

ORIGINAL ARTICLE

Cost of achieving equivalent outcomes in sicker patients after liver transplant

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Abstract

Background: We aimed to characterize variability in cost after straightforward orthotopic liver transplant (OLT).

Methods: Using the University HealthSystem Consortium and Scientific Registry of Transplant Recipients databases, we identified patients who underwent OLT between 2011 and 2014. Patients meeting criteria for straightforward OLT, defined as length of stay < 14 days with discharge to home, were selected ($n = 5763$) and grouped into tertiles (low, medium, high) according to cost of perioperative stay.

Results: Patients undergoing straightforward OLT were of similar demographics regardless of cost. High cost patients were more likely to require preoperative hemodialysis, had higher severity of illness, and higher model for end-stage liver disease (MELD) ($p < 0.01$). High cost patients required greater utilization of resources including lab tests, blood transfusions, and opioids ($p < 0.01$). Despite having higher burden of disease and requiring increased resource utilization, high cost OLT patients with a straightforward perioperative course were shown to have identical 2-year graft and overall survival compared to lower cost patients ($p = 0.82$ and $p = 0.63$), respectively.

Conclusion: Providing adequate perioperative care for OLT patients with higher severity of illness and disease burden requires increased cost and resource utilization; however, doing so provides these patients with long term survival equivalent to more routine patients.

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Introduction

With growing emphasis on efforts to reduce healthcare expenditures in the United States, attention is being directed toward evaluating the performance and associated economic impact of institutions performing high cost, complex, surgical procedures.^{1–3} In an attempt to curtail rising costs, policymakers and healthcare providers have shifted away from volume-based reimbursement practices toward implementation of value-based payment models and bundled capitation.^{4–7} Financial incentives tied to reductions in postoperative complications,

readmission rates, and overall patient morbidity have been proposed as methods for achieving cost savings while improving quality of care.^{8,9}

As a result of these changes, orthotopic liver transplantation (OLT) faces questions regarding its cost-effectiveness and economic viability.^{10–12} Widely regarded as a high-risk surgical procedure with significant potential for morbidity, OLT is a resource-intensive intervention that is offered to patients who are often extremely debilitated and have a high burden of disease.^{13,14} Furthermore, demand for OLT is rising annually as eligibility criteria continue to expand. As the acuity and complexity of patients undergoing OLT increases, there is a compelling need for optimizing resource utilization without adversely affecting short and long-term outcomes.^{15,16}

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Although previous reports have emphasized the correlation between hospital costs and rates of postoperative complications, little is known regarding variability in cost for patients undergoing complex surgery whose postoperative course is straightforward.^{17,18} Furthermore, the costs required to achieve these optimal outcomes in patients undergoing OLT with higher severity of illness (SOI) and increased burden of disease are not well understood. The objective of this study was to identify determinants of cost after OLT, characterize the variability in cost for patients undergoing straightforward OLT, and determine the overall impact on graft and patient survival.

Methods

Study population

A retrospective, cohort study was performed utilizing a linkage between the Scientific Registry of Transplant Recipients (SRTR) and University HealthSystem Consortium (UHC) databases. The SRTR is a national database of transplant statistics gathered by the Organ Procurement and Transplantation Network (OPTN) through organ procurement organizations and hospitals nationwide. The OPTN is a nonprofit entity that governs the operation of its member organ procurement organizations, defines national policies on organ allocation, and maintains the waitlist for transplantation candidates. Clinical data for organ donors and recipients were obtained from the SRTR Standard Analysis File. Data from the SRTR were then linked with clinical and hospital encounter data obtained through the UHC Clinical Database/Resource Manager (CDB/RM). The UHC is a network of 118 academic medical centers and 298 associated hospitals, representing an alliance of 95% of the nation's major non-profit academic medical centers. Through the UHC, the CDB/RM collects information on patient demographics, International Classification of Diseases, 9th revision diagnoses, financial data, and procedure data. Financial data is reported as hospital charges per patient encounter, which are then converted to estimates of total direct cost through federally reported area wage indices and institution-specific Medicare cost-to-charge ratios. All information collected in the linked dataset was coded such that investigators did not have access to any patient identifying information.

The SRTR and UHC datasets were linked as previously described through recipient age, date of procedure, and transplant center.^{19–21} All OLT recipients who underwent transplantation between January 1, 2011 to December 31, 2014 were identified ($n = 12,245$). This represents 52% of the total number of OLT performed during this time. From this group, patients who underwent straightforward OLT, defined as having a length of stay < 14 days with discharge to home, were included for analysis ($n = 5763$). Length of stay has previously been described as a meaningful marker of cost and resource utilization in LT.¹¹ Patients were then divided equally into tertiles according to cost of perioperative stay, defined as the total direct cost

associated with the index hospitalization, and categorized into low, medium, and high cost groups. Utilizing a primary predictor variable of transplant cost, outcome variables of patient survival and graft survival were evaluated. Median follow-up period for our cohort was 2 years.

Variables defined

The following recipient characteristics were collected: age (years), gender, race (white, black, Hispanic, or other), body mass index (BMI), SOI scores, insurance type (private, government, or other), cause of liver disease, physical capacity, medical comorbidities, functional status (independent, dependent, or severely ill), and model for end-stage liver disease (MELD) score. Additionally, the following donor characteristics were obtained: age (years), gender, race (white, black, Hispanic, or other), donor type (donation after cardiac death [DCD], standard criteria donation [SCD], or expanded criteria donation [ECD]), cause of death (anoxia, cerebrovascular accident [CVA], trauma, or other), cold ischemia time (hours), and warm ischemia time (minutes). Perioperative resource utilization was determined by collecting the following data during the index hospitalization: number of laboratory tests obtained, number of radiographic studies obtained, blood product transfusion requirements, days on antibiotics, anti-reflux medication charges, and opioid requirements. Finally, the following postoperative hospital information was collected: length of stay (LOS), intensive care unit (ICU) LOS, in-hospital mortality, discharge destination, total direct cost, 30-day readmission rates defined as readmission to the index hospital within 30 days of discharge, graft survival, and patient survival.

Utilizing the SRTR dataset, we determined the total number of OLT procedures performed per year for each transplant center. Each center was ranked according to the volume of LT procedures performed, defined as center volume. All OLT procedures performed were included when determining center volume, not just those deemed straightforward according to the criteria noted above (length of stay < 14 days with discharge to home). These centers were then divided equally into tertiles and categorized into three groups: low volume (LV), middle volume (MV), and high volume (HV) centers. The number of procedures used to designate LV, MV, and HV were recalculated annually, and tertile categorizations were redefined for each year that was studied.

Statistical analysis

Low cost, medium cost, and high cost straightforward OLT cohorts were compared using univariate analysis. Continuous variables were described as estimates of central tendency (median) and interquartile ratio (IQR). Categorical variables were described as percentages (%). Categorical variables were analyzed using Pearson's chi-squared test, while continuous variables were compared through Wilcoxon rank-sum test. Kaplan–Meier estimates were utilized to compare long-term patient and graft survival between cost cohorts. Random

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