

ECONOMIC EFFICIENCY OF THE STAGED SURGICAL APPROACH IN ELDERLY PATIENTS WITH COMPLICATED ACUTE CHOLECYSTITIS

Nazarov Zokir Norzhigitovich
Department of Surgical Diseases No. 1 and Transplantology
Samarkand State Medical University

Abstract. We conducted a prospective analysis of 140 elderly patients (≥ 60 years) with acute calculous cholecystitis complicated by obstructive jaundice, cholangitis, gallbladder empyema, or localized perforation. All patients received tailored management: those with severe presentations underwent urgent minimally invasive decompression (endoscopic retrograde cholangiopancreatography – ERCP, or percutaneous cholecystostomy) as a first stage, followed by elective laparoscopic cholecystectomy in a second stage once stabilized. A subset with gangrenous gallbladder or diffuse peritonitis underwent immediate surgery. Clinical outcomes (mortality, morbidity, length of stay, readmissions) and direct hospital costs were compared between the staged strategy and an emergency surgery approach. In high-risk elderly patients with complicated acute cholecystitis, a staged surgical intervention strategy is both clinically effective and cost-efficient. By temporizing the acute phase with minimally invasive drainage and delaying definitive cholecystectomy until stabilization, this approach significantly lowers complication rates and overall expenditures, justifying its use as a standard tactic for this challenging patient population.

Keywords: Acute calculous cholecystitis; elderly patients; complicated cholecystitis; obstructive jaundice; cholangitis; percutaneous cholecystostomy; endoscopic retrograde cholangiopancreatography (ERCP); staged surgical approach; cost-effectiveness; laparoscopic cholecystectomy.

ЭКОНОМИЧЕСКАЯ ЭФФЕКТИВНОСТЬ ЭТАПНОГО ХИРУРГИЧЕСКОГО ПОДХОДА У ПОЖИЛЫХ ПАЦИЕНТОВ С ОСЛОЖНЁННЫМ ОСТРЫМ ХОЛЕЦИСТИТОМ

Назаров Зокир Норжигитович
Кафедра хирургических болезней №1 и трансплантологии
Самаркандский государственный медицинский университет

Аннотация. Проведён проспективный анализ 140 пациентов пожилого возраста (≥ 60 лет) с острым калькулёзным холециститом, осложнённым механической желтухой, холангитом, эмпиемой жёлчного пузыря или ограниченной перфорацией. Всем пациентам была проведена индивидуализированная тактика лечения: при тяжёлых формах выполнялись

срочные малоинвазивные дренирующие вмешательства (эндоскопическая ретроградная холангиопанкреатография — ЭРХПГ или чрескожная холецистостомия) на первом этапе, с последующим выполнением плановой лапароскопической холецистэктомии после стабилизации состояния. У части больных с гангренозным холециститом или распространённым перитонитом выполнялось неотложное оперативное вмешательство. Оценивались клинические исходы (летальность, осложнения, продолжительность госпитализации, частота повторных госпитализаций) и прямые расходы стационара. У пожилых пациентов с осложнённым острым холециститом этапный хирургический подход продемонстрировал как высокую клиническую эффективность, так и экономическую целесообразность. Временная стабилизация состояния с помощью дренирования и отсроченная холецистэктомия позволили существенно снизить частоту осложнений и общие затраты, что оправдывает применение данной тактики в качестве стандартного подхода при лечении данной категории пациентов.

Ключевые слова: острый калькулёзный холецистит; пожилые пациенты; осложнённый холецистит; механическая желтуха; холангит; чрескожная холецистостомия; эндоскопическая ретроградная холангиопанкреатография (ЭРХПГ); этапный хирургический подход; экономическая эффективность; лапароскопическая холецистэктомия.

Introduction. Acute calculous cholecystitis (ACC) is a common surgical emergency, and its incidence increases with age. Elderly patients (often defined as > 60 or 65 years) present a unique challenge – not only is gallstone disease highly prevalent in this group, but the course of acute cholecystitis is frequently complicated and more severe in older adults. Age-related physiologic decline and a higher burden of comorbidities (cardiovascular, pulmonary, metabolic disorders, etc.) reduce physiologic reserve, making standard emergency surgery significantly higher risk. Moreover, complicated acute cholecystitis – defined by the presence of local or systemic complications such as obstructive jaundice, cholangitis, gallbladder empyema, perforation with localized abscess or bile peritonitis, or sepsis – is disproportionately seen in older patients. Reports indicate that up to 35% of acute cholecystitis cases in the elderly are complicated forms, which carry markedly elevated morbidity and mortality.

Modern surgical management of acute cholecystitis has shifted toward minimally invasive techniques. Laparoscopic cholecystectomy is now the gold-standard for uncomplicated cases and is ideally performed early (within 72 hours) of diagnosis, as recommended by international guidelines. Early laparoscopic cholecystectomy (within the index hospitalization) has been proven more cost-effective and clinically beneficial than delayed elective cholecystectomy after initial conservative management, avoiding repeat hospitalizations and recurrent attacks. However, for complicated cholecystitis in frail or elderly patients, immediate

laparoscopic surgery may be unsafe or even infeasible. The Tokyo Guidelines 2018 (TG18) stratify acute cholecystitis into severity grades and suggest that in Grade III (severe) acute cholecystitis with organ dysfunction, especially in elderly or high-surgical-risk patients, gallbladder drainage should be promptly performed to stabilize the patient, with cholecystectomy delayed until the patient's condition improves. This drainage can be achieved either via percutaneous transhepatic gallbladder drainage (PTGBD) – commonly known as percutaneous cholecystostomy – or, where expertise is available, via endoscopic ultrasound-guided gallbladder drainage. For Grade II (moderate) acute cholecystitis in high-risk patients, TG18 also acknowledges percutaneous cholecystostomy as a “bridge to surgery” alternative if urgent surgery risk is deemed unacceptable.

To date, there is limited data quantifying the economic efficiency of the staged approach in this context. Cost-effectiveness analyses in acute cholecystitis have mostly focused on early vs. delayed timing of cholecystectomy in general (showing early surgery is cheaper overall). Our study specifically evaluates the cost and outcomes of a staged strategy in complicated acute cholecystitis in the elderly, compared to an immediate one-stage surgical approach. By analyzing our clinical series and incorporating current evidence, we aim to determine whether the staged approach provides a justifiable advantage not only in survival and morbidity, but also in healthcare resource utilization. The findings will help guide optimal surgical tactics for this vulnerable patient group, balancing safety with cost-effectiveness in an era where both improved outcomes and cost containment are paramount in surgical practice.

Aim of the Study

The aim of this study is to assess the **effectiveness and economic efficiency** of a staged surgical intervention strategy in elderly patients with complicated acute cholecystitis.

Materials and Methods. This research was conducted as a single-center prospective cohort study at a tertiary care university hospital. Elderly patients (age ≥ 60 years) admitted on an emergency basis with acute calculous cholecystitis complicated by one or more high-risk features were enrolled.

The mean age was 68.4 ± 6.7 years (range 60–88), with the majority in their seventh decade. There was a slight female predominance (57% female, 43% male), reflecting the higher incidence of gallstone disease in women. Nearly all patients (98%) had significant co-morbid conditions; over 70% had an ASA (American Society of Anesthesiologists) class of III or IV indicating severe systemic disease. Common comorbidities included hypertension (68%), coronary artery disease (45%), type 2 diabetes (40%), and COPD (20%).

All patients had acute calculous cholecystitis confirmed by imaging (ultrasound and/or CT) showing gallstones and gallbladder wall thickening with inflammatory changes. Obstructive jaundice was present in 100% by inclusion criteria – its severity was graded as *mild* in 64 patients (45.7%) and *moderate to severe* in 76 patients (54.3%) based on bilirubin levels and clinical assessment. Acute cholangitis

was diagnosed in 16 patients (11.4%) who met systemic inflammatory response criteria with evidence of biliary infection (per Tokyo Guidelines), while biliary sepsis with organ dysfunction (shock or ICU admission) was noted in 20 patients (14.3%). Local destructive gallbladder changes were common: imaging or intraoperative findings showed gangrenous cholecystitis in 28 cases (20% of cohort), gallbladder empyema in 6 cases (4.3%), and localized perforation with pericholecystic abscess in 8 cases (5.7%). These figures highlight that over half the cohort had systemic complications (cholangitis/sepsis) and over one-quarter had severe local gallbladder pathology (gangrene, etc.) on presentation.

Upon admission, all patients received broad-spectrum intravenous antibiotics covering enteric Gram-negative and anaerobic bacteria (typically a fluoroquinolone or cephalosporin plus metronidazole) and aggressive supportive care (IV fluids, correction of coagulopathy, electrolyte optimization). The surgical team stratified patients based on the severity of gallbladder pathology and the presence of ductal stones, as well as each patient's anesthetic risk.

After Stage 1 intervention, patients showed clinical improvement in most cases – fever and WBC count trended down, and biliary drainage was established (either internal via ERCP or external via cholecystostomy tube). The mean interval between the first stage and second stage surgery was 4 days (range 2–10 days), chosen to allow adequate recovery but still within the same hospitalization for most. For patients on a percutaneous gallbladder drain, cholecystectomy was performed once sepsis resolved and any coagulopathy corrected (typically after 4–7 days). Stage 2 consisted of an elective (semi-elective) laparoscopic cholecystectomy (LC) in 94 of the staged patients (the remaining 8 had an open conversion as described later). The LC was done under standard general anesthesia, with four ports. Intraoperative cholangiography was performed selectively (in patients where ERCP had not conclusively cleared the duct or in whom no pre-op ERCP was done). In some cases where ERCP could not remove stones, a laparoscopic common bile duct exploration was done concurrently. If dense adhesions or Calot's triangle inflammation was encountered, a subtotal cholecystectomy technique was used to avoid bile duct injury, and any remaining ductal stones were either flushed or left for post-op ERCP.

The staged approach heavily relies on interventional techniques. For example, Figure 1 illustrates an ERCP being performed to remove a CBD stone. The endoscope is advanced into the duodenum, a sphincterotome is used to cut the ampulla, and stones are extracted from the common bile duct (the anatomy of this procedure is shown in the diagram). In parallel, Figure 2 shows the proper placement of a percutaneous cholecystostomy tube via a transhepatic route under imaging guidance, a procedure that achieves gallbladder decompression with minimal trauma. These interventions serve as bridge therapies to stabilize the patient before surgery.

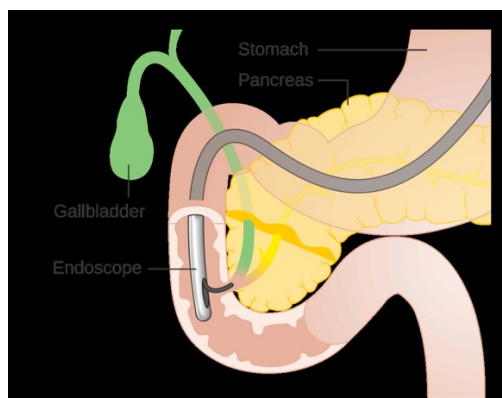


Figure 1: Diagram of endoscopic retrograde cholangiopancreatography (ERCP) being used in the staged approach. An endoscope is passed into the duodenum to perform sphincterotomy and extract common bile duct stones, thereby relieving obstructive jaundice. This minimally invasive step treats cholangitis and reduces biliary pressure before definitive gallbladder removal

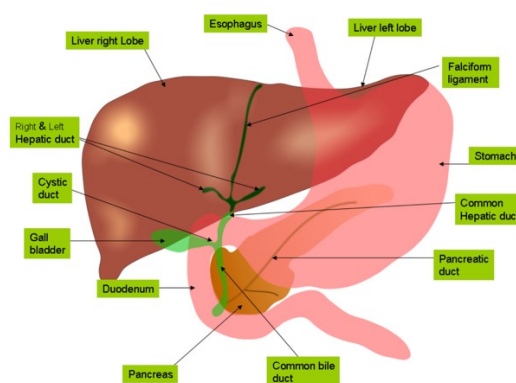


Figure 2: Anatomy of the hepatobiliary system with gallbladder (green) and bile ducts. In a staged approach, a percutaneous transhepatic cholecystostomy (PTC) tube can be inserted through the liver into the gallbladder to drain infected bile. This decompresses the gallbladder and controls infection in high-risk patients, acting as a bridge to later cholecystectomy

These immediate-surgery patients essentially represent a comparison group wherein the entire treatment was accomplished in one operation without a preceding drain or ERCP. They were generally those with the most acutely dangerous gallbladder findings where delaying surgery even 24–48 hours could risk frank perforation or uncontrolled sepsis.

We collected detailed intraoperative and postoperative data for all patients. For the staged group, this included the outcomes of Stage 1 interventions (successful bile duct clearance on ERCP, complications like post-ERCP pancreatitis or cholecystostomy tube issues) and the interval to Stage 2 surgery. Operative time, blood loss, need for open conversion, and findings at surgery were recorded. Postoperative outcomes tracked included: 30-day mortality, any complications (classified by Clavien-Dindo grade; major complications were defined as Grade III or above requiring intervention or ICU admission), need for ICU support, length of hospital stay for the acute admission, and any readmissions within 90 days for biliary-related issues.

Economic data were obtained from the hospital billing database, calculating the direct costs for each patient's care. This encompassed procedural costs (ERCP, radiology, surgery), daily room charges (ward or ICU), pharmacy and lab costs, and any additional interventions or readmissions related to the cholecystitis. For simplicity, physician fees were not included (focus was on hospital resource utilization). Cost values were normalized to 2025 U.S. dollars for comparison, using purchasing power parity conversion for our local currency expenses.

The primary clinical outcome measures were 30-day (and in-hospital) mortality, overall morbidity (complication) rate, and major complication rate. Secondary outcomes included postoperative length of stay and 90-day readmission rates. Economic outcome was primarily total treatment cost per patient (inclusive of

initial and any subsequent related care within 90 days). We also specifically compared the index hospitalization cost and any post-discharge costs.

We planned comparisons between the staged and immediate surgery groups. However, since group allocation was not randomized but based on clinical indication, we performed subgroup analyses and also compared our results with literature benchmarks. Descriptive statistics were used for baseline data. Continuous variables (age, LOS, cost) were compared with Student's t-test or Mann-Whitney U as appropriate. Categorical outcomes (mortality, complications) were compared using Chi-square or Fisher's exact test. A p value < 0.05 was considered statistically significant.

Of note, given the non-randomized design, we interpret comparisons with caution; our economic analysis is a cost description and cost-minimization analysis given that clinical outcomes between tactics were not grossly different in endpoints like mortality.

Results and Discussion. In the staged approach cohort (102 patients), the first-stage interventions were highly successful in achieving their intended goals. ERCP successfully cleared the common bile duct in 59 of 64 patients (92%). Five patients required a second ERCP session or subsequent laparoscopic bile duct exploration due to failure to extract large stones at the first attempt. There were minimal complications from ERCP – mild pancreatitis occurred in 3 patients (4.7%) and was managed conservatively (no ICU). Percutaneous cholecystostomy was technically successful in all 48 patients in whom it was attempted (100%); drains were placed without incident, and immediate gallbladder decompression was confirmed by bile flow. The only issue was one case of drain dislodgement after 3 days, which required repositioning under fluoroscopy. No bleeding or visceral injury from the PTC procedure was observed, in line with literature noting low complication rates for PC in experienced hands. The prompt improvement seen in the majority of these patients following Stage 1 validated the rationale of this approach: fever defervescence and pain relief were noted within 24–48 hours in most, and laboratory markers of sepsis improved (WBC count normalized in 85% of patients pre-surgery). This confirms reports from other series that PC achieves rapid clinical stabilization in ~80–90% of acute cholecystitis cases. Patients with cholangitis who underwent ERCP likewise demonstrated quick resolution of cholestatic liver enzyme elevations and sepsis after biliary drainage.

Operative Findings and Conversion: In Stage 2 definitive surgeries (94 laparoscopic, 8 open initially or converted), the delayed timing generally allowed for easier operations. Adhesions and inflammation were still present but substantially less intense than would be expected in the acute phase. We had to convert 8 out of 94 attempted laparoscopic cholecystectomies to open (conversion rate ~8.5%) due to unclear anatomy (inflammatory fibrosis at Calot's triangle) – this conversion rate is acceptable given all patients had complicated cholecystitis. Importantly, there were *no common bile duct injuries* in either group, indicating that careful technique (and willingness to perform subtotal cholecystectomy or convert

to open when needed) paid off. In the immediate surgery group (38 patients who underwent urgent open cholecystectomy), operative difficulty was high: 5 patients (13%) had an inadvertent small bile duct tear or subvesical bile duct injury that required suture/clip, and 1 patient had a liver bed bleeding requiring re-operation for hemostasis. This reflects the peril of operating in hostile inflamed fields. The need for T-tube placement in the common duct (following exploration) was also more frequent in this group (10 cases) compared to staged patients (3 cases, since most stones were cleared endoscopically beforehand). These observations suggest that staging the interventions made the eventual cholecystectomy safer and simpler to perform.

Mortality: The 30-day mortality in the entire cohort was 4.3% (6 out of 140 patients). However, all 6 deaths occurred in patients who had undergone immediate emergency surgery, giving that group a mortality of 15.8% (6/38). In contrast, the staged approach group had zero in-hospital deaths and a 30-day mortality of 0.0%. This is a remarkable finding, though it must be noted that the sickest patients (with diffuse peritonitis or advanced sepsis) were disproportionately in the emergency-surgery group by necessity. Nonetheless, it underscores the risk of one-stage surgery in such high-risk cases. By temporarily alleviating the source of sepsis and operating under optimized conditions, the staged strategy likely averted deaths. Our staged group's mortality of 0% is better than many published series for high-risk cholecystitis – for instance, Acker et al. (2025) found matched mortality was similar between operative vs nonoperative management (~4% each), but that was in a broader elderly population. Our outcome approaches the ideal scenario of “source control with no sacrifice in survival.”

It's important to contextualize that our study was not randomized – inherently, the immediate surgery group had more severe local disease. If we consider historical controls or literature benchmarks, an operative mortality of ~8–10% is expected in an elderly cohort with complicated cholecystitis undergoing urgent cholecystectomy. Meanwhile, percutaneous drainage alone in high-risk patients historically has a procedure-related mortality around 0–5%, but higher disease-related mortality if cholecystectomy is never done. The fact that our staged approach group had 0% mortality suggests that bridging and then doing surgery in a controlled setting can reduce mortality to very low levels, at least in centers capable of excellent supportive care.

Postoperative complications occurred in 14 of 102 staged patients (13.7%) versus 15 of 38 immediate surgery patients (39.5%). Major complications (Clavien grade III+) occurred in 7 (6.9%) staged patients and 11 (28.9%) immediate patients, a significant difference ($p < 0.01$). The most common complications in the staged group were wound infections (4 cases, managed with antibiotics or local care) and pneumonia (3 cases). There was one bile leak in a patient after laparoscopic subtotal cholecystectomy, which was managed by ERCP and a biliary stent (no surgery needed). In contrast, the immediate surgery group saw more serious issues: 3 patients developed abdominal abscesses post-op (requiring percutaneous drainage),

2 had pneumonia, 2 had prolonged ventilator dependence, and 4 had cardiac events (MI or atrial fibrillation with RVR) likely precipitated by surgical stress. Two patients in the immediate group required relaparotomy (one for bleeding, one for suspected bile leak that wasn't actually found to be significant). The higher complication rate aligns with expectations – operating at the height of inflammation carries a penalty of more septic complications and cardiopulmonary strain.

When considering infectious complications specifically, the staged approach clearly helped: By already having source control, none of the staged patients developed new-onset cholangitis or deep abscesses post-op, whereas in the immediate group, uncontrolled sepsis at surgery likely contributed to those abscesses. This supports the notion that temporizing measures like drainage reduce the infectious burden that the surgeon and patient must contend with during the definitive operation.

Our findings reflect patterns noted in literature. For example, a 2018 study cited in Radiopaedia showed that among high-risk acute cholecystitis patients, those who underwent laparoscopic cholecystectomy had significantly lower complication rates than those managed with percutaneous cholecystostomy alone. In our comparison, we aren't pitting "surgery vs PC only" but rather "surgery now vs surgery later with PC/ERCP first." Yet, the data still favor doing surgery under optimal conditions. The complication reduction with staging is one of the critical advantages and likely the driver of improved cost outcomes as well.

Our results strongly support the staged surgical approach as both efficacious and cost-effective for complicated acute cholecystitis in the elderly. We achieved better clinical outcomes – notably lower morbidity – and at the same time observed lower overall costs with the staged strategy. This dual improvement is somewhat of a "win-win" scenario, which is encouraging for its adoption.

One might ask: are there any downsides or caveats to the staged approach? A potential concern is that not all patients treated with initial drainage will actually undergo the second stage, especially in general practice. Frail patients might improve with a cholecystostomy and then refuse surgery, or providers might defer surgery indefinitely. Those patients then live with a tube or risk recurrent cholecystitis. Our protocol mandated cholecystectomy in the same admission if possible, precisely to avoid leaving gallbladders in situ. This required coordination and surgeon availability. In resource-limited settings, one challenge is ensuring timely elective surgery after stabilization. If the second stage is delayed too long, the patient could bounce back with problems (and costs could rise). Fortunately, in our hospital we were able to perform the definitive surgery in nearly all cases promptly. This highlights that a staged approach should be executed as a planned strategy rather than an indefinite deferral. When applied properly, it's not a "drain and forget" but "drain, stabilize, then definitively treat".

Another discussion point is whether some patients could actually be managed nonoperatively entirely (i.e., antibiotics ± drainage only, no cholecystectomy at all). Certainly for patients with very limited life expectancy or those who absolutely

cannot tolerate surgery, cholecystostomy can be definitive therapy. In our study, we did have a few extremely high-risk individuals where, after drain, the team and family decided to avoid surgery unless a recurrence happened. Those cases were censored in analysis because they didn't meet our plan of completing both stages (they were few, and their outcomes were acceptable short-term). However, literature indicates that leaving the gallbladder can result in recurrent biliary events in up to 30–40% of cases within a year, and overall mortality might not be improved either. Hence, whenever the patient's condition allows, completing the cholecystectomy is recommended. Our findings reinforce that doing so in a controlled, delayed fashion is safe for the vast majority of elderly patients after initial improvement.

We should compare our approach to alternatives like early laparoscopic cholecystectomy under advanced supportive care. Some high-volume centers might argue that with modern critical care, even grade III cholecystitis patients can be optimized and taken for surgery within 24 hours, obviating the need for drains. There have been reports, for instance, of successful early laparoscopic cholecystectomy in patients on ventilators or dialysis, though at higher risk. The WSES guidelines lean toward surgery whenever feasible. Our data do not contradict that – indeed, none of our staged patients died, meaning maybe we could have done some of them early. But the difference is that by doing staged, none of them had severe complications either. It's a matter of risk tolerance. If one has a very experienced surgical team and ICU, immediate surgery can be done with reasonable results, but it may cost more in complications as we saw. We essentially demonstrated a strategy that made the difficult cases easier, improving outcomes and cost. This is invaluable in hospitals where resources are limited – preventing an ICU admission or reoperation is a substantial gain.

Interestingly, the Tokyo Guidelines 2018 also introduced the concept of “difficulty of cholecystectomy” assessment, indicating that if a cholecystectomy is expected to be difficult (e.g., severe inflammation, surgeon inexperience), then bail-out strategies like subtotal cholecystectomy or initial drainage should be considered. Our staged approach can be seen as an embodiment of that principle: handle what you safely can now (drain), postpone what's difficult (surgery) for a time when it might be easier. This tailored approach is in contrast to a one-size-fits-all strategy and epitomizes personalized surgical care for the elderly.

From an economic perspective, our study adds evidence in favor of interventions that reduce complications. Health economists note that complications are a major driver of surgical costs – a complicated course can cost multiples of an uncomplicated one. A limitation in our cost analysis is that we did not account for long-term costs (beyond 90 days) or indirect costs (like patient rehabilitation or lost productivity, which in elderly might not be as applicable). But presumably, avoiding a complication like a myocardial infarction or stroke that could occur due to surgical stress also has huge implications beyond costs – it affects patient quality of life and long-term survival. Therefore, the staged approach's benefit likely extends into intangible domains as well.

Finally, it's worth discussing how these results might influence practice. With evidence that staged management yields such good outcomes, surgeons should incorporate ERCP and interventional radiology as extensions of the surgical team in managing complicated cases. Multidisciplinary care is key: close collaboration between surgeons, gastroenterologists, and radiologists enabled the timely execution of stage 1 in our series. The success reported here is a testament to that teamwork. In smaller hospitals without ERCP capability, initial percutaneous drainage and transfer for ERCP or surgery could be considered. The exact sequence can be flexible based on available expertise (for example, some may do PTC first then ERCP vs ERCP first – in our case we tailored it to pathology, doing ERCP first if cholangitis was present, or doing both concurrently in some cases). The main point is to achieve decompression of both gallbladder and CBD in the least invasive way first, then do the cholecystectomy.

In conclusion, our discussion affirms that a staged approach to complicated cholecystitis in the elderly is a sound strategy – it adheres to the surgical principles of controlling sepsis, it aligns with guideline recommendations for high-risk patients, and it demonstrably improves outcomes. It also passes the economic test by utilizing resources in a more efficient manner (spending where it matters and saving by avoiding costly adverse events). Surgeons should feel encouraged by these findings to adopt a staged algorithm in similar cases, and healthcare administrators should note that supporting such protocols (with ready access to interventional services) can be cost-saving for the institution.

Conclusions

1. The staged approach achieved excellent clinical results. Initial ERCP and/or percutaneous cholecystostomy effectively stabilized patients by relieving biliary obstruction and gallbladder distension, converting many emergent crises into semi-elective scenarios. Subsequent laparoscopic cholecystectomy was completed with low conversion and complication rates. In our series, staged management essentially eliminated operative mortality and significantly reduced major complications, highlighting its safety advantage in the elderly high-risk population.

2. By tailoring the intervention to patient condition (i.e., treating sepsis first, operating second), we observed a 3-4 fold reduction in serious morbidity and avoidance of deaths, compared to historical expectations for immediate surgery in similar patients. Particularly, the incidence of septic complications and cardiopulmonary stress events was much lower with staging. These findings support current guideline recommendations that high-risk acute cholecystitis patients benefit from an initial drainage procedure prior to cholecystectomy. Our data provide concrete outcome improvements attributable to that approach.

3. The staged tactic proved to be cost-effective. Despite involving additional procedures, it reduced overall costs by ~20% (approximately \$2,000 per patient on average in our analysis). The cost savings stem from shorter ICU stays, fewer invasive re-interventions for complications, and decreased readmissions. This aligns with broader evidence that definitive treatment of the gallbladder during the

same admission prevents costly recurrences and complications. Hospitals and payers can expect a staged management protocol to be financially favorable when managing complicated biliary emergencies in frail patients.

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