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## ORIGINAL CLINICAL SCIENCE

# Contemporary analysis of early outcomes after lung transplantation in the elderly using a national registry

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**KEYWORDS:**

contemporary;  
early outcomes;  
elderly;  
lung transplantation;  
national

**BACKGROUND:** With an increasing number of potential recipients and a comparatively static number of donors, lung transplantation (LT) in the elderly has come under significant scrutiny. Previous studies have been limited by single-center experiences with small population sizes and often mixed results. Using a national registry, we sought to evaluate the following: (1) differences in survival outcomes in septuagenarians compared with sexagenarians; and (2) the effect of temporal trends on the development of other comorbidities in this population.

**METHODS:** We analyzed the Scientific Registry of Transplant Recipients (SRTR) data files from the United Network for Organ Sharing (UNOS) database to identify recipients who underwent LT between the years 2000 and 2013. The study period was divided into two equal eras. Using Kaplan–Meier analysis, we compared the 30-day, 3-month, 1-year, 3-year and 5-year patient survival between septuagenarians and sexagenarians in both eras. Separate multivariate analyses were performed to estimate the risk of renal failure, risk of rejection and length of hospital stay (LOS) post-LT in each of these time periods.

**RESULTS:** A total of 6,596 patients were identified comprising 1,726 (26.2%) during 2000 to 2005 and 4,870 (73.8%) during 2006 to 2012. In the “early era,” 32 (1.9%) septuagenarians and 1,694 (98.1%) sexagenarians underwent LT, whereas 543 (11.1%) septuagenarians and 4,327 (88.9%) sexagenarians underwent transplantation in the “latter era.” A comparison of patient survival between the two groups in the early era revealed no difference at 30 days (95.7% vs 93.8%,  $p = 0.65$ ). However, 3-month (91.2% vs 75%,  $p = 0.04$ ) and 1-year patient survival (79.5% vs 62.5%,  $p = 0.048$ ) were both lower in the septuagenarian group. In the later era, however, there were no differences in 30-day (96.2% vs 96.8,  $p = 0.5$ ), 3-month (92.7% vs 91.9%,  $p = 0.56$ ) or 1-year (81.7% vs 78.6%,  $p = 0.12$ ) patient survival between the two age groups. Survival rates at 3 years (63.7% vs 49.3%,  $p < 0.001$ ) and 5 years (47.5% vs 28.2%,  $p < 0.001$ ) were each significantly lower in the septuagenarian group.

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**CONCLUSION:** Overall, LT outcomes for the elderly have improved significantly over time and early outcomes in the modern era rival those found in younger recipients.

J Heart Lung Transplant ■■■■;■:■■■-■■■

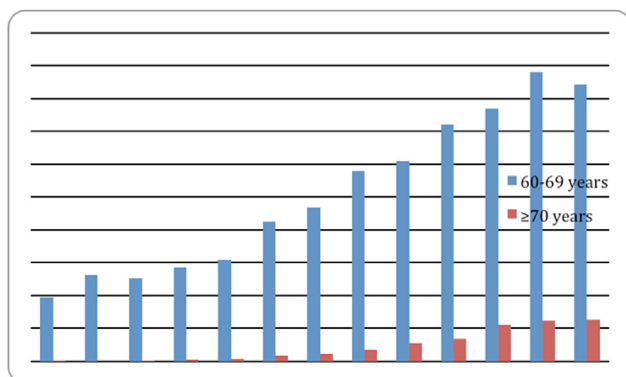
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Lung transplantation is the most effective therapeutic option for treating patients with end-stage lung disease (ESLD).<sup>1,2</sup> There has been a significant improvement in outcomes for these patients and an increasing number of recipients are becoming eligible for transplantation.<sup>3,4</sup> The improved outcomes stem from the more effective immunosuppression regimens, improved management of infectious complications, and adoption of evidence-based guidelines that better govern donor and recipient selection. The International Society for Heart and Lung Transplantation (ISHLT) recommends that the age of 65 years serves as a relative contraindication to transplantation. Despite this, there has been a steady increase in the number of recipients aged  $\geq 70$  years (Figure 1).<sup>4,5</sup> The paucity of suitable donor lungs relative to the number of potential recipients on the waiting list poses a significant barrier. Faced with this shortage, the benefit of lung transplantation for elderly recipients has been a subject of both scrutiny and controversy.

Prevailing data regarding elderly patient outcomes have been conflicting.<sup>6-9</sup> Initial studies are based on single-center experiences with relatively small numbers of patients that are limited in their statistical power and scope of recommendation. In our analysis, we used a national database to evaluate differences in outcomes for septuagenarians compared with sexagenarians who underwent lung transplantation in the USA within the period from 2000 to 2012. In addition, we evaluated temporal differences in outcomes over the duration of the study period in an effort to identify predictors of mortality in this study population.

## Methods

We analyzed data from the Scientific Registry of Transplant Recipients (SRTR) data files from the United Network for Organ Sharing (UNOS) database to identify recipients who had undergone lung transplantation (LT) between January 2000 and December 2012. Patients included in the analysis were  $\geq 60$  of



**Figure 1** Trends in lung transplantation over the period of 2000 to 2012 for septuagenarians and sexagenarians in the USA.

age and had undergone either single or double LT within the study period. Both patient-level data and transplantation center data were provided in a de-identified format. We excluded patients who had undergone lung re-transplantation and those with multiple-organ transplantation. We categorized the study population into sexagenarians (60 to 69 years of age) and septuagenarians (aged  $\geq 70$  years of age). Our primary outcome was all-cause mortality, as documented within the registry. Other outcomes studied included treatment for rejection in the first year after lung transplantation, length of hospital stay (LOS) post-LT, peri-operative stroke, renal failure requiring hemodialysis and primary cause of death. The two groups were compared using pre-selected recipient-, donor- and transplant-related characteristics. Categorical variables were compared with Pearson's chi-square, continuous variables using Student's *t*-test, whereas non-parametric variables were compared using Wilcoxon's rank-sum test. A Kaplan-Meier analysis with log-rank analysis was performed to estimate the differences in 30-day, 3-month and 1-year survival between the two age groups.

The study period was divided into two discrete eras comprising transplantations performed between 2000 and 2005 and those between 2006 and 2012 to assess the longitudinal impact of time on outcomes. We performed separate Kaplan-Meier analyses for each era to estimate the 30-day, 3-month, 1-year, 3-year and 5-year survival for both groups. A multivariate Cox proportional hazard model was fitted using recipient-, donor- and transplant-related variables to establish predictors of 1- and 5-year mortality. We used a backward stepwise selection with a *p*-value of 0.25 to include variables in the model. Multivariate logistic regression was used to compare the risk of treatment for graft failure at 1 year post-transplant and the risk of post-transplant dialysis-dependent renal failure between the two age groups. We excluded patients who had dialysis before transplantation in the latter model. Similarly, multivariable linear regression analysis was done to assess any differences in the hospital length of stay between the two age groups. Results were considered significant at  $p < 0.05$ . All analyses were performed using STATA, version 12.0 (StataCorp, College Station, TX).

## Results

We identified a total of 6,596 patients aged  $\geq 60$  years who had undergone LT within the study period. This comprised 575 (8.7%) septuagenarians and 6,021 (91.3%) sexagenarians. We observed that septuagenarians were more likely to be male (80.0% vs 62.3%,  $p < 0.0001$ ), diagnosed with idiopathic pulmonary fibrosis (IPF; 68.5% vs 41.0%,  $p < 0.0001$ ), diabetic (16.8% vs 13.5%,  $p = 0.03$ ) and be of white ethnicity (90.6% vs 89.3%,  $p = 0.001$ ). Septuagenarians were more likely to have received an organ from older donors (34 vs 32 years,  $p = 0.01$ ) and from donors who were less likely to have died from trauma (45.6% vs 49.1%,  $p = 0.003$ ). Overall, we found no statistically significant differences between the two groups in the use of mechanical ventilation ( $p = 0.17$ ), ischemic time ( $p = 0.37$ ), use of inhaled nitric oxide ( $p = 0.18$ ), extracorporeal membrane oxygenation (ECMO)

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