Improving the Allocation of Transplantable Lungs

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Lungs are scarce in U.S. (deceptively so)

Number of Patients Removed From Waiting List Due to Death or Too Sick to Transplant

Data from the Organ Procurement and Transplantation Network, January 10, 2011
Supply more

- Improve consent among traditional brain-dead donors
- Increase use of donors after circulatory determination of death
- Liberalize medical criteria for organ acceptance

Allocate better

- Efficiency
- Equity
Single vs. bilateral LT: International trends

Single vs. bilateral LT for COPD/α1AT-def

Propensity-score matched
HR: .89 (.80 - .97)

Figure 4: Kaplan-Meier estimates for survival after lung transplantation, according to type of procedure for 3024 pairs of patients who were matched by propensity score.
Generalized Markov Model

**Strategies:**
1. SLT for all COPD
2. BLT for all COPD

Patients with other dx’s listed as they normally would be

Once transplanted, procedure- and disease-specific median survival times applied (ISHLT)

Munson JC, Christie JD, Halpern SD. AJRCCM 2011; 184: 1282-88
Model outputs

1. Number of lives saved (transplants performed)

2. Total number of post-transplant life-years gained

- All models used base simulations of 1,000 patients; 95% confidence intervals generated using Monte Carlo sampling of input parameters
- Unable to adjust for quality of life
Donor availability and lives saved

Deaths (base case): 185 (SLT) vs. 234 (BLT); difference = 49 (95% CI: 45-54)

Munson JC, Christie JD, Halpern SD. AJRCCM 2011; 184: 1282-88
Local competition influences the number of lives saved.

- **Waitlist length** influences the number transplanted:
  - For **20 patients**:
    - SLT: 809
    - BLT: 758
  - For **10 patients**:
    - SLT: 888
    - BLT: 857
  - For **5 patients**:
    - SLT: 931
    - BLT: 914

Munson JC, Christie JD, Halpern SD. AJRCCM 2011; 184: 1282-88
Donor availability and life-years gained

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Some U.S. single-center studies had reported 3-year survival of 70-75%; median across U.S. = 64%

□ Implications:

✓ Opportunities to learn and improve overall quality of care

✓ Efficiency of allocation: should we include center-specific estimates of post-transplant survival in LAS?

Context Although case loads vary substantially among US lung transplant centers, the impact of center effects on patient outcomes following lung transplantation is unknown.

Objective To assess variability in long-term survival following lung transplantation among US lung transplant centers.

Design, Setting, and Patients Analysis of data from the United Network for
Lung Allocation Score (LAS)

- Adopted May 1, 2005; previously lungs allocated by waiting time accrued (first-come, first-served)

The **transplant benefit measure** for candidate $i$ ($\text{Benefit}_i$) is:

$$
\text{Benefit}_i = \boxed{\text{PT}_i - \text{WL}_i}
= \text{expected days lived during 1^{st} year post-transplant} - \text{expected days lived during additional year on waiting list}
= \text{additional days of life lived with a transplant than without a transplant}
$$
Figure 3. Adjusted Outcomes for the 61 Active US Lung Transplantation Centers Expressed as Hazard Ratio for Death

Center No.

HR among centers: 0.70 – 1.71, yielding predicted 5-year survival of 30% to 61%

85% pts transplanted @ centers with > 25% excess mortality
63% pts transplanted @ centers with > 50% excess mortality
13% pts transplanted @ centers with > 100% excess mortality

Hypotheses

1. Distance from one’s residence to the nearest LT center is inversely associated with probability of being listed for LT

2. Introduction of the LAS may modify strength of this relationship
   a. Could ameliorate due to greater chance of being transplanted even if listed late, encouraging more remote listings
   b. Could exacerbate due to overall later listings/quicker transplants, making the “right time” potentially “too late” for distant dwellers
Data

**Denominator**: 2000 U.S. Census data, persons 18-70

**Numerator**: 2008 UNOS data, listing and transplant numbers

**Distance**: Penn Cartographic Modeling Lab, centroids of all U.S. zip codes to nearest of 61 LT centers (“as the crow flies”)

**Units of analysis**: 31,229 zip codes (277.5 million people) in continental U.S.
Distance influences listing probability

RR per 100 miles
Pre-LAS: 0.87 (0.83 – 0.90); p<0.001*
Post-LAS: 0.81 (0.78 – 0.85); p<0.001

time period-by-distance interaction: \( p = 0.35 \)

*Significant at \( p < 0.05 \).
Conclusions and future directions

1. Allocating only 1 lung to COPD patients requires that physicians acknowledge duties to society as well as to patients
   - Will transplant professionals do so?

2. Allocation efficiency might be improved with center-specific LAS

3. But this may come at the cost of equity of access
   - Could we instead identify best practices and export them to lower-performing centers?
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