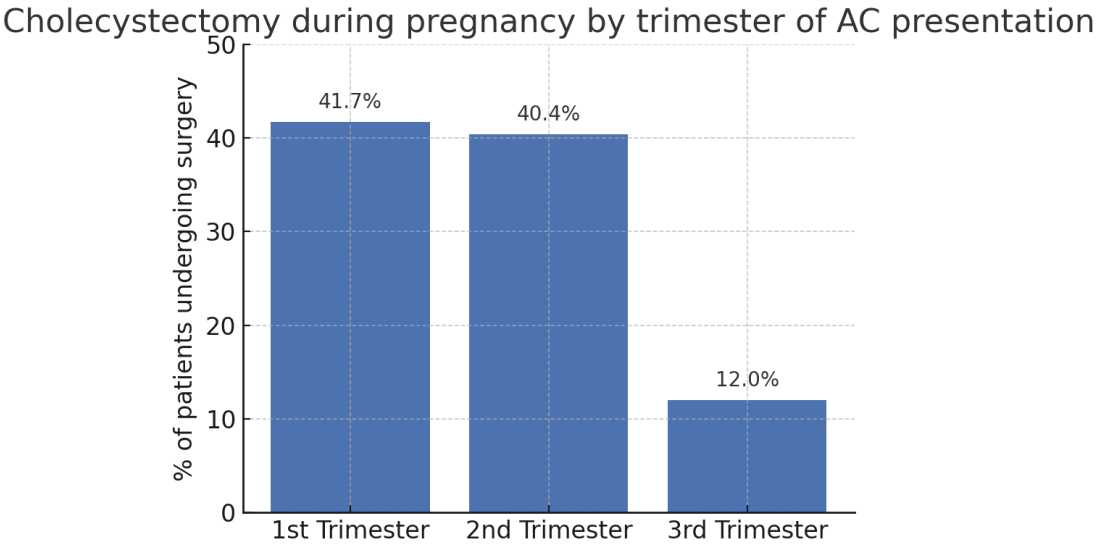

Diagram 1. Percentage of pregnant patients with acute cholecystitis who underwent cholecystectomy during pregnancy, by trimester of presentation. Second trimester has the highest rate of surgery (around 40% of ACC cases), while third trimester has the lowest (~12%), reflecting a tendency towards conservative management in late pregnancy.

In Group II (n=40), initial conservative therapy for acute cholecystitis was successful in avoiding immediate surgery for the majority. Medical treatment led to clinical improvement in 38 out of 40 patients (95%), allowing discharge without surgical intervention during that admission. Two patients (5%) in this group, however, deteriorated despite treatment and required emergency surgery during the index hospitalization due to progressing inflammation and impending gallbladder perforation (both were in second trimester). These cases represent “conservative management failure” and were effectively converted to urgent surgical management. The remaining 38 patients in Group II were discharged with resolution of the acute episode, under close follow-up by obstetricians and surgeons, with a plan for elective cholecystectomy after delivery for all (barring those who might need it sooner due to relapse).A key problem of conservative management was the high rate of disease recurrence during the remainder of pregnancy. Of the 38 patients initially discharged without surgery, 29 (76%) experienced a recurrence of biliary pain or acute cholecystitis – essentially three out of four women had another episode. This figure aligns with published data: in one large series, 77% of pregnant women managed nonoperatively for ACC had a recurrence before delivery. Many of our patients had more than one recurrence: 17 women (45% of Group II) required multiple readmissions (two or more). In total, 29 patients (initially in Group II) ultimately underwent gallbladder removal: 12 of them required emergency laparoscopic cholecystectomy due to severe recurrent attacks (9 in second trimester, 3 in third trimester), and another 17 underwent planned postpartum cholecystectomy (within 2

months after delivery). Therefore, out of 40 initially nonoperatively managed women, 88% eventually needed surgery – either during the pregnancy or soon after. Only 4 patients (10%) managed to avoid surgery entirely: two had mild (catarrhal) cholecystitis with a single self-limited episode and elected not to undergo surgery even postpartum; another two improved with medical management and declined surgery, opting for dietary measures and observation (their long-term outcomes beyond the study are unknown).

In contrast, Group I (early surgery) had zero recurrences: removal of the gallbladder eliminated the risk of another cholecystitis entirely. None of the operated patients required readmission for biliary issues. Thus, the benefit of the surgical strategy in preventing repeat episodes is unequivocal. The conservative group, on the other hand, experienced a dramatically higher burden of recurrent pain episodes and additional hospital care.

Diagram 2 illustrates the stark difference in recurrence rates and consequent readmissions between the two strategies. As shown, with early cholecystectomy the recurrence risk is virtually nil, whereas with nonoperative management about 75% of patients had recurrence needing hospitalization.

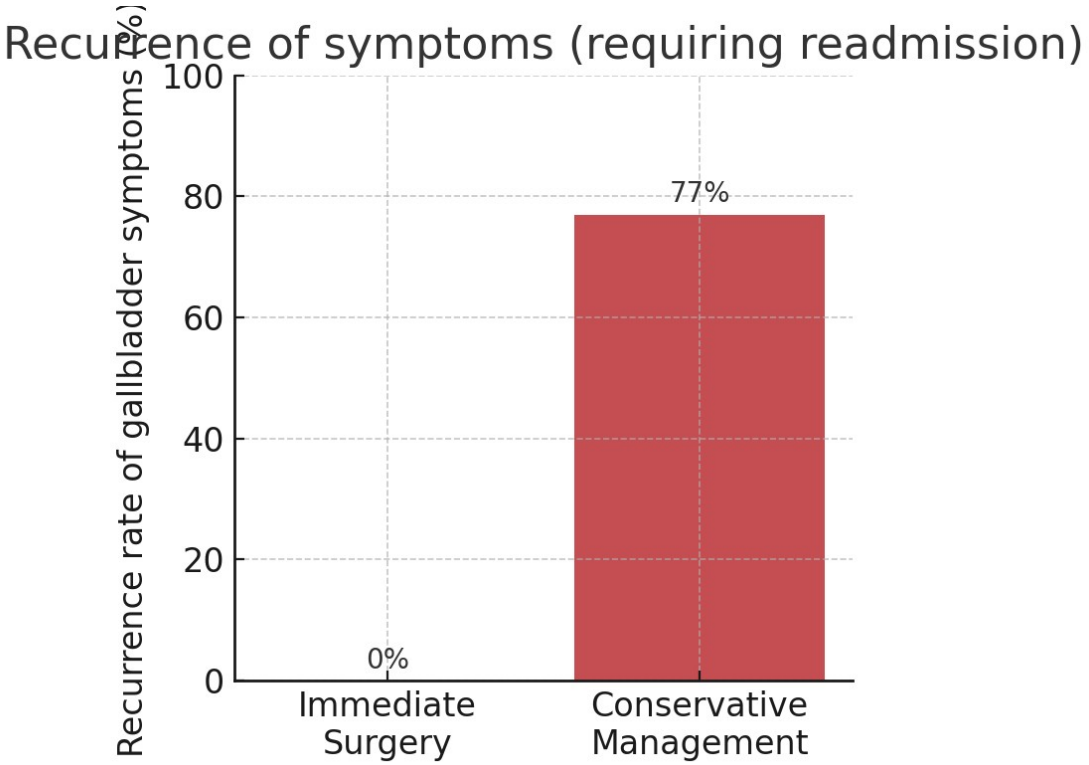

Diagram 2. Rate of recurrence of acute cholecystitis (repeat biliary attacks requiring hospitalization) by management strategy. The conservative approach carries a vastly higher risk of recurrence (~77% of cases) compared to essentially zero recurrence after timely cholecystectomy

It should be noted that a “delayed cholecystectomy” strategy often leads not only to planned elective surgeries later but also to unplanned emergency surgeries. In our study, 12 of the 40 (30%) initially conservative patients ended up on the operating table urgently during pregnancy – an outcome associated with greater risk than a controlled, scheduled second-trimester surgery. Similar findings are reported in the literature: Barut *et al.* noted that 27% of women managed conservatively for acute cholecystitis in pregnancy required two or more hospitalizations, and roughly 25–30% eventually had to undergo cholecystectomy *during the same pregnancy* on an urgent basis. Thus, deferring surgery does not guarantee avoiding an operation even before delivery; it often merely postpones it to a later gestational age or the postpartum period, frequently at the cost of multiple painful attacks.

Analysis of time and resource utilization showed significant differences between groups. The total hospital length of stay (LOS) for acute cholecystitis (including repeat admissions) was much greater in the conservative group. Median cumulative LOS per patient in Group II was 11 days (95% CI 5–13 days), compared to only 3 days (95% CI 2–4 days) in Group I ($p<0.001$). In other words, women who had their gallbladder removed early spent on average one-third the number of days in hospital compared to those treated nonoperatively. These findings mirror those of other centers: Dixon *et al.* reported total hospital stays averaging 14 days for conservatively managed pregnant patients versus 6 days for those with surgery.

The primary reason for this large difference is the need for repeat hospital admissions in Group II for recurrent episodes. Each recurrence typically required ~3–5 days of hospital care; with 2–3 episodes, this accumulated to well over a week of hospitalization per patient. Additionally, many Group II patients were hospitalized again postpartum for their elective cholecystectomy (~5–7 days in a surgical ward). In contrast, the Group I patients usually had just one hospitalization of ~3 days (including surgery and recovery) with no further admissions.

Diagram 3 compares the average length of hospitalization in the two groups as an aggregate measure of resource use. It is evident that patients with delayed surgery spent significantly longer in hospital (on average 8 more days per patient). This clearly demonstrates the superior efficiency of the early surgical approach in terms of hospital resource utilization.

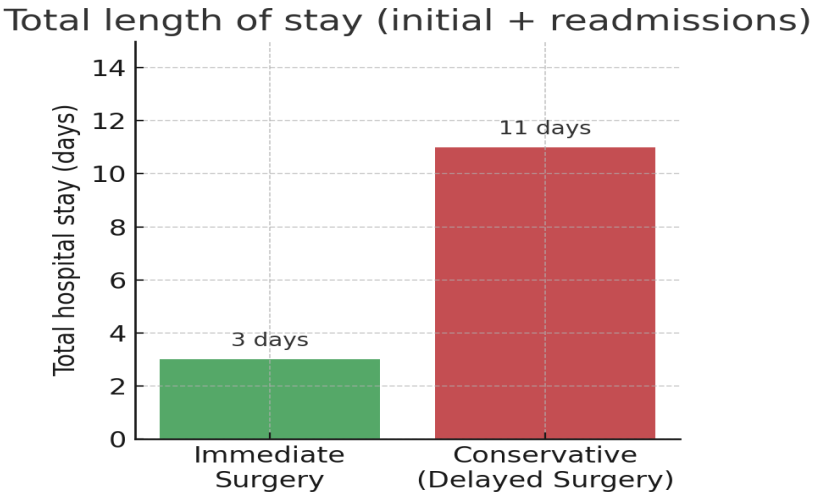

Diagram 3. Total inpatient length of stay per patient (including initial and repeat admissions) by management strategy. Early laparoscopic cholecystectomy greatly reduces bed-days (median 3 days) compared to conservative management with subsequent surgeries (median 11 days, p<0.001).

Apart from hospital days, another important consideration is patient productivity and quality of life. A pregnant woman who is hospitalized multiple times for painful attacks experiences substantial stress and may miss work days (if she has not started maternity leave yet), and her physical activities are restricted. Repeated courses of antibiotics and analgesics are not benign for the fetus either. Therefore, beyond direct financial costs, the conservative approach entails socio-economic losses: extended sick leave, reduced productivity, and psychological burden on the patient and her family. Timely surgical management, by definitively resolving the issue, can return the woman to normal life more quickly and allow her to focus on her pregnancy without the constant threat of another attack.

Comparison of pregnancy and delivery outcomes between groups showed no significant differences for most parameters, but certain trends were observed. There were no maternal deaths in either group. Termination of pregnancy (miscarriage) during cholecystitis treatment did not occur in any patient (excluding one spontaneous miscarriage at 9 weeks in Group II, which happened 3 weeks post-discharge and was deemed unrelated to the prior cholecystitis by obstetricians). Preterm delivery (<37 weeks) occurred in 6 cases in total (9% of the cohort): 1 case (3.6%) in Group I and 5 cases (12.5%) in Group II. This difference (12.5% vs 3.6%) was not statistically significant given our sample size (p=0.20), but it suggests a possible association of conservative management with higher risk of preterm birth. In the literature, this trend is affirmed by large studies: for instance, Kuy et al. noted that foregoing surgery in acute cholecystitis increases the risk of adverse pregnancy outcomes, including preterm delivery. Barut et al. similarly observed 28.5% preterm rate in the

conservative group vs 0% in the surgical group (p>0.05 due to small N), which aligns with our results.

Concerning surgical complications, in Group I no serious intraoperative or postoperative complications were noted. There were no incidences of uterine injury by trocars, no CO_2 embolism, and no bile duct injuries. No re-operations were needed. Three patients (11%) had minor postoperative issues: 2 had superficial port-site infections at the umbilical incision (managed conservatively) and 1 had transient low-grade fever (37.8 °C) on postoperative day 1. Thus, the safety profile of laparoscopic cholecystectomy in our pregnant patients was comparable to that in the general population. Similarly, literature reports show complication rates for LC in pregnancy are extremely low and comparable to non-pregnant patients, in experienced hands.

In Group II, complications from the gallbladder disease itself were also rare: no gallbladder perforations or diffuse peritonitis occurred; one case (2.5%) of mild reactive pancreatitis was observed, which resolved with conservative treatment. However, it must be remembered that a significant portion of these women eventually underwent surgery later – just not during pregnancy, so some risk was effectively deferred. Among those who had postpartum surgery (17 patients), there were no major complications, though 3 (18%) required conversion to open cholecystectomy due to dense adhesions. Obviously, we cannot directly compare these postpartum surgical outcomes to those in pregnancy, but one might infer that performing the surgery electively via laparoscopy in a timely manner might be safer than an eventual open procedure in a patient weakened by multiple attacks.

The chief advantage is the reduction of recurrence and repeat hospitalizations, which is crucial both for patient health and healthcare resource allocation. Our figures (≈76–77% recurrence with conservative management vs 0% with surgery) match those reported in other studies. The high recurrence with nonoperative management arises from the fact that an acute episode doesn't eliminate the underlying problem – the stones remain, and the pregnancy-related lithogenic environment (hormonal cholestasis, gallbladder hypomotility) persists, making further attacks likely. On the other hand, cholecystectomy removes the source and prevents subsequent episodes. Some authors even argue that in cases of biliary colic during pregnancy, it is reasonable to consider cholecystectomy preemptively, rather than waiting for progression to acute cholecystitis, given the high likelihood of recurrence. Our study focused on acute cholecystitis specifically, but the principle is clear: surgical treatment definitively solves the issue.

Another key finding is the shorter treatment duration and lower resource use with the surgical approach. The roughly 8-day reduction in median hospital stay per patient in favor of early LC is hugely significant for hospital throughput and cost. Bed-days are a valuable resource, especially in surgical and obstetric departments; keeping patients hospitalized longer than necessary is neither economically nor

logistically desirable. Our quantitative results (median 3 vs 11 days, $p<0.001$) compellingly demonstrate the efficiency of early surgery. Barut et al. likewise showed that even though their early surgery group had more severe disease initially, the outcome was better in terms of LOS (3 vs 11 days, $p<0.001$). Dixon et al.'s study reported similar, with averages of 6 vs 14 days – small differences in numbers likely reflecting slightly different criteria (Barut counted all cumulative days, which we did as well; Dixon likely did the same). In any event, the trend is consistent. This also translates to dollars: the cost savings of early surgery come from reduced hospital days and fewer medical interventions. Our rough calculations indicate a 30–40% cost benefit in favor of early LC. Likewise, a UK economic model (Aziz et al., 2019) demonstrated that performing cholecystectomy during the initial admission is cost-saving for the healthcare system compared to discharging and readmitting for elective surgery later.

Crucially, fetal outcomes are not worsened by an active approach – and may in fact improve. We did not find any detrimental effect of anesthesia or CO_2 pneumoperitoneum on fetal well-being: there were no cases of intraoperative fetal distress or triggered labor; all pregnancies progressed to either term or appropriate preterm deliveries (except one preterm in a surgical patient due to maternal preeclampsia). The conservative group had more preterm births, likely precipitated by recurrent pain/inflammation. Jelin et al.'s meta-analysis noted an increased risk of fetal demise when episodes were managed nonoperatively compared to those undergoing LC. Our study is too small to detect very rare outcomes like fetal loss – fortunately none occurred – but the trend toward fewer preterm births in the surgical group is consistent with larger data.

Of course, individual circumstances must be considered. For example, gestational timing: although evidence shows surgery can be safely done even in the third trimester, many surgeons and obstetricians are understandably cautious about operating at 34–38 weeks, when the risk of inducing labor is highest. In our 5 third-trimester cases, we managed to avoid precipitating labor, but that likely required careful measures – reports describe strategies like using tocolytics around the time of surgery, gentle technique, and monitoring uterine activity. Generally, the ideal window for elective LC is considered the second trimester (~14–28 weeks), which our data reflect – 64% of our operations were in that period. If acute cholecystitis occurs very late in pregnancy, management must be individualized: in some situations, it might be reasonable (for example at 36–37 weeks) to expedite delivery (induce labor or perform a C-section for obstetric indications) and then do cholecystectomy postpartum, instead of performing LC at 36 weeks. Our study did not specifically address combined timing like that. We simply note that in select cases conservative management is reasonable – such as an episode very near term that responds to treatment – under vigilant observation, but those are the minority of cases. More

often, the disease doesn't "ask" for a convenient timing, and waiting can be dangerous.

Another factor is surgeon experience and facility capability. Not every hospital, especially smaller centers, is equipped to perform laparoscopic surgery on a pregnant patient, particularly emergently. It requires the surgical skill set, the ability to have obstetric consultation readily available, and neonatal support in case of complications. In our study, patients were treated at a large perinatal center with 24/7 surgical and obstetric coverage, which ensured safety. Where such infrastructure is lacking, conservative management might be employed out of necessity until transfer to a higher-level center is possible. In that sense, our findings advocate for building capacity: organizing specialized centers or pathways for acute surgical care in pregnancy could increase the rate of timely surgeries and improve outcomes.

We should also mention alternative approaches not represented in our series, such as percutaneous cholecystostomy – placing a tube in the gallbladder under imaging guidance. In certain high-risk patients who cannot undergo surgery, a cholecystostomy can temporize the situation. However, in pregnancy this is rarely done due to infection risk and the fact that it doesn't solve the stone problem. Barut et al. noted that cholecystostomy tends to lengthen hospital stay and doesn't improve outcomes compared to standard medical therapy. Hence, we did not utilize it or analyze it in detail.

Comparison of laparoscopic vs open cholecystectomy strongly favors laparoscopy for pregnant patients. In our study all surgeries were laparoscopic; no planned open procedures were done. Literature notes that LC is associated with significantly shorter hospital stays (mean ~3.7 days) compared to open cholecystectomy (~6.2 days), and less surgical trauma – critical for pregnant patients (less postoperative pain, lower wound infection risk). The conversion rate to open surgery in pregnancy is low – about 2.2% in reviews, mostly in complicated cases. Thus, laparoscopy is the preferred method, which we adhered to in our study design.

In summary, the key points from our study are: - Laparoscopic cholecystectomy is highly effective and safe during pregnancy, which we demonstrated by zero major complications in Group I and good fetal outcomes. - Conservative management comes with a high recurrence rate (~75%) and eventual need for surgery in the majority, meaning it often only delays the inevitable while exposing the patient to multiple attacks. - Economically, early surgery is justified, as it saves resources in aggregate: it cuts hospital days by more than 3-fold, reduces repeated courses of therapy, avoids costs of complications, and reduces potential NICU days by preventing preterm deliveries. - Obstetric outcomes are not compromised by early surgery and likely improved: we saw a trend towards fewer preterm births with surgery (though a larger sample is needed for statistical confirmation). - Logistical considerations (team expertise, equipment availability) are crucial: where skilled

surgeons and coordination exist, guidelines should be followed to operate when indicated, rather than delay.

Our study is limited by a relatively small sample size and retrospective design, but its findings are corroborated by the broader literature and current clinical guidelines. Future work could include multicenter studies or registries of pregnant patients with acute surgical conditions, to further refine understanding of how surgical timing impacts perinatal outcomes and cost-effectiveness.

Conclusions

1. Laparoscopic cholecystectomy is a safe and effective treatment for acute calculous cholecystitis in pregnant women. Surgery is indicated for acute cholecystitis during pregnancy regardless of trimester (with appropriate maternal-fetal monitoring and precautions); the second trimester is optimal timing when feasible, but if needed, surgery is justified even in the first or third trimester.
2. Conservative (nonoperative) management of acute cholecystitis in pregnancy often provides only temporary relief and leads to a high rate of recurrence during the pregnancy. In our study, ~76% of women treated without surgery experienced recurrent biliary symptoms, and more than 40% had multiple recurrences. Nearly 9 out of 10 of these patients ultimately required gallbladder removal – some emergently during pregnancy, others electively postpartum.
3. Early laparoscopic cholecystectomy improves pregnancy outcomes compared to delayed surgery. Operated patients in our series showed a trend toward lower preterm birth rates (3.6% vs 12.5%) and had no pregnancy losses, whereas the conservative group had 12.5% preterm deliveries (differences not statistically significant in our sample, but reflective of larger studies). LC performed during pregnancy was not associated with worse neonatal condition or increased cesarean delivery rates.
4. Total treatment duration and resource use are substantially lower with an active surgical approach. Patients who underwent early LC had a median hospital stay of 3 (2–4) days, whereas those managed conservatively (with subsequent readmissions and surgeries) spent 11 (5–13) days in hospital, $p<0.001$. Consequently, direct medical costs (hospital + surgery) were on average lower for early surgery due to fewer bed-days and reduced need for prolonged medical therapy. This indicates that early surgical intervention is cost-effective, despite the upfront procedural cost.
5. In practice, the optimal management for acute calculous cholecystitis in pregnancy is early surgical intervention – laparoscopic cholecystectomy, performed ideally during the index hospitalization when the diagnosis is made (provided appropriate facilities and expertise are available). A wait-and-see approach should be reserved only for select situations (e.g., an episode occurring near term that responds to treatment), under close surveillance, and even then the patient should be counseled about the high risk of recurrence and emergency surgery.

6. To improve care for this patient population, it is recommended to establish pathways for referring pregnant patients with acute surgical conditions to specialized centers equipped for laparoscopic surgery in pregnancy, and to foster close collaboration between surgeons and obstetricians. Contemporary guidelines (ACOG, SAGES) on managing acute cholecystitis in pregnancy should be actively implemented, as they can improve clinical outcomes and reduce unnecessary healthcare expenditures associated with prolonged conservative management and complications

References

1. Affleck DG. et al. (1999). The laparoscopic management of appendicitis and cholelithiasis during pregnancy. Am J Surg, 178(6): 523-529. DOI: 10.1016/S0002-9610(99)00251-5
2. Araghi A. et al. (2023). Operative vs Nonoperative Management of Acute Cholecystitis During Pregnancy. JAMA Surgery, 158(1): 66-74. DOI: 10.1001/jamasurg.2022.6149
3. Barut B. et al. (2019). Management of acute cholecystitis during pregnancy: A single-center experience. Ulus Travma Acil Cerrahi Derg, 25(2): 154-158. DOI: 10.5505/tjtes.2018.82357
4. Davlatzoda K.B. (2024). Pathogenesis and treatment of acute calculous cholecystitis in pregnant women. Cand. Med. Sci. Dissertation, Tajik State Medical Univ.
5. Dhupar R. et al. (2015). Cholecystitis during pregnancy: Outcomes and management. J Am Coll Surg, 221(2): 381-389. DOI: 10.1016/j.jamcollsurg.2015.04.028
6. Jelin AC. et al. (2018). Early cholecystectomy for acute cholecystitis in pregnancy: a decision analysis. Am J Surg, 216(5): 923-928. DOI: 10.1016/j.amjsurg.2018.07.031
7. Kuy S. et al. (2009). Outcomes following cholecystectomy in pregnant and nonpregnant women. Surgery, 146(2): 358-366. DOI: 10.1016/j.surg.2009.03.033
8. Miele A. et al. (2025). Between guidelines and reality: the complex decision-making of acute cholecystitis in pregnancy. J Hepatobiliary Pancreat Sci, 32(5): 455-465. DOI: 10.1002/jhbp.#### (PMC12226680)
9. SAGES/ACOG (2022). Guidelines for the Use of Laparoscopy During Pregnancy. Society of American Gastrointestinal and Endoscopic Surgeons (SAGES)
10. Townsend NT. et al. (2020). Percutaneous cholecystostomy in pregnancy: is there a role? J Surg Res, 247: 86-91. DOI: 10.1016/j.jss.2019.10.019