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Health care utilization and consequences of readmission in the first year after lung transplantation

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BACKGROUND: Hospital readmissions are costly and have become a focus for quality improvement. We aimed to determine risk factors, rate, and outcomes of readmissions within the first year after lung transplantation and the potential impact on patient survival.

METHODS: A retrospective cohort study of all lung transplant recipients ≥18 years old who had undergone initial transplantation (2004–2013) at a single center was conducted. Logistic regression was used to identify independent predictors of readmission for patients who survived hospitalization. Cox regression was used to explore the relationship between readmission and long-term risk of death, while adjusting for potential confounders for patients who survived the first year.

RESULTS: During the study period, 412 patients met inclusion criteria for the readmission analysis. There were 276 patients (67%) readmitted within 1 year after lung transplantation for a total of 609 readmissions (average ± SD, 1.5 ± 2). Average length of readmission stay was 6 days ± 7, with 44% of readmissions lasting ≤3 days. Airway complications were found to be a significant risk factor for readmission (odds ratio, 4.18; 95% confidence interval, 1.78–9.54; $p = 0.001$). After adjustment, the overall risk of death was significantly higher with each readmission during the first year (hazard ratio, 1.22; 95% confidence interval, 1.13–1.31, $p < 0.0001$).

CONCLUSIONS: Most patients who survive the first post-operative year experience at least 1 readmission, with patients who experience airway complications at particular risk. Patients discharged to inpatient rehabilitation were less likely to be readmitted. The cumulative burden of multiple readmissions is associated with worse long-term survival.

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The costs incurred for hospital readmission in the United States are estimated to be approximately $40 billion per year.[1,2] Thus, readmissions have become a focus of quality improvement programs as a target for cost saving. Of particular concern, the Medicare Payment Advisory Commission reported that 75% of readmissions are avoidable.[3] In 2012, the Strengthening Medicare and Repaying Taxpayers (SMART) Act was passed into law, which provides states the ability to levy fines or reduce reimbursement payments to hospitals that fail to reach benchmark rates for the percentage of preventable readmissions it could have in a particular calendar year.[4] The focus is currently on medical diagnoses; however, the program is expected to

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expand and eventually include more medical and surgical conditions. Although 30-day readmission rates after major surgical procedures have been reported to be 15%–23%,[5–7] it is expected that readmissions after lung transplantation would be higher because of the increased severity of illness, technical complexity of the operation, and high potential for both short-term and long-term complications. Vigneswaran et al [8] reported a 44% 90-day readmission rate for lung transplant recipients at Loyola University Medical Center, with pulmonary complications accounting for most readmissions. In addition, the authors reported decreased 1-, 3-, and 5-year survival rates for patients who were readmitted within 90 days compared with patients who were not readmitted. However, variables that may help predict hospital readmissions are unclear. Identifying causes of readmissions may help to determine if readmissions are preventable and/or predictable. More importantly, readmissions that occur beyond current benchmark standards (30 and 90 days) are a significant problem that, to our knowledge, has not yet been reported in the lung transplant literature. The aim of this study was to evaluate rates, diagnoses, risk factors, and outcomes of readmissions within the first year after lung transplant and their potential impact on long-term patient survival.

Methods

After obtaining institutional review board approval, a retrospective review of all patients undergoing single or bilateral lung transplantation at the University of Washington Medical Center between January 1, 2004, and December 31, 2013, was conducted. Patients with initial lung transplantation at an outside institution who underwent a second lung transplant at the study institution and patients <18 years old were excluded (Figure 1). Variables extracted included age, sex, ethnicity, body mass index (BMI), transplant diagnosis, cytomegalovirus (CMV) donor/recipient status, comorbid conditions (hypertension, diabetes mellitus, coronary artery disease), baseline serum creatinine, need for cardiopulmonary bypass (CPB), type of transplant, length of index intensive care unit (ICU) stay, length of index hospital stay, inpatient major morbidity, inpatient minor complications such as atrial fibrillation and pleural space issues (air leak $\geq$ 7 days, need for chest tube re-insertion, or discharged home with chest tube in place), discharge destination (home, short-term nursing facility, vent-weaning facility, or inpatient rehabilitation), primary caregiver (e.g., spouse, parent, adult child), insurance type, highest education level achieved, development of airway complications (anastomotic or non-anastomotic complications that required débridement, dilation, or stent placement on at least more than 1 occasion), dates of discharge, dates of readmissions, causes of readmissions, and vital status. Lung transplant recipients are followed in clinic every month for the first 6 months and then every 3−4 months through the first 2 years.

Readmission was defined as any inpatient hospital stay for $\geq$24 hours after discharge from lung transplantation. Two time periods were captured: readmissions within 30 days and within 1 year. The primary diagnosis or reason for each readmission was identified based on direct review of the medical records. Causes for readmission were broadly classified into systems based on admitting diagnosis, with an additional category for pleural space issues (see Supplementary Appendix, available at www.jhltonline.org).

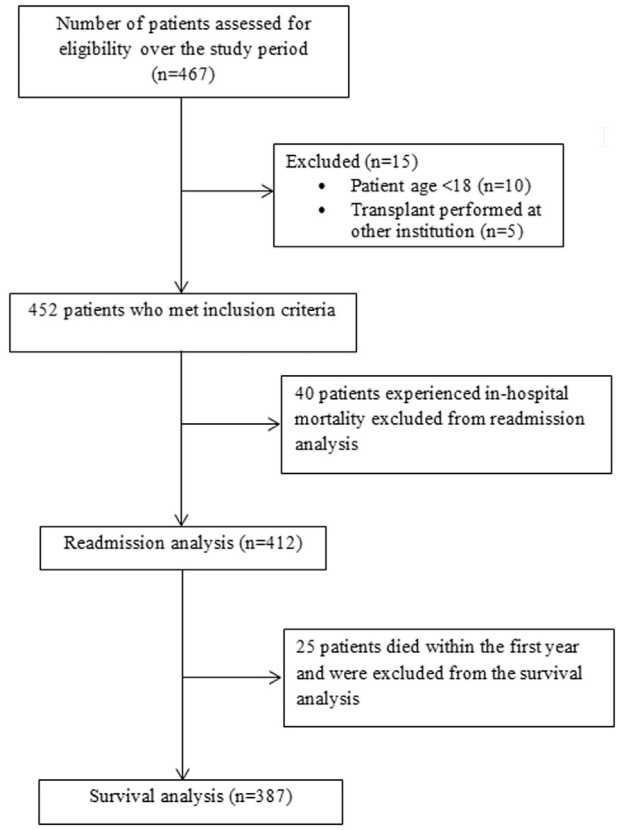

Figure 1 Flow diagram depicting patients excluded from final analysis.

The length of stay of each hospitalization and subsequent readmission was recorded.

To assess predictors of readmission, a multiple logistic regression model was fit. Patients who did not survive the index hospitalization were excluded from the logistic regression analysis. Patient survival was defined as the time between recipient lung transplantation and recipient death. Patients who died within the first year post-transplant were excluded from the survival analysis, as it is assumed that 100% of patients who die within the first year would meet readmission criteria. The Kaplan-Meier method was used to evaluate the unadjusted relationship between overall survival and readmission. Cox regression was used to evaluate the relationship between hospital readmission and time-to-event outcomes, while adjusting for potential confounders, including age, sex, ethnicity, BMI, transplant diagnosis, CMV donor/recipient status, comorbid conditions, baseline serum creatinine, need for CPB, type of transplant, length of index ICU stay, length of index hospital stay, inpatient major morbidity, inpatient minor complications, primary caregiver, insurance type, highest education level achieved, discharge destination, and development of airway complications. For multiple logistic regression analyses and Cox proportional hazards analyses, backward selection and a significance level of $\alpha = 0.05$ was used. Covariates considered are summarized and presented in the tables provided. Missing data were treated as missing and therefore were not included in the model building. No imputation methods were used. At each step in the model-building process, only complete cases were included. Assumptions checked included non-informative censoring and proportionality of hazard functions. To check non-informative censoring, survival time was plotted by censorship status for each explanatory variable. Vital status was confirmed 2 months before the end-of-study date. Vital status that was not recorded in the