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# Inter-Hospital Transfer and Outcomes in Acute Cholangitis: A National Inpatient Analysis

Muhammad Haris Latif[1,*], Imran Khokhar[2], Ayesha Kang[1], Eman Mazhar[3], Kahee A. Mohammed[4], Joel Riley[5], Hani-El-Halawany[6], Kamran Qureshi[4]

1-Department of Internal Medicine, SSM Health St. Mary's Hospital, Saint Louis, MO, USA
2-Department of Internal Medicine, Reading Hospital Tower Health, Reading, PA, USA
3-Department of Internal Medicine, Nishtar Medical University, Multan, Pakistan
4-Department of Internal Medicine, Saint Louis University School of Medicine, Saint Louis, MO, USA
5-Department of Gastroenterology, SSM Health St. Mary's Hospital, Saint Louis, MO, USA
6-Department of Gastroenterology, SSM Health DePaul Hospital, Saint Louis, MO, USA

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ABSTRACT

**Background:** Inter-hospital transfer is frequently used to facilitate access to advanced biliary intervention and higher-level care for patients with acute cholangitis. However, its association with inpatient outcomes remains incompletely defined. We evaluated the relationship between transfer-in status and clinical outcomes among adults hospitalized with acute cholangitis.
**Methods:** We performed a retrospective hospitalization-level analysis using the National Inpatient Sample. Adult hospitalizations with acute cholangitis were identified using ICD-10-CM codes and stratified by interhospital transfer status. Survey-weighted analyses compared patient characteristics, outcomes, and resource utilization. Multivariable survey-weighted logistic regression assessed the adjusted association between transfer-in status and adverse outcomes.
**Results:** An estimated 36,125 acute cholangitis hospitalizations were identified nationally; 16.8% involved inter-hospital transfer. Transferred hospitalizations were more often among White patients, patients from lower-income ZIP codes, and those treated at large urban teaching hospitals. Transferred patients had higher unadjusted rates of shock, acute respiratory failure, mechanical ventilation, dialysis, and in-hospital mortality (5.8% vs 4.5%; $P = 0.047$). After adjustment, transfer-in status was not significantly associated with in-hospital mortality (adjusted odds ratio [aOR], 1.26; 95% CI, 0.95–1.68; $P = 0.106$), but was associated with acute respiratory failure (aOR, 1.30; 95% CI, 1.06–1.58; $P = 0.011$), mechanical ventilation (aOR, 1.64; 95% CI, 1.28–2.10; $P < 0.001$), and dialysis (aOR, 1.39; 95% CI, 1.01–1.92; $P = 0.045$).
**Conclusions:** Transfer-in status was not significantly associated with adjusted in-hospital mortality, but it was associated with markers of greater illness severity and resource utilization. Findings should be interpreted within the limitations of administrative hospitalization data.

## 1. Introduction

Acute cholangitis is a potentially life-threatening biliary infection that can rapidly progress to sepsis and organ failure. Prompt recognition, early antibiotics, hemodynamic stabilization, and timely biliary decompression are central to management, as delays in source control are associated with increased morbidity and mortality [1–3].

Endoscopic retrograde cholangiopancreatography (ERCP) is the preferred modality for biliary decompression in most patients with acute cholangitis, as it allows rapid drainage of infected bile while simultaneously addressing the underlying etiology, such as choledocholithiasis or malignant obstruction [4–6]. International consensus guidelines, including the Tokyo Guidelines, recommend early biliary drainage, often defined as within 24 hours, for patients with moderate or severe cholangitis and for those who fail to improve with initial medical therapy [1, 3]. Regional referral networks enable access to advanced endoscopic and high-level care services, but the independent effect of inter-hospital transfer on outcomes in acute cholangitis remains uncertain [7–9].

In acute cholangitis, literature has predominantly focused on the timing of ERCP, with earlier biliary drainage associated with improved outcomes [10–12]. In contrast, inter-hospital transfer depends not only on clinical severity but also on referral networks, hospital capability, and access to specialized care. Transfer patterns may also reflect structural inequities within regionalized health systems. Understanding which patients are transferred and how outcomes differ after transfer may therefore inform both care delivery and equity-focused policy. The adjusted association between inter-hospital transfer and clinical outcomes remains poorly defined. Whether inter-hospital transfer independently contributes to adverse outcomes or instead reflects appropriate escalation of care for patients with severe cholangitis, remains unclear.

[*] Corresponding author: Muhammad Haris Latif, Department of Internal Medicine, SSM Health St. Mary's Hospital, Saint Louis, MO, USA. Email: haris.2288@gmail.com



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This study used a nationally representative inpatient database to evaluate the association between inter-hospital transfer and outcomes among patients hospitalized with acute cholangitis. Patient characteristics, resource utilization, and clinical outcomes were compared between transferred and directly admitted patients. The analysis also assessed whether inter-hospital transfer was independently associated with in-hospital mortality or markers of disease severity after adjustment for patient and hospital-level factors.

## 2. Methods

### 2.1. Data source

We conducted a hospital-level retrospective study using the National Inpatient Sample (2020 – 2022), a nationally representative database of U.S. hospitalizations. Survey weights were applied to generate national estimates. Institutional review board approval was not required because the data are de-identified [13].

### 2.2. Study population

The study population included adults (≥18 years) hospitalized with acute cholangitis, identified by ICD-10-CM codes recorded in any diagnosis; therefore, some hospitalizations may represent secondary diagnoses of cholangitis. To prevent double-counting and to focus on patients with known transfer-in status, we excluded elective admissions and those transferred out to another acute care hospital. We used the NIS transfer-in indicator to determine inter-hospital transfer status. As transferred patients enter the NIS only at the receiving hospitalization, whereas direct admissions are observed from the start of hospitalization, this study is best interpreted as a comparison of receiving-hospital outcomes after transfer rather than a complete assessment of the episode-of-care effect of transfer itself.

Due to the nature of administrative hospitalization data, the NIS does not include laboratory values, physiological severity scores, medication timing, or precise time stamps for clinical interventions or inter-hospital transfers [14].

### 2.3. Study Variables

The primary exposure was inter-hospital transfer status, categorized as direct admission or admission following transfer from another acute care hospital.

Patient-level variables included age, sex, race/ethnicity, primary payer, median household income quartile by ZIP code, and weekend admission. Comorbidities were identified using ICD-10-CM codes and included cardiovascular, pulmonary, renal, hepatic, metabolic, and malignant conditions.

Hospital-level characteristics included bed size, teaching status, and geographic region. All variables were prespecified based on clinical relevance, prior literature, and availability within the National Inpatient Sample.

### 2.4. Study objectives

After identification of the study population, inter-hospital transfer status, categorized as either direct admission or transfer, was defined as the primary exposure variable.

Outcomes were classified as primary and secondary. The primary outcome was in-hospital mortality. Secondary outcomes included comorbid burden of disease, shock, acute respiratory failure, mechanical ventilation, dialysis, acute kidney injury, length of stay, total hospital charges, and discharge disposition.

Acute respiratory failure, mechanical ventilation, dialysis, and shock were analyzed as markers of illness severity during the receiving hospitalization rather than as transfer-attributable complications, because the NIS does not reliably establish the temporal sequence of these events.

### 2.5. Statistical Analysis

Multivariable survey-weighted logistic regression models were subsequently used to evaluate the adjusted association between inter-hospital transfer and the following outcomes: in-hospital mortality, shock, acute respiratory failure, mechanical ventilation, and dialysis. [15]. Covariates were prespecified based on clinical relevance, prior literature, and data availability in the National Inpatient Sample [16]. These covariates included age, sex, weekend admission, race/ethnicity, primary expected payer, hospital bed size, hospital teaching status, hospital region, calendar year, diabetes mellitus, hypertension, congestive heart failure, atrial fibrillation, chronic obstructive pulmonary disease, chronic kidney disease, malignancy, sepsis, cirrhosis, and obesity.

To prevent overadjustment, variables identified as potential mediators on the causal pathway between disease severity and mortality were excluded from the primary mortality model. These included shock and mechanical ventilation, which were analyzed separately as secondary outcomes. All analyses incorporated the complex design of the National Inpatient Sample survey. This included discharge-level weights, hospital clustering, and stratification. Missingness among variables included in the adjusted analyses was limited, occurring primarily in race/ethnicity (176 observations) and primary expected payer (9 observations). Statistical significance was assessed using two-sided tests at the 0.05 significance level.

## 3. Results

### 3.1. Study Cohort

Among 19.7 million adult hospitalizations in the National Inpatient Sample from 2020 to 2022, 7,870 (0.04%) met criteria for acute cholangitis. Among the initially identified adult hospitalizations with acute cholangitis, 339 unweighted transfer-out hospitalizations were excluded before final cohort assembly, corresponding to an estimated 1,695 hospitalizations nationally. After exclusions, 7,225 unweighted cases remained, and application of survey weights yielded an estimated 36,125 cases nationwide.

Among these hospitalizations, 83.2% were direct hospitalizations and 16.8% were inter-hospital transfer hospitalizations, as shown in **(Figure 1)**.

### 3.2. Baseline Patient and Hospital Characteristics

Age and sex were similar in direct admissions and transferred patients. Transferred patients were more likely to be white, from lower-income ZIP codes, and receive care at large, urban teaching hospitals. A higher proportion were admitted in the Midwest and fewer in the West **(Table 1)**. Weekend admissions were more common among transferred patients.

### 3.3. Comorbidity Burden

**(Table 2)** summarizes baseline comorbidities by transfer status. Transferred patients had a higher cardiopulmonary comorbidity burden. Compared to direct admissions, they had higher rates of congestive heart failure, atrial fibrillation, chronic obstructive pulmonary disease, and morbid obesity.

Diabetes, hypertension, kidney disease, cirrhosis, malignancy, sepsis, and chronic pancreatitis rates were similar between groups. Rates of prior biliary instrumentation were similar between groups. There was a nonsignificant trend toward higher rates of biliary stent use

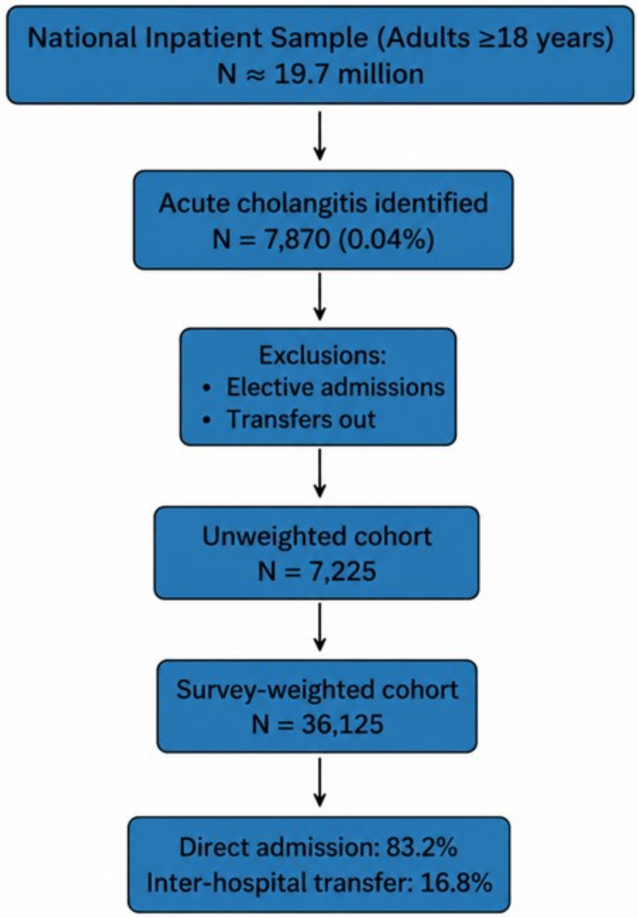


**Figure 1:** Flow diagram illustrating cohort selection for adult hospitalizations with acute cholangitis in the National Inpatient Sample.

among transferred patients. Pancreatic duct stents were used more often in transferred patients.

### 3.4. Unadjusted Clinical Outcomes and Severity

Unadjusted clinical outcomes and severity markers appear in **(Figure 2)** and **(Table 3)**. Transferred patients exhibited higher disease severity markers than direct admissions. Compared with direct admissions, transfer-in hospitalizations were characterized by greater severity markers during the receiving hospitalization, including higher frequencies of shock, respiratory failure, mechanical ventilation, and dialysis.

In-hospital mortality was moderate but significantly higher among inter-hospital transfer patients than among direct-admission patients. Rates of acute kidney injury, endoscopic retrograde cholangiopancreatography (ERCP), and percutaneous biliary drainage were similar between groups. Transferred patients were less likely to be discharged directly home and more likely to require placement in skilled nursing or rehabilitation.

### 3.5. Resource Utilization

Transferred patients experienced longer hospitalizations. Although mean total hospital charges were numerically higher among transferred admissions, the difference did not reach statistical significance **(Table 4)**.

### 3.6. Adjusted Outcomes Associated with Inter-Hospital Transfer

After multivariable adjustment for demographic, hospital-level, calendar-year, and baseline comorbidity variables, inter-hospital transfer was not significantly associated with in-hospital mortality (aOR 1.26, 95% CI 0.95 – 1.68; P = 0.106). Transferred patients had significantly higher odds of mechanical ventilation, acute respiratory failure, and dialysis **(Table 5)** and **(Figure 3)**. The final analytic cohort included 7,225 hospitalizations. The fully adjusted mortality model included 7,018 hospitalizations after complete-case exclusion of records with missing model covariates and model-specific exclusions. Variable-level missingness was primarily observed for race/ethnicity and primary expected payer (supplementary table S2); additional model-specific exclusions accounted for the remaining difference. In a sensitivity analysis excluding race/ethnicity and primary expected payer from the adjustment set, the association between transfer-in status and in-hospital mortality was materially unchanged.

## 4. Discussion

### 4.1. Principal Findings

This nationally representative analysis shows that inter-hospital transfer among patients hospitalized with acute cholangitis signals greater illness severity and increased resource use. Transferred hospitalizations had higher unadjusted mortality; however, transfer-in status was not significantly associated with in-hospital mortality after adjustment. These findings represent adjusted associations

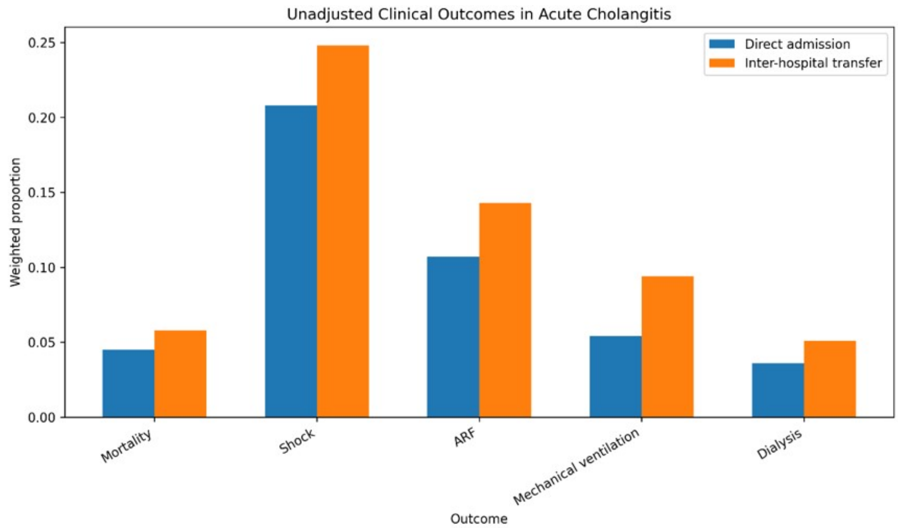


**Figure 2:** Unadjusted weighted proportions of adverse clinical outcomes among patients hospitalized with acute cholangitis, stratified by inter-hospital transfer status.

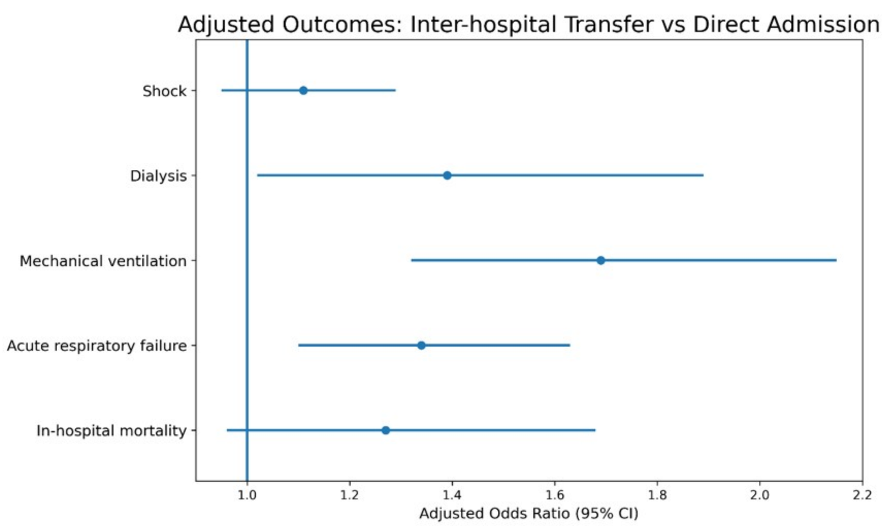


**Figure 3:** Forest plot displaying adjusted odds ratios (95% confidence intervals) for adverse outcomes associated with inter-hospital transfer among patients with acute cholangitis.
Models were adjusted for age, sex, weekend admission, race/ethnicity, primary expected payer, hospital bed size, hospital teaching status, hospital region, calendar year, diabetes mellitus, hypertension, congestive heart failure, atrial fibrillation, chronic obstructive pulmonary disease, chronic kidney disease, malignancy, sepsis, cirrhosis, and obesity.

within a hospitalization-level dataset and do not establish causality or the full episode-of-care effect of inter-hospital transfer. Thus, transfer status appears to reflect the underlying severity of illness.

### 4.2. Sociodemographic and geographic differences in transfer patterns

Significant racial, geographic, and insurance-related differences were observed in inter-hospital transfer patterns among patients with acute cholangitis. Transferred patients were more likely to be White and less likely to be Hispanic or Asian/Pacific Islander, suggesting that referral patterns may reflect disparities in access to tertiary centers, regional availability of endoscopic services, or structural features of referral networks rather than biologic differences in disease severity [17]. Geographic variation was also evident, with a higher proportion of transfers originating from the Midwest and a lower proportion from the Western United States, likely reflecting regional differences in hospital density and access to advanced endoscopic and higher-level care services [18]. Transferred patients were more commonly insured by Medicare, consistent with older age and greater comorbidity burden; importantly, ERCP utilization during the receiving hospitalization was similar across transfer groups despite differences in insurance status.

### 4.3. Comparison With Prior Literature

These findings extend earlier studies in acute cholangitis. Most prior research focused on the timing of biliary decompression rather than the effects of inter-hospital transfer [19]. Delayed ERCP is tied to higher mortality and organ failure, especially in severe cases [19]. Few studies have evaluated whether transfer independently predicts worse outcomes, independent of disease severity, among

**Table 1:** Baseline characteristics of adult hospitalizations for acute cholangitis, stratified by inter-hospital transfer hospitalization status.

| Characteristic | Direct admission | Inter-hospital transfer | P value |
|---|---|---|---|
| Number of hospitalizations | 6,009 (83.2%) | 1,216 (16.8%) | — |
| Age, mean (SE), years | 70.9 (0.20) | 70.9 (0.43) | 0.92 |
| Female sex, % | 50.0 | 47.4 | 0.09 |
| Race, % | | | <0.001 |
| White | 66.1 | 80.6 | |
| Black/African American | 6.9 | 4.8 | |
| Hispanic | 15.2 | 6.7 | |
| Asian/Pacific Islander | 8.1 | 2.9 | |
| Native American | 0.6 | 1.8 | |
| Other | 3.1 | 3.1 | |
| Median ZIP income quartile, % | | | <0.001 |
| 1st (lowest) | 22.2 | 30.6 | |
| 2nd | 22.8 | 33.8 | |
| 3rd | 26.7 | 19.9 | |
| 4th (highest) | 28.4 | 15.7 | |
| Primary payer, % | | | 0.003 |
| Medicare | 67.5 | 71.6 | |
| Medicaid | 9.1 | 7.2 | |
| Private | 18.2 | 15.8 | |
| Self-pay | 2.9 | 2.0 | |
| Other | 2.4 | 3.4 | |
| Weekend admission, % | 26.4 | 31.3 | <0.001 |
| Hospital bed size, % | | | <0.001 |
| Small | 18.4 | 9.1 | |
| Medium | 28.8 | 22.9 | |
| Large | 52.8 | 68.1 | |
| Teaching status, % | | | <0.001 |
| Rural | 3.6 | 2.2 | |
| Urban non-teaching | 15.7 | 6.1 | |
| Urban teaching | 80.7 | 91.7 | |
| Hospital region, % | | | <0.001 |
| Northeast | 20.9 | 18.3 | |
| Midwest | 18.3 | 30.6 | |
| South | 31.2 | 28.6 | |
| West | 29.7 | 22.5 | |

Values are survey-weighted means or percentages. P values were calculated using survey-adjusted Wald tests. Analyses account for the National Inpatient Sample complex survey design.

different procedures and disease processes [20]. Our results suggest that, though transferred patients are sicker, transfer itself is not significantly associated with worse survival, even after adjusting for demographics and hospital factors.

### 4.4. Shock and organ failure patterns

Shock was more frequent among transferred patients in unadjusted data, but this was not statistically significant after adjustment. This suggests that shock reflects disease severity rather than a transfer effect. Shock and mechanical ventilation were excluded from the primary mortality model to avoid overadjustment, since they are on the path from disease severity to death.

**Table 2:** Baseline Comorbidities of Cholangitis Hospitalizations by Inter-Hospital Transfer Hospitalization Status. Abbreviations- CBD: Common Bile Duct; HIV: Human Immunodeficiency Virus.

| Comorbidity | Direct Admit (%) | Inter-hospital Transfer (%) | p-value |
|---|---|---|---|
| Diabetes mellitus | 34.7 | 35.0 | 0.836 |
| Hypertension | 71.4 | 70.7 | 0.620 |
| Congestive heart failure | 20.8 | 24.8 | 0.002 |
| Atrial fibrillation | 23.5 | 27.0 | 0.008 |
| Chronic obstructive pulmonary disease | 10.7 | 15.2 | <0.001 |
| Obesity | 21.6 | 23.7 | 0.097 |
| Morbid obesity | 7.5 | 9.3 | 0.029 |
| Chronic kidney disease | 23.4 | 23.9 | 0.672 |
| Portal vein thrombosis | 2.0 | 2.2 | 0.640 |
| Pulmonary embolism | 0.83 | 0.82 | 0.973 |
| Cirrhosis | 5.9 | 6.6 | 0.402 |
| Acute or chronic liver failure | 5.0 | 5.9 | 0.176 |
| Any malignancy | 12.6 | 11.2 | 0.199 |
| Sepsis | 35.6 | 37.3 | 0.243 |
| Chronic pancreatitis | 2.6 | 2.5 | 0.850 |
| Biliary stent present | 40.6 | 43.8 | 0.060 |
| Pancreatic duct stent | 3.1 | 4.6 | 0.012 |
| Prior laparoscopic cholecystectomy | 15.2 | 13.9 | 0.268 |
| Post-cholecystectomy cholangitis | 0.9 | 1.0 | 0.760 |
| Retained CBD stones | 0.17 | 0.08 | 0.493 |
| HIV | 0.52 | 0.33 | 0.396 |

Values represent survey-weighted column percentages. P values were calculated using design-based F statistics accounting for National Inpatient Sample stratification, clustering, and discharge-level weighting.

The higher frequencies of shock, acute respiratory failure, mechanical ventilation, and dialysis among transfer-in hospitalizations likely reflect greater illness severity at presentation to the receiving hospital rather than adverse events directly caused by transfer itself. Because the NIS lacks temporal granularity, these variables cannot be reliably classified as present at arrival or as developing later in hospitalization. Accordingly, they should be interpreted as markers of severity within the receiving hospitalization rather than causal consequences of inter-hospital transfer.

Transferred patients demonstrated higher rates of end-organ dysfunction, a pattern consistent with prior studies of inter-hospital transfer populations across acute gastrointestinal conditions. At the same time, sepsis prevalence was similar between groups and is presented as a descriptive clinical characteristic rather than a transfer-attributable outcome [21]. Acute kidney injury rates were similar, so that renal dysfunction alone may be less discriminatory for transfer decisions than respiratory failure or hemodynamic instability.

### 4.5. Biliary decompression and procedural patterns

Although ERCP utilization during the receiving hospitalization was similar between groups, the NIS does not provide time-to-procedure

**Table 3:** Clinical Outcomes and Severity of Acute Cholangitis Hospitalizations, Stratified by Inter-Hospital Transfer Hospitalization Status (Survey-Weighted).

| Outcome / Severity Indicator | Direct Admit (%) | Inter-Hospital Transfer (%) | P value |
|---|---|---|---|
| In-hospital mortality | 4.5 | 5.8 | 0.047 |
| Shock (any) | 20.8 | 24.8 | 0.0016 |
| Acute kidney injury (AKI) | 22.0 | 19.7 | 0.100 |
| Acute respiratory failure | 10.7 | 14.4 | 0.0003 |
| Mechanical ventilation | 5.5 | 9.5 | <0.001 |
| Dialysis | 3.6 | 5.2 | 0.0088 |
| ERCP performed | 76.2 | 77.6 | 0.330 |
| Percutaneous biliary drainage (PTBD) | 0.23 | 0.41 | 0.270 |
| Discharge disposition | | | <0.001 |
| Routine home | 55.4 | 51.2 | |
| Skilled nursing/rehab | 16.2 | 19.6 | |
| Home health | 22.9 | 22.7 | |
| Against medical advice | 0.9 | 0.7 | |

Percentages represent survey-weighted column proportions (within transfer group)—p-values obtained using survey-adjusted $X^2$ tests. ERCP utilization reflects procedures performed during the receiving hospitalization, as procedures performed at referring hospitals are not captured in the NIS.

**Table 4:** Hospital Resource Utilization in Acute Cholangitis by Inter-Hospital Transfer Status.

| Outcome / Utilization Measure | Direct Admission | Inter-Hospital Transfer | P value |
|---|---|---|---|
| Length of stay, days (mean ± SE) | 6.91 ± 0.09 | 7.98 ± 0.25 | <0.001 |
| Total hospital charges, USD (mean ± SE) | 111,645 ± 1,960 | 117,419 ± 6,340 | 0.210 |

Values represent survey-weighted means ± standard errors. P values were calculated using survey-adjusted Wald tests, accounting for the complex sampling design of the National Inpatient Sample, including discharge-level weights, hospital clustering, and stratification.

data and does not capture procedures performed at referring hospitals. Therefore, these findings should not be interpreted as evidence of comparable timing of biliary decompression across the full episode of care. We cannot exclude the possibility that transfer-related delays in ERCP affected outcomes in some patients.

Percutaneous biliary drainage was infrequently performed in both transferred and directly admitted patients, consistent with current guidelines favoring ERCP as the primary approach for biliary decompression in acute cholangitis [4]. Although procedural timing could not be assessed, the low use of percutaneous drainage suggests that definitive endoscopic therapy was generally available at receiving hospitals.

### 4.6. Discharge disposition and post-acute care needs

Transferred patients were less likely to be discharged home. They more often needed placement in post-acute care, like nursing or rehab facilities. This pattern shows that the functional impact of severe illness goes beyond in-hospital outcomes, affecting recovery and discharge plans.

**Table 5:** Adjusted Outcomes Associated with Inter-Hospital Transfer in Acute Cholangitis

| Outcome | Adjusted OR (95% CI) | P value |
|---|---|---|
| In-hospital mortality | 1.26 (0.95–1.68) | 0.106 |
| Shock | 1.06 (0.89–1.26) | 0.537 |
| Acute respiratory failure | 1.30 (1.06–1.58) | 0.011 |
| Mechanical ventilation | 1.64 (1.28–2.10) | <0.001 |
| Dialysis | 1.39 (1.01–1.92) | 0.045 |

All models were adjusted for age, sex, weekend admission, race/ethnicity, primary expected payer, hospital bed size, hospital teaching status, hospital region, calendar year, diabetes mellitus, hypertension, congestive heart failure, atrial fibrillation, chronic obstructive pulmonary disease, chronic kidney disease, malignancy, sepsis, cirrhosis, and obesity using survey-weighted logistic regression accounting for the complex NIS sampling design

### 4.7. Resource utilization and health system implications

Inter-hospital transfer was associated with longer length of stay and greater utilization of higher-level care, likely reflecting higher illness acuity and greater clinical complexity among transferred hospitalizations. Despite increased use of higher-level care resources, mean total hospital charges were numerically higher among transferred hospitalizations but not significantly different between groups. Because charges were not inflation-adjusted and administrative data do not allow assessment of efficiency or comparative performance across referral pathways, these findings should be interpreted descriptively only. These findings suggest that resource use among transferred patients is associated with greater clinical complexity.

This pattern is consistent with regionalized care models for shock, gastrointestinal bleeding, and other urgent conditions, in which transferred patients demonstrate higher unadjusted mortality and resource utilization without excess risk after adjustment [17]. Similar adjusted mortality estimates should not be interpreted as evidence of the causal effect of transfer, because this hospitalization-level dataset cannot capture the full episode of care or the timing of transfer. The infrequent use of percutaneous biliary drainage in both groups is consistent with endoscopic retrograde cholangiopancreatography as the preferred first-line approach [4], and similar charge findings have been reported in prior referral-based analyses of complex conditions [22].

### 4.8. Strengths and Limitations

This study leverages the National Inpatient Sample, the largest all-payer inpatient database in the United States, allowing for nationally representative estimates of acute cholangitis hospitalizations and inter-hospital transfer patterns with strong external validity. By examining transfer status rather than procedural timing, the analysis addresses an essential gap in the literature and provides insight into regionalized care for severe biliary disease. Although granular physiologic data were unavailable, validated claims-based indicators of disease severity – including acute respiratory failure, mechanical ventilation, and dialysis – were used to capture end-organ dysfunction. Survey-weighted modeling and avoidance of overadjustment for downstream mediators further strengthen internal validity. The evaluation of multiple outcomes, including mortality, organ failure, resource utilization, and discharge disposition, provides a comprehensive assessment of the clinical and health-system impact of inter-hospital transfer in acute cholangitis.

As with all analyses of administrative data, this study is subject to limitations, including potential misclassification related to ICD-10-CM coding and the absence of laboratory values, physiologic severity scores, antibiotic timing, and precise timestamps for transfer or biliary intervention. As a result, Tokyo Guidelines 2018 severity grading and time to biliary decompression could not be directly assessed, and residual confounding from unmeasured physiologic severity cannot be excluded. The retrospective design also limits causal inference despite multivariable adjustment for relevant confounders [23, 24]. The adjusted mortality estimate was directionally elevated but did not reach conventional statistical significance, suggesting a modest association between transfer status and mortality cannot be excluded. The database could not establish whether these severity markers were present on arrival or developed later. Exclusion of transfer-out hospitalizations may have introduced selection bias by removing a subset of initially admitted patients who subsequently required escalation to another acute-care hospital, thereby accentuating severity differences between direct admissions and transfer-in cases. Because the primary cohort used an any-diagnosis definition, the study may have included hospitalizations in which acute cholangitis was a concurrent rather than a principal reason for admission, thereby increasing cohort heterogeneity.

## 5. Conclusion

In this hospitalization-level analysis of the National Inpatient Sample, transfer-in status was not significantly associated with in-hospital mortality after full adjustment. Transfer-in hospitalizations were associated with selected markers of greater illness severity and higher resource utilization. These findings should be interpreted with consideration of the limited clinical granularity of administrative data and the inability to assess the full episode of care, including transfer-related timing and pre-transfer management.

Gastroenterologists and health care systems may use these insights to optimize triage and referral pathways, anticipate higher-level care needs, and ensure timely access to endoscopic intervention. Future studies that integrate administrative data with physiologic measures and procedural timing may further clarify how disease severity, transfer processes, and treatment delays interact to influence outcomes in acute cholangitis.

## Conflicts of Interest

The authors declare no conflicts of interest relevant to this manuscript.

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## Institutional Review Board (IRB)

Ethics approval and institutional review board review were not required because this study used the National Inpatient Sample, a publicly available de-identified administrative database.

## Large Language Model

We employed an advanced Large Language Model (LLM) to improve the manuscript's English-language writing, clarity, and style. This use was limited to language refinement and did not generate new data, analyses, interpretations, or scientific content. The authors reviewed and approved all final content.

## Author Contributions

MHL, IK, AK, EM, KAM, JR, HEH, and KQ contributed substantially to the study conception and design, data analysis and interpretation, manuscript drafting, and critical revision of the intellectual content. All authors approved the final manuscript and agreed to be accountable for all aspects of the work. The authors thank the Healthcare Cost and Utilization Project (HCUP) and the Agency for Healthcare Research and Quality for providing access to the National Inpatient Sample database. No additional individuals contributed substantially to the design, analysis, interpretation, or drafting of this manuscript beyond the listed authors.

## Data Availability

The data that support the findings of this study are available from the Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample. These data are not publicly shareable by the authors because they are subject to HCUP data-use restrictions and must be obtained directly from HCUP by eligible researchers.

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