Original Research Article

Impact of inter-hospital transfer on outcomes of urgent cholecystectomy

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ABSTRACT

Background: This study used a national cohort to characterize the impact of inter-hospital transfer status on outcomes following nonelective cholecystectomy for cholecystitis.

Methods: Nonelective cholecystectomies were identified using the 2016-2019 National Inpatient Sample. Multivariable models adjusting for patient and hospital characteristics were utilized to assess outcomes of interest.

Results: Of an estimated 530,696 patients, 5.3% were transferred. Transferred patients were older, more often male, and more likely to report income in the 0th-25th percentile, compared to others. After adjustment, transfer was associated with increased odds of infectious complications (AOR 1.31, 95%CI 1.06–1.60) and non-home discharge (AOR 1.59, 95%CI 1.45–1.74), but not mortality. Transfer was linked to a $600 cost decrement at the operating hospital (95%CI -$880–330).

Conclusions: Transfer status is associated with greater postoperative infection, but not mortality. Given that disparities may play a role in transfer decisions, more work must be done to identify transfer drivers and improve patient outcomes.

1. Introduction

Inter-hospital transfer is common practice, particularly for patients requiring more specialized care than a facility’s services can provide. However, the coordination of transport and transfer of care can pose risks to the patient, including delayed time to operation, progression of pathology, and higher incidence of complications, such that transfer is associated with greater in-hospital mortality. In a study of optimal timing of cholecystectomy for acute cholecystitis, Brooks and colleagues noted that patients who undergo operations later in their hospitalization face significantly longer duration of stay and accumulate greater costs. Yet, access to experienced facilities may be associated with significantly improved patient outcomes, such as reduced in-hospital mortality, postoperative complications, and resource utilization, as evidenced by the volume-outcome relationship seen in many surgical procedures. Transfer decisions, therefore, rest on a multifaceted risk-benefit analysis.

Prior studies examining inter-hospital transfer after emergency general surgery have reported inferior postoperative outcomes and increased resource utilization. However, they have relied on decade-old data, in some cases drawn from a single institution. Thus, the contemporary impact of transfer on outcomes of patients undergoing cholecystectomy has yet to be studied at the national level. Improving outcomes in this patient population is critical, as over 1.2 million cholecystectomies are performed in the United States each year.

The present study examined the association of transfer status with in-hospital mortality, perioperative complications, length of stay, and hospitalization costs among patients undergoing cholecystectomy. Additionally, we identified factors associated with the requirement of transfer. We hypothesized that transferred patients would experience increased complications and mortality after nonelective cholecystectomy as well as require greater resource use.

2. Methods

2.1. Data source & cohort definitions

All nonelective adult (≥18 years) hospitalizations for cholecystectomy were tabulated from the 2016-2019 National Inpatient Sample (NIS). The NIS is the largest publicly-available, all-payer database, which provides accurate estimates for 97% of annual US hospitalizations. It is maintained by the Healthcare Cost and Utilization Project (HCUP), a network of databases and software developed through

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federal-state partnerships and sponsored by the Agency for Healthcare Research and Quality.\textsuperscript{1,2}

Patients undergoing cholecystectomy for acute cholecystitis were identified using International Classification of Diseases, Tenth Revision (ICD-10) procedural and diagnosis codes (Supplemental Table 1). Records missing key data or involving robotic surgery were excluded. To ensure sample homogeneity and broaden generalizability, patients were also excluded if they received a cholecystectomy more than five days after admission, or if they presented with concomitant chronic pancreatitis, gallbladder cyst, hepatobiliary malignancy or had a history of liver transplantation (60.8\%) (Fig. 1).

2.2. Variable definitions & study outcomes

Patient and hospital factors were characterized using the HCUP data dictionary and available ICD-10 diagnosis fields. The Elixhauser co-morbidity index, a previously-validated composite measure of 30 conditions, was utilized to assess the burden of chronic illness. Postoperative complications were analyzed using previously reported ICD-10 codes.\textsuperscript{14,15} Patient transfer status was defined using the NIS “TRAN_IN” variable, which indicates transfer into a hospital. Patients were stratified into the transfer cohort (TR) if they were transferred from a different acute care center or another type of healthcare facility to a new admitting hospital. All others were considered the non-transfer group (NTR).

Annual hospital institutional volume for cholecystectomy was calculated and used to categorize hospitals as low-, medium-, or high-volume centers, based on cutoffs at the 33rd and 67th percentiles. Hospitalization costs were calculated after application of hospital-specific cost-to-charge ratios to overall charges and inflation adjustment to the 2019 Personal Health Care Price Index.\textsuperscript{16}

The primary outcomes of this study were in-hospital mortality, postoperative complication rates, length of stay (LOS), and hospitalization costs. Complications were classified as infectious, respiratory, thrombotic, and renal, with relevant codes shown in Supplemental Table 1.

2.3. Statistical analysis

Variables are reported as medians with interquartile range (IQR) if continuous or as proportions (%) if categorical. Effect size was assessed using standardized mean differences (SMD), with significance considered as >0.1.\textsuperscript{17} The adjusted Wald, Chi-Square, and Mann Whitney U tests were used to compare patient and hospital characteristics. Temporal trends were evaluated using Cuzick’s non-parametric test (nptrend).\textsuperscript{18}

To account for baseline differences among transferred and non-transferred patients, entropy balancing was used to generate a balanced cohorts based on age, sex, comorbidity burden, socioeconomic status, and key hospital factors, including geographic region, volume tertile, and teaching status.\textsuperscript{19} Risk-adjusted analyses were performed using the propensity score-derived treatment weights. Multivariable linear and logistic regression models were developed to identify the association of inter-hospital transfer status with outcomes of interest. Covariates were selected using elastic net regularization, a method that reduces overfitting and enhances generalizability of the models.\textsuperscript{20} Models were optimized using receiver operating characteristics as well as Akaikie and Bayesian information criteria, as appropriate. Additionally, we performed a second sensitivity analysis limiting our study cohort to patients undergoing laparoscopic cholecystectomy. Regression outputs are reported as adjusted odds ratios (AOR) for logistic and as beta-coefficients (β) for linear models. All analyses were performed using Stata 16.1 (StataCorp, College Station, TX). Significance was set as α = 0.05. This study was deemed exempt from review by the Institutional Review Board of the University of California, Los Angeles.

3. Results

Of an estimated 530,696 hospitalizations for cholecystectomy considered for analysis, 5.3\% (28,250) were transferred from an outside hospital (TR group). Cholecystectomy volume declined over the study period (nptrend p < 0.001), but the proportion of patients experiencing inter-facility transfer increased significantly (4.2\% in 2016 to 6.2\% in 2019, nptrend p < 0.001) (Fig. 2).

Patient and hospital characteristics for the cohorts are shown in
Fig. 2. Temporal trends in annual cholecystectomy hospitalizations and the percentage of transferred patients

Cholecystectomies for acute cholecystitis declined from 2016 to 2019. However, the proportion of patients who experienced inter-hospital transfer experienced a positive upward trend since 2016. Both analyses of trend are significant at p < 0.001.

Table 1. TR patients were older (58 years [IQR: 42–71] vs 53 years [IQR: 38–67] and more likely to be male (45.5 vs 39.8%, SMD = 0.12), compared to NTR. The TR cohort also presented with a higher median Elixhauser Comorbidity Index and greater frequency of congestive heart failure (9.5 vs 5.4%, SMD = 0.15), coronary artery disease (15.3 vs 10.4%, SMD = 0.15), and hypertension (51.2 vs 44.7%, SMD = 0.13) (Table 1). Compared to NTR, a greater proportion of TR patients were classified as White (71.5 vs 59.1%, SMD = 0.20) or belonged to the lowest income quartile (33.5 vs 29.3%, SMD = 0.18). The groups were comparable with respect to insurance coverage and geographic region. Although they were less commonly treated at high-volume institutions (57.7 vs 64.9%, SMD = 0.12), TR patients were more often treated at metropolitan teaching hospitals (72.4 vs 62.5%, SMD = 0.16). Patients in the TR cohort were less likely to undergo laparoscopic cholecystectomy, relative to those in the NTR cohort (89.7 vs 93.6%, SMD = 0.14). Further, both TR and NTR patients most frequently underwent their procedure one day after admission (Table 1).

After risk adjustment, several factors were associated with greater odds of transfer, including Elixhauser Comorbidity Index (AOR 1.08/per unit, 95% CI: 1.05–1.12) and Medicare insurance status (AOR 1.15, 95% CI 1.07–1.25, Ref: Private Insurance) (Table 2). Importantly, income quartile designation was inversely correlated with odds of inter-hospital transfer. Income in the 26th-50th and the 0-26th percentiles were linked to a 71% and 88% greater relative odds of transfer, respectively (AOR 1.71, 95% CI: 1.53–1.90; AOR 1.88, 95% CI: 1.67–2.10, Ref: top quartile) (Fig. 3). Additionally, transfer was related to hospitalization in the Midwest (AOR 2.17, 95% CI 1.87–2.52), South (AOR 1.28, 95% CI 1.11–1.48), and West (1.56, 95% CI 1.32–1.78). Black race (AOR 0.57, 95% CI 0.50–0.64) and Hispanic ethnicity (AOR 0.59, 95% CI 0.53–0.66) were associated with reduced odds of transfer, as compared to White (Table 2).

Unadjusted rates of mortality, as well as infectious, respiratory, thrombotic, and intraoperative complications were similar between the TR and NTR groups. However, TR patients experienced increased lengths of stay (3.17 ± 2.81 days vs 2.83 ± 3.81 days, SMD = 0.20). TR patients also experienced increased rates of non-home discharge, defined as discharge to short-term hospitals, skilled nursing facilities, and intermediate care facilities, relative to NTR (17.1 vs 9.3%, SMD = 0.23). Hospitalization costs were comparable between the groups (Table 3).

Following entropy balancing and risk adjustment, transfer remained associated with the development of infectious complications (AOR 1.31, 95% CI 1.06–1.60). Additionally, transfer status was associated with a $605 decrease in hospitalization costs (95% CI -$876-335), but a 0.30 incremental increase in duration of stay (95% CI 0.21–0.40). Inter-hospital transfer was also linked to a 59% increase in relative odds of non-home discharge (95% CI 1.45–1.74) (Fig. 4). Further, after limiting the cohort to patients undergoing laparoscopic cholecystectomy, similar
findings were observed as reported above (Supplemental Table 2).

4. Discussion

Inter-hospital transfer is associated with greater in-hospital mortality, complications, and resource utilization across a number of conditions. However, few have examined the impact of transfers for nonelective cholecystectomy. We used a nationally representative cohort of cholecystitis patients undergoing nonelective cholecystectomy and made several important observations. We found transfer to be associated with increased odds of infectious complications, but not in-hospital mortality. Further, transfer was linked to an increase in LOS, but lower hospitalization costs at the operating facility. These findings
warrant further discussion.

Previous work has identified patient factors associated with inter-hospital transfer. In agreement with work by Shannon et al., Philip et al., and Fernandes-Taylor et al., we determined that income was inversely related to transfer, such that income in the 0\textsuperscript{th} to 26th percentile was associated with an 88% increase in relative odds of transfer, as compared to income in the highest quartile.\textsuperscript{19-21, 22} This finding suggests that financial reasons may be related to transfer decisions. Further, similar to Mueller and colleagues,\textsuperscript{23} we identified non-White race to be associated with lower odds of transfer. It is possible these differences in transfer odds are related to location of original hospitalization, such that non-White patients were more commonly initially hospitalized at metropolitan hospitals which potentially have lower rates of transfer, as compared to White patients.\textsuperscript{24} Due to the limitations of NIS, our analysis could not consider factors related to the referring hospital, such as its status as a teaching or community hospital, or its transfer rate. Ultimately, further investigation is required to ensure that these socioeconomically disadvantaged and non-White populations do not experience additional disparities in inter-hospital transfer.

Medicare insurance coverage was linked with greater odds of inter-hospital transfer, compared to others. These findings may, in part, be explained by the older age and greater burden of comorbidities among Medicare recipients. Clinicians may transfer patients, whether covered by Medicare or another insurance provider, to facilities where they had been previously treated to maintain continuity of care, or to align with patient or family preferences in the choice of operating center.\textsuperscript{25} In addition, self-pay was associated with lower odds of transfer. Although the Emergency Medical Treatment and Active Labor Act prohibits emergency departments from refusing transfer requests based on insurance status, it is possible that transfer could be denied if the patient has already been admitted.\textsuperscript{10} The NIS does not provide granularity as to whether patients were transferred from the emergency room, surgical floor, or intensive care unit, leaving this subject up to future study. Ultimately, the link between socioeconomic factors and inter-hospital transfer underscores the continuing impact socioeconomic status has on transfer decisions and overall health outcomes. This pervasive phenomenon warrants novel policy to ensure transfer decisions are made based on clinical factors, not income or insurance coverage.

Previous national studies considering transfer status in surgical contexts present inconsistent findings. Evaluating the impact of transfer on colorectal surgery outcomes using the National Surgical Quality Improvement Program (NSQIP) database, Sharp et al. found transfer to be associated with greater mortality and complication rates.\textsuperscript{26} Similarly, considering inter-hospital transfer for emergency general surgery, Yelverton et al. identified a two-fold increase in odds of mortality among transferred patients, compared to others.\textsuperscript{10} However, in a different NSQIP study evaluating urgent colorectal surgery outcomes, transfer was not found to be independently related to inferior outcomes.\textsuperscript{27} In the present investigation, we did not find a significant association between inter-hospital transfer and in-hospital mortality. There are several factors that may explain this result. Notably, patient transfer may often lead to delays in care.\textsuperscript{25, 28} Yet, we report that both transferred and non-transferred patients most often undergo their cholecystectomy one day after admission, suggesting similar timelines once admitted to the operating facility. Due to the restrictions of NIS, we could not examine any delays patients experienced before transfer, leaving a direction for future analysis.

Nearly all patients underwent a laparoscopic cholecystectomy (93.6% of non-transferred patients, 89.7% of transferred patients), considered the gold standard of treatment for acute cholecystitis.\textsuperscript{29} Laparoscopic cholecystectomy is associated with a low baseline mortality rate of \textasciitilde 1%, as compared to \textasciitilde 5% for open.\textsuperscript{29} Thus, any adverse effects of transfer may be blunted by the safety and efficacy of this low-risk procedure. A greater proportion of transferred patients underwent an open cholecystectomy, as compared to non-transferred. However, it is unclear whether factors associated with transfer led these patients to have more complicated cases and require an open cholecystectomy, or whether a complicated case was the justification for the transfer; further investigation is needed to parse the relationship between transfer status and differences in surgical approach. Indeed, transfer may occur due to a number of reasons, including acuity and complexity that could not be fully treated at the initial hospital. Importantly, more complex or higher-risk cases may require aspects of perioperative care that are beyond the scope of certain centers. For example, transfer may be prompted by the need for dialysis capabilities, 24 h/day critical care physician support in intensive care units, or other more resource-intensive components.\textsuperscript{30} Yet, a cholecystectomy is a procedure that is well within the toolkit of a general surgeon.\textsuperscript{31, 32} so more granularity about each case is needed to clarify the justification and potential benefit of transfer. Future studies could consider case complexity and the myriad factors that may drive inter-hospital transfer, including information about the referring facility.

In line with prior work, we identified an association between inter-hospital transfer and the development of infectious complications. Huntington et al. considered the impact of transfer on commonly performed surgical procedures through a NSQIP-based analysis and found that nearly one-third of transferred patients developed an infection or postoperative sepsis.\textsuperscript{33} Similarly, in another study of inpatient general surgery cases, transferred patients more frequently experienced surgical site infections, as compared to direct admissions.\textsuperscript{34} Although transferred patients may present with greater infection or disease due to transfer-associated delays or case complexity, this greater propensity for infection may also be nosocomial. Evaluating the impact of transfer on cardiac surgery patients in a three-institution study, Prabhu et al. found that relative to others, transferred patients were five times more likely to develop a hospital-acquired infection, potentially due to significantly longer pre-operative hospitalizations experienced at the referring center.\textsuperscript{35} Prolonged hospital stay is a well-known risk factor for infection.\textsuperscript{36} The implementation of the Surgical Care Improvement Project (SCIP) has been linked to a decrease in postoperative surgical site infections.\textsuperscript{36} However, the continued burden of hospital-acquired infection suggests additional quality improvement efforts are needed to reduce infection rates and spread, particularly through reducing inter-hospital variation in infection prevention.\textsuperscript{37} In addition, further research is needed to clarify the extent to which aspects of inter-hospital transfer specifically contribute to the burden of infection remaining even after SCIP measures are implemented.

Unexpectedly, transfer was associated with an incremental \textasciitilde $600 decrease in expenditures incurred at the operating facility. Several factors may explain this reduction in costs, including elimination of costs associated with a full emergency department workup, as well as avoidance of repeat imaging and greater utilization of studies from the transferring facility.\textsuperscript{38} Critically, as only costs from the operating facility were available for analysis, we could not compute the overall cost of hospitalization, including costs from the referring facility and medical transport. Medical transport in particular is extremely resource-heavy and would dramatically increase the total cost of care for a transferred patient.\textsuperscript{39} As such, although costs may be slightly reduced at the operating facility, total hospitalization expenditures including medical transport could be significantly greater for transferred patients, as compared to non-transferred.\textsuperscript{40} Thus, this cost analysis is fundamentally incomplete. However, future studies could investigate this comprehensive cost burden, as well as the additional, non-monetary consequences of transfer, including outright loss of tertiary care capabilities.\textsuperscript{10, 11}

This study has several important limitations. Given the structure of NIS, characteristics of the transferring center and information regarding procedures, complications, and duration of stay at index admission were not available for analysis. Variation in surgeon expertise was not reported but may have significantly affected patient outcomes. NIS does not identify whether patients were transferred from the emergency department, surgical floor, or intensive care unit. Patient acuity or physiologic status at the point of procedure is not reported by the NIS.
Additionally, information regarding clinical status, including vital signs and lab values, was unavailable for analysis. Ultimately, these factors make it difficult to ascertain the severity of patient illness at the time of cholecystectomy. Indeed, a transfer decision rests on patient physiologic parameters and clinical decision making, neither of which could be considered in this study. In addition, as an administrative, coding-based study, our consideration of patient comorbidities and outcomes may be affected by local billing practices. Yet, this study remains a large, nationally representative analysis examining cholecystectomy outcomes after inter-hospital transfer.

In conclusion, we found that transfer was associated with greater infectious complications and non-home discharge, but no difference in mortality in patients undergoing nonelective cholecystectomy for cholecystitis. Lower income was associated with greater odds of transfer, as was Medicare insurance coverage and a greater burden of comorbidities. Future studies that consider additional drivers of inter-hospital transfer may reveal disparities in transfer decisions. Finally, referring hospital characteristics should be further investigated to better elucidate reasons for transfer and determine optimal transfer timing to improve patient outcomes.

Declaration of competing interest

The authors have no financial disclosures or conflicts of interest to report.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2022.09.035.

References

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