At-a-Glance

- **Proposal to Revise the Lung Allocation Score (LAS) System**

- **Affected Policy**: Policy 3.7.6 (Lung Allocation)

- **Thoracic Organ Transplantation Committee**

  The Thoracic Organ Transplantation Committee proposes a revision to the Lung Allocation Score (LAS) system. This revision includes modifications to the covariates in the waiting list and post-transplant survival models, coefficients of the covariates, and baseline waiting list and post-transplant survival rates used in the LAS calculation. The Thoracic Organ Transplantation Committee intended for the LAS system to be dynamic so that it addresses disease severity and post-transplant survival for a given current candidate population. Except for the addition of partial pressure of carbon dioxide (PCO_2) as a covariate to the LAS system's waiting list model, a thorough revision of the LAS system has not occurred since its implementation in 2005.

  The LAS system prioritizes candidates who are at least 12 years of age for allocation of deceased donor lung offers. The revisions to the LAS system will enable prioritization of candidates using data derived from a candidate population transplanted due to their LASs, instead of their waiting time.

- **Affected Groups**
  Transplant Administrators
  Transplant Physicians
  Transplant Surgeons
  Public Relations Staff
  Public Education Staff
  Transplant Program Directors
  Lung Transplant Candidates
  General Public

- **Number of Potential Candidates Affected**
  The proposed modification will affect all lung transplant candidates who are 12 years of age or older. As of January 31, 2012, there were 1310 such active candidates on Waitlist℠.

- **Expected Impact on OPTN Key Goals and Adherence to OPTN Final Rule**
  The proposed policy addresses the "increase access to transplants" and "improve post-transplant survival" key goals. In addition, the proposed policy modification addresses the following construct in the OPTN Final Rule:

  §121.8 Allocation of organs. (a) Policy development. […] (6) Shall be reviewed periodically and revised as appropriate; […]

- **Specific Request for Comment**
  Please comment on the entire policy revisions proposed.

Proposal to Revise the Lung Allocation Score (LAS) System

Affected Policy: Policy 3.7.6 (Lung Allocation)

Thoracic Organ Transplantation Committee

Summary and Goals of the Proposal:

The Thoracic Organ Transplantation Committee (Committee) proposes a revision to the Lung Allocation Score (LAS) system. This revision includes modifications to the covariates in the waiting list and post-transplant survival models, coefficients of the covariates, and baseline waiting list and post-transplant survival rates used in the LAS calculation. The Committee intended for the LAS system to be dynamic so that it addresses disease severity and post-transplant survival for a given current candidate population. Except for the addition of partial pressure of carbon dioxide (PCO_2) as a covariate to the LAS system's waiting list model, a thorough revision of the LAS system has not occurred since its implementation in 2005.

The LAS system prioritizes candidates who are at least 12 years of age for allocation of deceased donor lung offers. The revisions to the LAS system will enable prioritization of candidates using data derived from a candidate population transplanted due to their LASs, instead of their waiting time.

Background and Significance of the Proposal:

The LAS system considers the waiting list urgency and the post-transplant survival of a lung transplant candidate. Each survival model in the LAS system is based on a statistical model. The waiting list urgency model is intended to represent what is expected to happen to a candidate, given his or her clinical characteristics, during the next year if he or she does not receive a transplant. The post-transplant survival model is intended to represent what is expected to happen to a candidate, given his or her clinical characteristics, during the first year after a transplant. These two survival models are put together in a calculation that results in a Lung Allocation Score. *A Guide to Calculating the Lung Allocation Score* explains the LAS calculation in detail:
http://www.unos.org/docs/lung_allocation_score.pdf

Several covariates comprise the LAS waiting list urgency model and the post-transplant survival model. Each covariate in the waiting list model affects the prediction of a candidate's ability to survive while waiting for a transplant. Each covariate in the post-transplant survival model affects the prediction of a candidate's ability to survive in the year following his or her transplant.

One covariate that is used in both the waiting list and post-transplant survival models is the lung diagnosis grouping. The LAS system categorizes disease diagnoses into Groups A, B, C, and D, where:

- Group A comprises obstructive lung diseases;
- Group B comprises pulmonary vascular diseases;
- Group C comprises cystic fibrosis; and,
- Group D comprises restrictive lung disease.

The most commonly reported disease in Group A is obstructive pulmonary. The most commonly reported disease in Group B is pulmonary hypertension. The most commonly reported disease in Group C is cystic fibrosis. The most commonly reported disease in Group D is idiopathic pulmonary fibrosis.

Policy 3.7.6.1.b provides a complete list of disease diagnoses in each group. The list of disease diagnoses in the waiting list and post-transplant models are the same.

The following is a current list of covariates programmed in the LAS system:

Waiting List Survival Model

- Age
- Body mass index (BMI)
- Continuous mechanical ventilation
- Diabetes
- Diagnosis
    - Group A
    - Group B
    - Group C
    - Group D
    - Detailed Diagnoses
- Forced vital capacity (FVC)
- Functional Status
- Oxygen required at rest (Groups A, C, and D)
- Partial pressure of carbon dioxide (PCO_2) (serial and at least 15% increase in PCO_2 value)
- Pulmonary artery (PA) systolic pressure (Groups A, C, and D)
- Six-minute walk distance

Post-Transplant Survival Model

- Age
- Continuous mechanical ventilation
- Diagnosis
    - Group A
    - Group B
    - Group C
    - Group D
    - Detailed diagnoses
- Forced vital capacity (FVC) (Groups B and D)
- Functional Status
- Pulmonary capillary wedge pressure of at least 20 mm Hg (Group D)
- Creatinine – serum

In addition to the covariates listed above, the OPTN/UNOS Board of Directors approved the inclusion of bilirubin and increase in bilirubin (if at least 50%) in the waiting list survival model. As will be explained later in this document, bilirubin is not programmed in the current LAS system but will be included with the programming effort associated with this project.

Each covariate listed above receives a mathematically produced coefficient for use in the LAS calculation. The coefficient corresponds to the covariate's influence on waiting list mortality or post-transplant survival. Each diagnosis group, which is a covariate, has a different coefficient.

The LAS system treats some disease diagnoses as covariates and therefore, uses specific coefficients for them. The proposed policy refers to these diagnoses as "detailed diagnoses." These detailed diseases are:

- Bronchiectasis;
- Eisenmenger's syndrome;
- Lymphangioleiomyomatosis;
- Obliterative bronchiolitis (not re-transplant);
- Pulmonary fibrosis, not idiopathic;
- Sarcoidosis with mean pulmonary artery (PA) pressure greater than 30 mm Hg; and,
- Sarcoidosis with mean PA pressure of 30 mm Hg or less.

Historically, the Committee has identified these detailed diseases as possibly influencing a greater or lesser waiting list mortality or post-transplant survival than other diseases classified in the same group as a detailed diagnosis. So, for a candidate that has a "detailed diagnosis," the LAS calculation uses a coefficient for that diagnosis, in addition to the coefficient used for the grouping (A, B, C, or D) in which that diagnosis resides. So, for a candidate diagnosed with bronchiectasis, for example, the LAS calculation uses a coefficient for the bronchiectasis covariate in addition to the coefficient used for the diagnosis Group A covariate, where bronchiectasis is classified.

Covariates and their coefficients proposed for use in the revised LAS system are in Policy 3.7.6.a (see Tables 1 and 2). What follows in the "Revising the LAS System" section is a discussion of the Committee's efforts to update the LAS system, and modify the covariates in the waiting list mortality and post-transplant survival models. In February 2012, the Committee voted in favor of the proposed revisions to the LAS system, which includes modifications to the covariates and their coeffiencts, and the baseline and survival rates: 23-supported; 0-opposed; and, 0-abstained.

Revising the LAS System

In its multi-year deliberations to revise the LAS system, the Committee considered the following policy options for updating the LAS system to include the cohort of patients who received transplants due to their LASs:

- Update the LAS system, i.e., only change the baseline survival rates and coefficients for the existing covariates in the LAS; or
- Revise the LAS system, which:
    i) Adds new covariates to the waiting list and post-transplant models;
    ii) Changes the coefficients for all covariates in the waiting list mortality and post-transplant survival models; and,
    iii) Changes the baseline waiting list and post-transplant survival rates.

The Committee's goal in revising the LAS system was to: a) improve the system's ability to address the disease severity of candidates waiting for lung transplants by modifying covariates in the system's statistical models; and b) to update the baseline survival rates and coefficients to reflect the current waiting list population.

The Committee requested that the Scientific Registry of Transplant Recipients (SRTR)[1] update the LAS system, as described above, and validate the analyses resulting in the revised LAS system. The Committee considered inclusion of new covariates in the waiting list and post-transplant survival models to improve the LAS system's ability to identify candidates in urgent need of transplant as well as those candidates who would fare well after transplant. In its efforts to identify these covariates, the Committee referred to data collected in the Lung Retrospective Data Collection Project[2], the Reveal Registry[3], as well as covariates considered anecdotally to have clinical relevance in identifying disease progression among lung transplant candidates.

[1] http://www.srtr.org/ [The SRTR supports each OPTN/UNOS committee.]

[2] The goal of the lung retrospective data collection project was to obtain more detailed information regarding the disease progression and medical urgency for lung transplant waiting list registrations and transplants. These data were used in the ongoing refinement and improvement to the current LAS system.

[3] As written on the Reveal Registry's web site: "REVEAL is a multicenter, observational, U.S.-based registry study of pulmonary arterial hypertension. A planned 3500 patients will be enrolled by December 2009 and will be followed for at least 5 years." For more information, visit the following website: http://www.revealregistry.com/

Result: Revised LAS Waiting List Model

This section provides a list of covariates added to the revised waiting list survival model, covariates that are in the current waiting list model but modified in the revised waiting list survival model, and covariates in the current waiting list survival model and are retained without modification in the revised waiting list survival model. This section also explains the coefficient selected for the bilirubin covariate in the revised waiting list survival model.

Covariates Added to the Waiting List Survival Model

- Cardiac index (if it is less than 2 L/min/m^2, then the coefficient for the cardiac index covariate is used in the LAS calculation)
- Central venous pressure (CVP), but only used in the LAS calculation for candidates in Group B whose CVP is greater than 7 mm Hg
  While new to policy, the Waitlist℠ already collects CVP data. Therefore, reporting CVP data to the OPTN Contractor will not be a new data entry effort for transplant programs.
- Creatinine – serum, but only used in the LAS calculation for candidates who are at least 18 years of age
- Six-minute-walk-distance if it is less than 1200 feet.

Covariates Modified in the Waiting List Survival Model

Current Covariate	*How the Covariate Changes in the Revised Waiting List Survival Model*
• Age	The revised model uses the same coefficient for the age covariate for candidates in all diagnosis groups. The current model has one coefficient for the age covariate for candidates in Groups A , B and C, and a different coefficient for the age covariate for candidates in Group D.
• Body mass index (BMI)	The revised model uses continuous BMI, but only when the value is less than 20 kg/m^2. The current LAS calculation uses continuous BMI, regardless of its value.
• FVC	The revised model uses FVC only if it is less than 80% for candidates in the Group D population. In the current model, the LAS calculation uses FVC for all diagnosis groups.
• Functional Status	The revised model uses "no assistance" in comparison with the baseline of "some assistance" and "total assistance" for the functional status covariate. The same categories are used in the current model but "some assistance" and "total assistance" are compared with the baseline of "no assistance"
• Oxygen, but only used in the LAS calculation if needed at rest	For the oxygen needed at rest factor, the revised model uses one coefficient in calculating the LAS for candidates in Groups A, C, and D, and a different coefficient for candidates in Group B. Currently, the LAS calculation uses the same coefficient for Groups A and D, and two separate coefficients for Groups B and C.
• Pulmonary artery (PA) systolic pressure used in the	The revised model uses one coefficient to calculate the LAS for candidates in Groups B, C, and D, regardless of the value

LAS calculation, regardless of the value, for candidates in Groups B, C, and D	of PA systolic pressure. In the current model, the LAS calculation uses one coefficient for the PA systolic pressure factor but only for candidates in Groups A, C, and D.
• PA systolic pressure used in the LAS calculation for candidates in Group A whose PA systolic pressure is greater than 40 mm Hg	For PA systolic pressure, the revised model uses one coefficient to calculate the LAS for candidates in Group A whose PA systolic pressure is greater than 40 mm Hg. In the current model, the LAS calculation uses one parameter estimate for the PA systolic pressure factor but only for candidates in Groups A, C, and D.
• Six-minute walk distance	The revised model uses continuous distance; the current model uses only an indicator of whether the six-minute walk distance was less than 150 feet.

Covariates Retained in the Waiting List Survival Model, without Modification

- Diabetes
- Diagnosis grouping A, B, C, and D
- Detailed diagnoses: Bronchiectasis; Eisenmenger's syndrome; Lymphangioleiomyomatosis; Obliterative bronchiolitis (not re-transplant); Pulmonary fibrosis, not idiopathic; Sarcoidosis with mean PA pressure greater than 30 mm Hg (Group D); and, Sarcoidosis with mean PA pressure of no more than 30 mm Hg (Group A)
- PCO_2 – only used in the LAS calculation if the PCO_2 is at least 40 mm Hg
- Increase in PCO_2 of at least 15% used in the LAS calculation
- Bilirubin (per 1 mg/dL) – only used in the LAS calculation if bilirubin is at least 1.0 mg/dL
- Increase in Bilirubin of at least 50%, but only used in the LAS calculation for candidates in diagnosis Group B

Covariate Removed from the Waiting List Survival Model

- Percent predicted FVC for candidates in diagnosis Groups A, B, and C

The Committee proposes the exclusion of percent predicted FVC for groups A, B and C , which is in the current waiting list model, because it did not have statistical significance in the revised waiting list model.

Bilirubin Covariate

As mentioned earlier, the bilirubin covariate is not yet part of the LAS calculation, which presented a statistical dilemma for the Committee. The current LAS system does not adequately address the hemodynamic decompensation of Group B candidates, especially candidates diagnosed with pulmonary hypertension. The Committee proposed and the OPTN/UNOS Board of Directors approved the inclusion of bilirubin in the LAS calculation, because an elevation in a bilirubin value is a marker for right heart failure. To include bilirubin in the revised LAS system would require the use of a coefficient derived from a cohort of patients who were waiting for lung transplants before 2005, i.e., before the current LAS system's implementation. The use of a coefficient based on this older cohort of patients is not optimal, because the other covariates proposed for inclusion in the LAS calculation will have coefficients based on patient data collected since the LAS system has been in place.

The Committee considered several options for addressing the use of the bilirubin covariate, and after careful deliberation and due to the clinical significance of elevated bilirubin levels, the Committee opted to include bilirubin in the revised LAS system. Therefore, the revised LAS calculation will include bilirubin, and bilirubin will be collected on Waitlist℠.

Result: Revised Post-Transplant Survival Model

This section provides a list of covariates added to the revised post-transplant survival model, covariates that are in the current post-transplant survival model but are modified in the revised waiting list model, covariates that are in the current post-transplant survival model and are retained without modification in the revised post-transplant survival model, and covariates that are in the current post-transplant survival model but are not included in the revised post-transplant survival model.

Covariates Added to the Post-Transplant Survival Model

- Increase in creatinine of at least 150%, but only when the higher value used to calculate the increase is at least 1 mg/dL
- Cardiac index (if less than 2 L/min/m^2, then the coefficient for cardiac index is included in the LAS calculation)
- Oxygen needed at rest
- Six-minute-walk distance if it is less than 1200 feet

Covariates Modified in the Post-Transplant Survival Model

Current Covariate	*How the Covariate Changes in the Revised Post-Transplant Survival Model*
• Age	The proposed model uses age at transplant as a continuous function, but only if age is greater than 45 years. The current model uses the candidate's age at transplant, regardless of the year.
• Creatinine	The proposed model uses creatinine at transplant only for candidates who are at least 18 years of age. The current model uses creatinine at transplant for candidates of all ages.
• Functional Status	The proposed model uses the indicator for "no assistance needed" in the LAS calculation for the functional status covariate compared with a baseline of "some assistance" or "total assistance". Currently, the model uses separate indicators for "no assistance needed" and "some assistance needed" (versus "total assistance needed") in the LAS calculation.

Covariates Retained in the Post-Transplant Survival Model, without Modification

- Continuous mechanical ventilation needed by the candidate at the time of transplant;
- Diagnosis grouping: A, B, C, and D
- Detailed diagnoses: Bronchiectasis; Eisenmenger's syndrome; Lymphangioleiomyomatosis Obliterative bronchiolitis (not-retransplant); Pulmonary fibrosis, not idiopathic; Sarcoidosis with mean PA pressure greater than 30 mm Hg (Group D); and, Sarcoidosis with mean PA pressure of no more than 30 mm Hg (Group A)

Covariates Removed from the Post-Transplant Model

- Percent predicted FVC for candidates in Groups B and D
- Pulmonary capillary wedge mean pressure of at least 20 mm Hg for candidates in Group D

Inclusion of the LAS System's Components that Are Rules but Are Not in Policy Today

Policies are rules that specify a required action or set of actions. Since the LAS is an allocation policy, this policy must clearly convey to lung transplant clinicians, candidates, and the public, the information that produces or influences an LAS. The proposed LAS revisions include these sets of information and delete educational information, i.e., not rules, from policy.

Some information presented in policy is not new to the LAS, such as the LAS equation or the complete listing of diseases, but is not provided in its entirety in current policy. Policy 3.7.6.1.a describes the LAS calculation, the formula for which has not changed from its inception; current policy describes the LAS calculation generally in prose. Policy 3.7.6.1.b lists each disease that is in Group A, B, C, and D; current policy lists only some of the diseases. Current policy identifies certain normal or least beneficial values that the LAS calculation uses when the actual values for select covariates are missing, expired, or less than an expected threshold.

Table 1 describes information that is part of the revised LAS policy but is not new to the revised LAS system, because this is already a part of the current LAS system.

Table 1: Information that is New to the Revised LAS Policy but which is Not New to the LAS System

Policy Modification	**New to the LAS System?**
Equation to calculate the LAS	No
Baseline waiting list survival probability (Tables 3 and 4 in Policy 3.7.6.3.a)	No
Baseline post-transplant survival probability	No
Coefficient for each covariate included in the LAS system	No

Listing of diseases included in each diagnosis group	No. Some of the diseases were already in policy but the modification includes the complete list of diseases classified in each group.
	
	The proposed modification includes the following new disease in Group B:
	• Pulmonary capillary hemangiomatosis
	
	The proposed modification also includes the following new diseases in Group D:
	• ABCA3 transporter mutation
	• Idiopathic interstitial pneumonia, with one or more of the following disease entities:[1]
	  ○ Acute interstitial pneumonia
	  ○ Cryptogenic organizing pneumonia/Bronchiolitis obliterans with organizing pneumonia (BOOP)

Policy Modification	New to the LAS System?
	○ Desquamative interstitial pneumonia ○ Idiopathic pulmonary fibrosis (IPF) ○ Lymphocytic interstitial pneumonia (LIP) ○ Nonspecific interstitial pneumonia ○ Respiratory bronchiolitis-associated interstitial lung disease • Secondary pulmonary fibrosis (specify cause) • Surfactant protein C mutation
Identification of normal or least beneficial values for LAS covariates that have them	No. Some of these values were already in policy but the values for the following covariates were not: • Diabetes • FVC • Oxygen needed at rest • Six minute walk distance. Since the proposed revisions do include new covariates, the policy includes the normal or least beneficial values for these new covariates, if applicable.
Change in policy numbering for PCO_2 and bilirubin sections	The numbering change is new, but the language is not new to policy.

Addition of the Idiopathic Interstitial Pneumonia Category in Group D

Group D now includes idiopathic interstitial pneumonia as a category for seven disease diagnoses. Of these seven diagnoses, only the following four are new to policy:

- Acute interstitial pneumonia
- Desquamative interstitial pneumonia
- Nonspecific interstitial pneumonia
- Respiratory bronchiolitis-associated interstitial lung disease

Of the remaining three diseases classified as idiopathic interstitial pneumonia, BOOP, IPF, and LIP are not new to policy. The inclusion of BOOP, IPF, and LIP in the idiopathic interstitial pneumonia category resulted in duplicate listings of these diseases in Group D. The proposed policy eliminates duplicate listings of these diseases. Cryptogenic organizing pneumonia is synonymous with BOOP; so, the two diagnoses appear as part of the idiopathic interstitial pneumonia category.[1] Current policy lists IPF as the same as usual interstitial pneumonia (UIP). UIP is outdated disease terminology and is actually the histologic pattern that describes the type of idiopathic interstitial pneumonia diagnosis; so, the proposed policy deletes UIP as a clinical diagnosis.[1] IPF, without the UIP association, is part of the idiopathic interstitial pneumonia category. LIP only appears under the idiopathic interstitial pneumonia category.

Normal or Least Beneficial Values

A normal value is one that a healthy individual is likely to exhibit. A least beneficial value is one that will calculate the lowest LAS for a candidate. The LAS calculation substitutes normal values for covariate data that may be difficult to obtain due to candidate-related reasons, e.g., performing the test may risk the candidate's health or the test may be too costly for the candidate to afford. Table 2 below lists the covariates in the revised LAS system that have least beneficial or normal values assigned to them. The proposed policy (Table 5 in Policy 3.7.6.3) identifies normal and least beneficial values for each covariate that has one.

Table 2: Covariates for which Least Beneficial or Normal Values Are Substituted

Covariates	**Type of Substituted Value When the Actual Value is Not Reported**
Bilirubin: current	Normal
Body mass index	Least beneficial value
Cardiac index	Normal
Central venous pressure	Normal
Continuous mechanical ventilation	Least beneficial value
Creatinine: serum	Least beneficial value
Diabetes	Normal
Forced vital capacity (FVC)	Least beneficial value
Functional Status	Least beneficial value
Oxygen needed at rest	Least beneficial value
PCO_2: current	Normal
Pulmonary artery systolic pressure	Normal
Six minute walk	Least beneficial value

The use of least beneficial values serves as a disincentive to transplant programs for allowing candidate data to expire. Therefore, the LAS calculation substitutes least beneficial values for data that transplant programs do not provide but there is no patient-related reason for this lack of provision. In preparing a future revision to the LAS system, the Committee may reconsider which covariates receive least beneficial values or normal values.

Missing or Expired Covariate Data Will No Longer Result in LASs of Zero

In the current LAS system, a candidate who is missing or has expired data for the functional status or assisted ventilation covariate receives an LAS of zero. Candidates with LASs of zero do not appear on the lung or heart-lung match run. The revised LAS system assigns least beneficial values for these two covariates that have missing or expired data; so, candidates will appear on match runs.

Covariate Data Obtained Through Heart Catheterization

As in the current LAS system, clinical data obtainable only through heart catheterization do not expire in the revised LAS system. The procedure for obtaining covariate data through heart catheterization is invasive. The heart catheterization test is required to obtain data for these covariates: cardiac index, central venous pressure, and PA systolic pressure.

PA Mean Pressure

The current LAS system also has a least beneficial value for PA mean pressure, which is not a covariate. The revised LAS system does not assign a least beneficial value for PA mean pressure. In the current and revised LAS system, candidates diagnosed with Sarcoidosis who have PA mean pressures of 30 mm Hg or less are in Group A, and those with PA mean pressures greater than 30 are in Group D. The current LAS system assigns 15 mm Hg as the least beneficial value for PA mean pressure; so, any candidate that reports an actual PA mean pressure of 30 mm Hg or less or is assigned the least beneficial value of 15 mm Hg is in Group A. Given this existing grouping of candidates diagnosed with Sarcoidosis, maintaining the existing least beneficial value assignment is not logical. Creating a new PA mean pressure categorization in the revised LAS model is superfluous.

Supporting Evidence and/or Modeling:

The Committee officially began its statistical evaluation of a revised LAS system in early 2009 and its deliberations are available on the OPTN website. Given the volume of data analyses that the Committee evaluated, and to provide the reader with only the salient information necessary to evaluate the Committee's decision about the proposed revised LAS system, the Committee encourages the reader interested in further details to contact the OPTN Contractor to obtain analytical documents that are not included in this policy proposal.

Study Cohort and Analytical Method for Determining the Revised LAS System

The study population for determining the revised waiting list model included all patients at least 12 years of age who were placed on the lung transplant waiting list between 9/01/06 and 9/30/08. If a patient was listed during this time period, then transplanted, and then listed again, the SRTR included this patient twice in the analysis. The study start date of 9/01/06 allowed the SRTR to consider only that time period when patients may have PCO_2 values available in the waiting list.

The study population for determining the revised post-transplant model included all patients at least 12 years of age who received lung transplants between 5/4/05 and 9/30/08. For each patient, the SRTR included only the first lung transplant during this period. The SRTR excluded multi-organ and living donor transplant recipients from the analysis.

The study population for the revised waiting list model validation analysis included all patients at least 12 years of age who were placed on the lung transplant waiting list between 10/01/08 and 11/30/09. If a patient was listed during this period, then transplanted, and then listed again, the SRTR included that patient twice in the analysis.

The study population for the revised post-transplant validation analysis included all patients who were at least 12 years of age who received lung transplants between 10/01/08 and 11/30/09. In the analysis, for each patient, the SRTR included only the first lung transplant during this period. The SRTR excluded multi-organ and living donor transplant recipients from the analysis.

Results: Overall

The implementation of bilirubin in the revised LAS system will likely provide some candidates in Group B with large increases in their LASs and improvements in their allocation rankings, addressing a criticism that the current LAS system may not be fully identifying and accurately reflecting an increase in waiting list mortality associated with an acute worsening of candidates with pulmonary hypertension. Other candidates whose allocation priorities are likely to increase in the revised LAS system are those who exhibit poor functional statuses, low cardiac index values, high creatinine values, high central venous pressure values, and need for continuous mechanical ventilation. Figures 1 through 4 compare LASs or ranks in the current LAS system to the revised LAS system. Figures 1, 3, and 4 provide correlation coefficients that apply to the comparison of LASs or ranks, regardless of diagnosis group.

Figures 1 and 2 illustrate change in LASs overall and by diagnosis groups. Most Group B candidates had an increase in their LASs and appear to experience an improvement in allocation ranking in the revised LAS system. For 85% of the candidates who were on the waitlist as of January 1, 2010, their revised LASs were within five points of their current LASs.

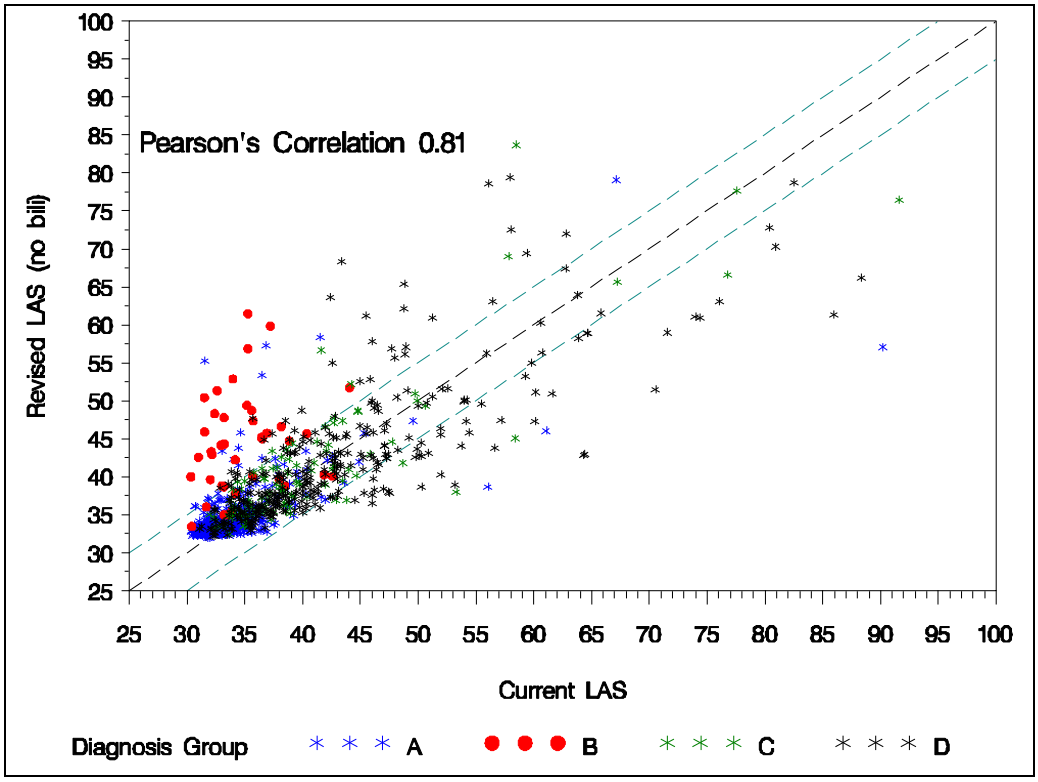
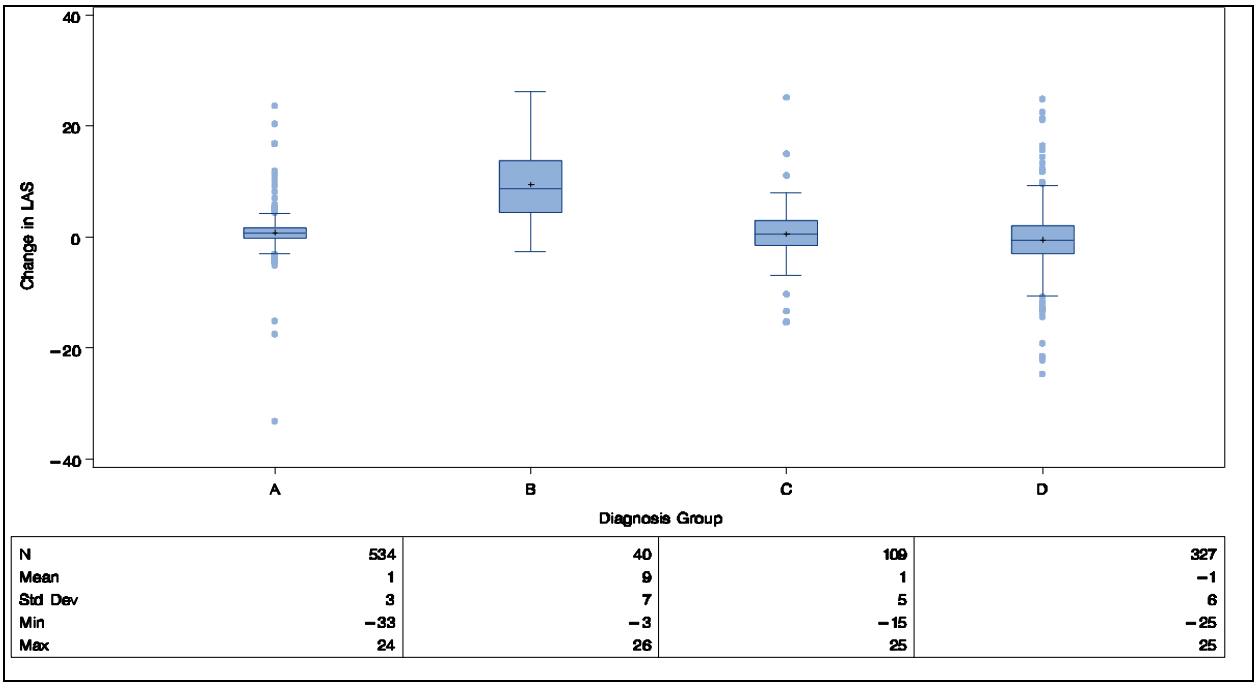


Figure 1: Scatter Plot of Current and Revised LASs by Diagnosis Group for Candidates on the Waitlist℠ on January 1, 2010



	A	B	C	D
N	534	40	109	327
Mean	1	9	1	−1
Std Dev	3	7	5	6
Min	−33	−3	−15	−25
Max	24	26	25	25

Figure 2: Change in LAS (Revised LAS – Current LAS) by Diagnosis Group for Candidates on the Waitlist℠ on January 1, 2010

Figures 3 and 4 illustrate change in allocation "ranking"[4] by age, and diagnosis group in the revised LAS system. The revised LAS system affects candidates in all age groups similarly, i.e., there is no difference in LASs by age. In these figures, the symbols that appear below the 45 degree line represent candidates with improved ranks in the revised LAS system, compared with the current LAS system. As shown in Figure 3, candidates in Group B may experience improved allocation ranking in the revised LAS system.

[4] "Rank" does not refer to an actual match-run position for any given candidate. The ranks displayed are hypothetical positions of candidates, and these candidates represent a combination of all blood types and geographic distributions. This figure does not account for individual candidate screening criteria that help determine actual match-run positions.

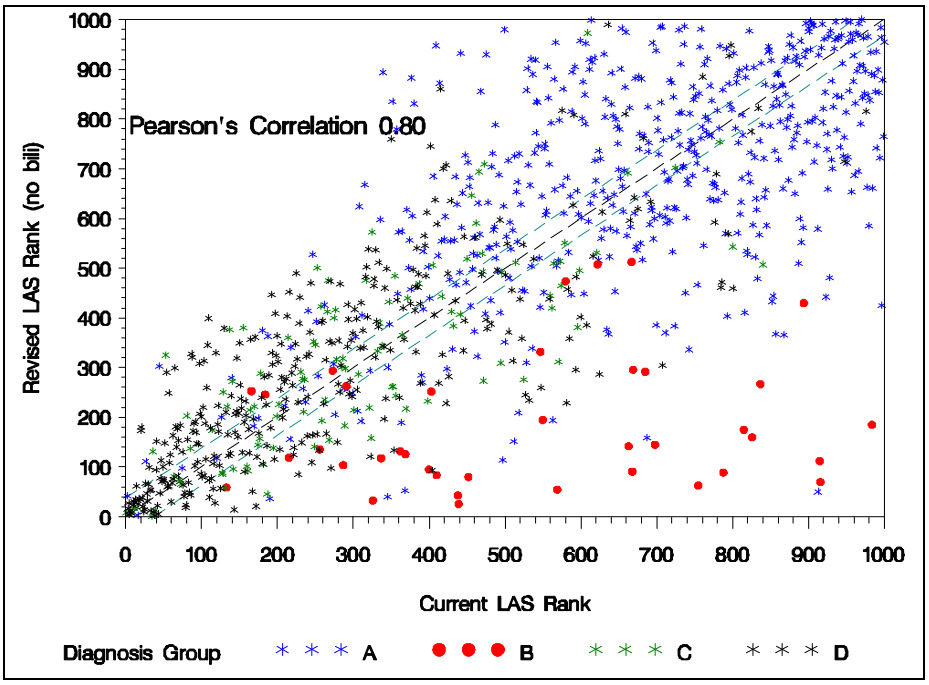


Figure 3: Scatter Plot of Current and Revised LAS "Ranks" by Diagnosis Group for Candidates on the Waitlist℠ on January 1, 2010

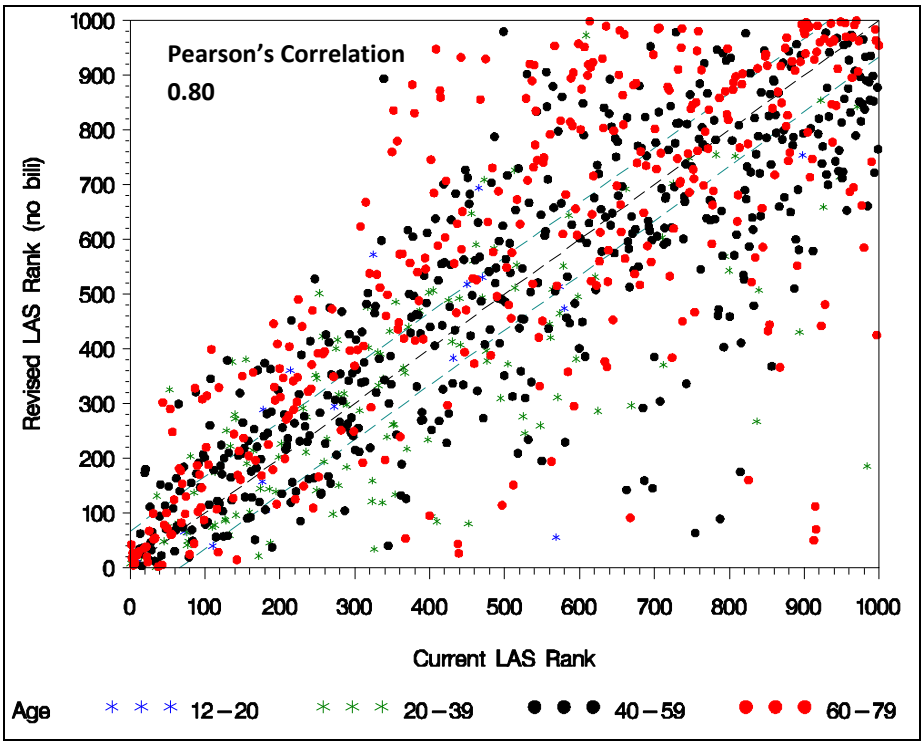


Figure 4: Scatter Plot of Current and Revised LAS "Ranks" by Age Group for Candidates on the Waitlist℠ on January 1, 2010

To select the final list of covariates for inclusion in the LAS system, the Committee considered different ways to use each covariate in the model (e.g., categorical, continuous, continuous with break points)

and chose the method that best described the trend of the data analyzed. Appendix A presents the effect of each covariate in the revised LAS system.

Exhibit A provides for each covariate in the waiting list and post-transplant model its coefficient and hazard ratio. These data are provided in tabular format, and include the confidence interval and p-value for each hazard ratio.

Result: Validation Analysis of the Revised LAS System

As mentioned earlier, the SRTR validated its analyses that resulted in the revised LAS system. The demographic and clinical characteristics of patients included in the validation analysis were similar to the patients included in the original waitlist model, and the revised waitlist model developed on the newer cohort had similar parameter estimates and statistical significance to the revised waitlist model. The index of concordance (IC)[5] was 0.86 for the revised waiting list model and 0.87 for the waiting list model using the validation cohort. The IC for the revised post-transplant survival model was 0.63, which was very similar to the validation model (0.61).

Expected Impact on Living Donors or Living Donation:

Not applicable.

Expected Impact on Specific Patient Populations:

The proposed revisions to the LAS system will affect all lung transplant candidates who are at least 12 years of age.

Expected Impact on OPTN Key Goals:

The goal in revising the LAS system is to: a) improve the system's ability to address the disease severity of candidates waiting for lung transplants by modifying covariates in the system's statistical models; and b) to update the baseline survival rates and coefficients to reflect the current waiting list population. Therefore, this proposal meets the OPTN Key Goal to increase access to transplants and improve post-transplant survival of lung transplant candidates.

Since the goal of the proposed revision is also to update the LAS system based on current data, the proposed revisions also address the following construct in the OPTN Final Rule:

> §121.8 Allocation of organs. (a) Policy development. […] (6) Shall be reviewed periodically and revised as appropriate; […]

Plan for Evaluating the Proposal:

At least annually, the Committee will review OPTN data analyses to assess the impact of the revised LAS system. The Committee will also evaluate site survey data, the literature, and anecdotal (clinical) observations to inform future revisions to the LAS system. As part of this effort, the Committee will also:

[5] A higher index of concordance indicates a more accurate model.

- Further examine the use of a longer survival time period in the post-transplant model
- The Committee's previous examination did not indicate an improvement in the accuracy of the model (as indicated by no increase in the concordance index of 0.60 for both methods) or a substantial change in the ranking of most candidates with this method.
- Assess whether the bilirubin coefficients that will be used in the revised LAS will continue to be appropriate with future candidate populations.
- Consider a timeline for future policy revisions to the LAS system.
- Identify additional covariates for inclusion in the LAS system
    - Collect data for these potential waiting list mortality or post-transplant survival covariates in the OPTN database; and
    - Evaluating covariates that were not statistically significant in historical analyses, but that may be in newer cohorts.
- Review other covariates that may be clinically significant predictors of waiting list or post transplant mortality from other data sources.

Additional Data Collection:

The proposed revisions to the LAS system require lung and heart-lung transplant programs to continue to report to the OPTN Contractor covariate-related and other data required in Waitlist℠. The revised LAS system will require entry of data for the following three new covariates: bilirubin, cardiac index, and central venous pressure. The addition of the disease idiopathic interstitial pneumonia and its entities in Group D, as well as four other diseases in Group D, will require the entry of new data.

The data collection required currently and as part of the revised LAS system employs the following data collection principle: "develop transplant, donation, and allocation policies."

Expected Implementation Plan:

The proposed policy modification will require programming in UNet℠.

Communication and Education Plan:

The following communication and educational activities will accompany this policy proposal.

Communication Activities			
Type of Communication	**Audience(s)**	**Deliver Method(s)**	**Timeframe**
Presentation of Proposed Policy at Regional Meetings	Members	In person	During the public comment period
Policy Notice following Board Approval of Revised LAS System	Members	OPTN and UNOS Websites	1 month after Board approval

UNet℠ System Notice upon implementation	All UNet℠ Users	Blast e-mail, UNet℠ notice	30 days before the implementation and again upon implementation
Formal Training Session	Heart and Lung Program Clinicians	Telephone and Internet	Prior to LAS implementation

Compliance Monitoring:

During on-site surveys, the Department of Evaluation and Quality (DEQ) staff reviews and verifies the clinical covariates entered into UNet^{SM} and utilized to calculate the LAS with the actual medical record documentation. Staff also verifies all information submitted to the Lung Review Board with the actual medical record documentation.

DEQ staff will also investigate any reports of noncompliance.

DEQ staff will request a corrective action plan if the center does not comply with the requirements of Policy 3.7 and forward the site survey results to the OPTN/UNOS Membership and Professional Standards Committee (MPSC) for review.

Policy Proposal:

Proposed new language is underlined (example) and language that is proposed for removal is struck through (~~example~~).

3.7.6 Lung Allocation System. Candidates waiting for lung transplants receive priority for deceased donor lung offers based on the Lung Allocation Score (LAS) if they are at least 12 years of age, or medical urgency priority if they are less than 12 years of age.

~~**3.7.6 Lung Allocation.** Candidates are assigned priority in lung allocation as follows:~~

3.7.6.1 Lung Allocation Score (LAS) System for Candidates of Ages 12 and Older. Candidates who are at least 12 years of age receive priority for deceased donor lung offers based on Lung Allocation Score (LAS), as well as geography and blood type.

~~**3.7.6.1 Candidates Age 12 and Older**. Candidates age 12 and older are assigned priority for lung offers based upon Lung Allocation Score, which is calculated using the following measures: (i) waitlist urgency measure (expected number of days lived without a transplant during an additional year on the waitlist), (ii) post transplant survival measure (expected number of days lived during the first year post transplant), and (iii) transplant benefit measure (post transplant survival measure minus waitlist urgency measure). Waitlist urgency measure and post transplant survival measure (used in the calculation of transplant benefit measure) are developed using Cox proportional hazards models. Factors determined to be important predictors of waitlist mortality and~~

~~post-transplant survival are listed below in Tables 1 and 2. It is expected that these factors will change over time as new data are available and added to the models. The Thoracic Organ Transplantation Committee will review these data in regular intervals of approximately six months and will propose changes to Tables 1 and 2 as appropriate.~~

a) The LAS Calculation

The LAS calculation uses all of the following measures:

- Waitlist urgency measure, which is the expected number of days a candidate will live without a transplant during an additional year on the waitlist;
- Post-transplant survival measure, which is the expected number of days a candidate will live during the first year post-transplant; and,
- Transplant benefit measure, which is difference between the post-transplant survival measure and the waitlist urgency measure.

The LAS calculation is the difference between transplant benefit and waitlist urgency: Raw Allocation Score = Transplant Benefit Measure – Waitlist Urgency Measure. A Raw Allocation Score ranges in days from negative 730 to positive 365. To determine a candidate's LAS, the Raw Allocation Score is normalized to a continuous scale of 0 to 100. The equation for the LAS calculation is:

$$LAS = \frac{100 * [PTAUC - 2 * WLAUC + 730]}{1095}$$

where

$$PTAUC = \sum_{k=0}^{364} S_{TX}(k)$$

$$S_{TX}(t) = S_{TX,0}(t)^{e^{\alpha_1 Y_1 + \alpha_2 Y_2 + \ldots + \alpha_q Y_q}}$$

$$WLAUC = \sum_{k=0}^{364} S_{WL}(k)$$

$$S_{WL}(t) = S_{WL,0}(t)^{e^{\beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p}}$$

The LAS calculation includes the following components:

- PTAUC: the area under the post-transplant survival probability curve during the first post-transplant year
- $S_{TX,0}(t)$: the baseline post-transplant survival probability at time t (see Table 5)
- $S_{TX}(t)$: the expected post-transplant survival probability at time t for an individual candidate
- Y_j: the value of the j^{th} characteristic for an individual candidate (e.g., candidate is on continuous mechanical ventilation)
- α_j:the coefficient for characteristic j from the post-transplant model (see Table 3) (e.g., $\alpha_{ventilation}=0.61$)

- WLAUC: the area under the waiting list survival probability curve during the next year
- $S_{WL,0}(t)$: the baseline waiting list survival probability at time t (see Table 4)
- $S_{WL}(t)$: the expected waiting list survival probability at time t for an individual candidate
- X_i: the value of the i^{th} characteristic for an individual candidate (e.g., candidate is diabetic)
- β_i: the coefficient for characteristic i from the waiting list model (see Table 1) (e.g., $\beta_{diabetes}$=0.47)

Tables 1 and 2 list the covariates and their coefficients in the waiting list and post-transplant survival models.

Table 1
Waiting List Mortality Calculation: Covariates and their Coefficients

For this covariate:	**The following coefficient is used in the LAS calculation:**
1. Age (per 10 years)	0.01
2. Bilirubin (per 1 mg/dL)	0.04 if bilirubin is at least 1.0 mg/dL (See Policy 3.7.6.1.d) 0.00 when bilirubin is less than 1.0 mg/dL
3. Bilirubin increase of at least 50%	1.41 for Group B (see Policy 3.7.6.1.b) 0.00 for Groups A, C, and D (see Policy 3.7.6.1.b)
4. Body mass index (BMI) per 1 kg/m^2	-0.13*(20 – BMI) for BMI less than 20
5. Cardiac index	0.54 if the cardiac index is less than 2 $L/min/m^2$ 0.00 if the cardiac index is greater than 2 $L/min/m^2$
6. Central venous pressure (CVP) per 1 mm Hg	0.02*(CVP – 7) for CVP greater than 7 (Group B only – see Policy 3.7.6.1.b) 0.00 if less than 7 mm Hg for Group B (see Policy 3.7.6.1.b) 0.00 for candidates in Groups A, C, and D
7. Ventilation status	0.68 if continuous mechanical ventilation needed 0.00 if no continuous mechanical ventilation needed
8. Creatinine (serum) per mg/dL	0.50 if at least 18 years of age (see Policy 3.7.6.e) 0.00 if less than 18 years of age
9. Diabetes	0.47 if diabetic 0.00 if not diabetic
10. Diagnosis Group A – See Policy 3.7.6.1.b for the	0.00

For this covariate:	The following coefficient is used in the LAS calculation:
diseases included in this group	
Diagnosis Group B – See Policy 3.7.6.1.b for the diseases included in this group	1.58
Diagnosis Group C – See Policy 3.7.6.1.b for the diseases included in this group	1.23
Diagnosis Group D – See Policy 3.7.6.1.b for the diseases included in this group	0.63
11. Detailed diagnosis: Bronchiectasis (Group A – see Policy 3.7.6.1.b)	0.67
Detailed diagnosis: Eisenmenger's syndrome (Group B – see Policy 3.7.6.1.b)	-0.63
Detailed diagnosis: Lymphangioleiomyomatosis (Group A – see Policy 3.7.6.1.b)	-0.32
Detailed Diagnosis: Obliterative bronchiolitis (not-retransplant) (Group D – see Policy 3.7.6.1.b)	0.45
Detailed Diagnosis: Pulmonary fibrosis, not idiopathic (Group D – see Policy 3.7.6.1.b)	-0.21
Detailed Diagnosis: Sarcoidosis with PA mean pressure greater than 30 mm Hg (Group D – see Policy 3.7.6.1.b)	-0.46
Detailed Diagnosis: Sarcoidosis with PA mean pressure of 30 mm Hg or less (Group A – see Policy 3.7.6.1.b)	0.93
12. Forced vital capacity (FVC) (per 10%)	-0.18 if FVC is less than 80% for Group D (see Policy 3.7.6.1.b) 0.00 if greater than 80% for Group D (see Policy 3.7.6.1.b) 0.00 for candidates in Groups A, B, and C (see Policy 3.7.6.1.b)
13. Functional Status	-0.45 if no assistance needed with activities of daily living 0.00 if some or total assistance needed with activities of daily living
14. Oxygen needed at rest (per	0.02 for Group B (see Policy 3.7.6.1.b)

For this covariate:	The following coefficient is used in the LAS calculation:
L/min)	0.12 for Groups A, C, and D (see Policy 3.7.6.1.b)
15. PCO_2 (per 10 mm Hg): current	0.11 if PCO_2 is at least 40 mm Hg (see Policy 3.7.6.1.b) 0.00 if PCO_2 is less than 40 mm Hg (see Policy 3.7.6.1.b)
16. PCO_2 increase of at least 15% – See Policy 3.7.6.1.b	0.23 if PCO_2 increase is at least 15% (see Policy 3.7.6.1.b) 0.00 if PCO_2 increase is less than 15% (see Policy 3.7.6.1.b)
17. Pulmonary artery (PA) systolic pressure (per 10 mm Hg)	0.42 for Group A if the PA systolic pressure is greater than 40 mm Hg 0.00 for Group A if the PA systolic pressure is 40 mm Hg or less 0.05 for Groups B, C, and D
18. Six minute walk distance (per 100 feet)	-0.08

~~**Table 1**~~
~~**Factors Used to Predict Risk of Death on the Lung Transplant Waitlist**~~

~~1. Forced vital capacity (FVC)~~
~~2. Pulmonary artery (PA) systolic pressure (Groups A, C, and D[1] – see 3.7.6.1.a)~~
~~3. O_2 required at rest (Groups A, C, and D[1] – see 3.7.6.1.a)~~
~~4. Age~~
~~5. Body mass index (BMI)~~
~~6. Diabetes~~
~~7. Functional Status~~
~~8. Six-minute walk distance~~
~~9. Continuous mechanical ventilation~~
~~10. Diagnosis~~
~~11. PCO_2 (see 3.7.6.1.b)~~
~~Bilirubin (current bilirubin – all gGroups; change in bilirubin – Group B; see 3.7.6.1.c)~~
~~12.~~

Table 2
Post-Transplant Survival Calculation: Covariates and Their Coefficients

For this covariate:	The following coefficient is used in the LAS calculation:
1. Age per year	0.02 if greater than 45 years of age 0.00 if less than 45 years of age
2. Creatinine (serum) at transplant	0.09 if at least 18 years of age (see Policy 3.7.6.1.e)

	0.00 if less than 18 years
3. Creatinine (increase of at least 150%)	0.77 if increase in creatinine is at least 150%, and when the higher value dermining this increase is at least 1 mg/dL (see Policy 3.7.6.1.e) 0.00 if increase in creatinine of 150% if the higher value determining this increase is less than 1 mg/dL 0.00 if increase in creatinine less than 150%
4. Cardiac index	0.35 if less than 2 L/min/m^2 0.00 if greater than 2 L/min/m^2
5. Ventilation status	0.61 if continiuous mechanical ventilation needed 0.00 if ventilation needed
6. Diagnosis Group A – See Policy 3.7.6.1.b for the diseases included in this group	0.00
Diagnosis Group B – See Policy 3.7.6.1.b for the diseases included in this group	0.61
Diagnosis Group C – See Policy 3.7.6.1.b for the diseases included in this group	0.36
Diagnosis Group D – See Policy 3.7.6.1.b for the diseases included in this group	0.46
7. Detailed diagnosis: Bronchiectasis (Group A – see Policy 3.7.6.1.b)	0.19
Detailed diagnosis: Eisenmenger's syndrome (Group B – see Policy 3.7.6.1.b)	0.91
Detailed diagnosis: Lymphangioleiomyomatosis (Group A – see Policy 3.7.6.1.b)	-1.52
Detailed Diagnosis: Obliterative bronchiolitis (not-retransplant) (Group D – see Policy 3.7.6.1.b)	-1.21
Detailed Diagnosis: Pulmonary fibrosis, not idiopathic (Group D – see Policy 3.7.6.1.b)	-0.07
Detailed Diagnosis: Sarcoidosis with PA mean pressure greater than 30 mm Hg (Group D – see Policy	-0.04

3.7.6.1.b)	
Detailed Diagnosis: Sarcoidosis with PA mean pressure of 30 mm Hg or less (Group A – see Policy 3.7.6.1.b)	-0.14
8. Oxygen needed at rest (L/min)	0.07 for Group A 0.02 for Groups B, C, and D
9. Functional Status	-0.19 if no assistance needed with activities for daily living 0.00 if some or total assistance needed with activities for daily living
10. Six-minute-walk-distance	-0.00045*(1200 – 6mw) 0.00 if six-minute-distance-walked is more than 1200 feet

~~**Table 2**~~
~~**Factors that Predict Survival after Lung Transplant**~~

~~1. FVC (Groups B and D – see 3.7.6.1.a)~~
~~2. PCW pressure ≥ 20 (Group D – see 3.7.6.1.a)~~
~~3. Continuous mechanical ventilation~~
~~4. Age~~
~~5. Serum Creatinine~~
~~6. Functional Status~~
~~7. Diagnosis~~

~~The calculations define the difference between transplant benefit and waitlist urgency: Raw Allocation Score = Transplant Benefit Measure – Waitlist Urgency Measure.~~

~~Raw allocation scores range from –730 days up to +365 days, and are normalized to a continuous scale from 0 – 100 to determine Lung Allocation Scores. The higher the score, the higher the priority for receiving lung offers. Lung Allocation Scores are calculated to sufficient decimal places to avoid assigning the same score to multiple candidates.~~

~~As an example, assume that a donor lung is available, and both Candidate X and Candidate Y are on the Waiting List. Taking into account all diagnostic and prognostic factors, Candidate X is expected to live 101.1 days during the following year without transplant. Also using available predictive factors, Candidate X is expected to live 286.3 days during the following year if transplanted today. On the other hand, Candidate Y is expected to live 69.2 days during the following year on the waitlist and 262.9 days post-transplant during the following year if transplanted today. Computationally, the proposed system would prioritize candidates based on the difference between each candidate's transplant benefit measure and the waitlist urgency as measured by the expected days of life lived during the next year.~~

~~**Table 3**~~

~~**Example Illustrating the LAS Calculation**~~

~~Parts of the Score Equation~~	~~Candidate X~~	~~Candidate Y~~
~~a. Post-transplant survival (days)~~	~~286.3~~	~~262.9~~
~~b. Waitlist survival (days)~~	~~101.1~~	~~69.2~~
~~c. Transplant benefit (a–b)~~	~~185.2~~	~~193.7~~
~~d. Raw allocation score (c–b)~~	~~84.1~~	~~124.5~~
~~e. **Lung Allocation Score**~~	~~**74.3**~~	~~**78.0**~~

~~In the example here, Candidate X's raw allocation score would be 84.1 and Candidate Y's raw allocation score would be 124.5.~~

~~Similar to the mathematical conversion of temperature from Fahrenheit to Centigrade, once the raw score is computed, it will be normalized to a continuous scale from 0–100 for easier interpretation by candidates and caregivers (see formula above). A higher score on this scale indicates a higher priority for a lung offer. Conversely, a lower score on this scale indicates a lower priority for organ offers. Therefore, in the example above, Candidate X's raw allocation score of 84.1 normalizes to a Lung Allocation Score of 74.3. Candidate Y's raw score of 124.5 normalizes to a Lung Allocation Score of 78.0. As in the example of raw allocation scores, Candidate Y has a higher Lung Allocation Score and will therefore receive a higher priority for a lung offer than Candidate X.~~

Tables 3 and 4 provide the baseline waiting list and post-transplant survival probabilities, which are used in the LAS calculation.

Table 3: Baseline Waiting List Survival ($S_{WL}(t)$) Probability

Time (days): t	$S_{WL}(t)$	Time (days): t	$S_{WL}(t)$	Time (days): t	$S_{WL}(t)$	Time (days): t	$S_{WL}(t)$	Time (days): t	$S_{WL}(t)$
0	1.000000	49	0.996644	98	0.993160	147	0.990540	196	0.987299
1	0.999991	50	0.996543	99	0.993098	148	0.990540	197	0.987263
2	0.999925	51	0.996518	100	0.993061	149	0.990540	198	0.987155
3	0.999867	52	0.996397	101	0.993005	150	0.990540	199	0.987122
4	0.999746	53	0.996397	102	0.993005	151	0.990540	200	0.986530
5	0.999598	54	0.996363	103	0.992938	152	0.990384	201	0.986530
6	0.999499	55	0.996305	104	0.992938	153	0.990333	202	0.986480
7	0.999371	56	0.996191	105	0.992883	154	0.990333	203	0.985963
8	0.999305	57	0.996119	106	0.992883	155	0.990333	204	0.985926
9	0.999218	58	0.995942	107	0.992851	156	0.990245	205	0.985926
10	0.999085	59	0.995942	108	0.992762	157	0.990245	206	0.985820
11	0.998990	60	0.995909	109	0.992724	158	0.990245	207	0.985820
12	0.998887	61	0.995909	110	0.992643	159	0.990145	208	0.985742
13	0.998816	62	0.995873	111	0.992643	160	0.989689	209	0.985742
14	0.998730	63	0.995846	112	0.992562	161	0.989689	210	0.985742
15	0.998660	64	0.995846	113	0.992089	162	0.989652	211	0.985708
16	0.998588	65	0.995614	114	0.992064	163	0.989575	212	0.985708
17	0.998455	66	0.995553	115	0.992040	164	0.989575	213	0.985541
18	0.998362	67	0.995553	116	0.991997	165	0.988903	214	0.985541
19	0.998259	68	0.995553	117	0.991966	166	0.988873	215	0.985541
20	0.998220	69	0.995500	118	0.991940	167	0.988873	216	0.985450
21	0.998068	70	0.995479	119	0.991940	168	0.988784	217	0.985450
22	0.998036	71	0.995349	120	0.991940	169	0.988722	218	0.985450
23	0.997972	72	0.995293	121	0.991514	170	0.988695	219	0.985330
24	0.997868	73	0.995136	122	0.991514	171	0.988695	220	0.985265
25	0.997770	74	0.994965	123	0.991514	172	0.988695	221	0.985265
26	0.997742	75	0.994821	124	0.991514	173	0.988655	222	0.985265
27	0.997667	76	0.994774	125	0.991488	174	0.988655	223	0.985265
28	0.997626	77	0.994702	126	0.991462	175	0.988655	224	0.985265
29	0.997540	78	0.994702	127	0.991393	176	0.988625	225	0.984621
30	0.997473	79	0.994634	128	0.991307	177	0.988548	226	0.984549
31	0.997391	80	0.994565	129	0.991307	178	0.988548	227	0.984549
32	0.997327	81	0.994547	130	0.991270	179	0.988548	228	0.984549
33	0.997297	82	0.994465	131	0.991236	180	0.988062	229	0.984549
34	0.997274	83	0.994465	132	0.991236	181	0.988062	230	0.984489
35	0.997242	84	0.994297	133	0.991053	182	0.988062	231	0.984489
36	0.997242	85	0.994297	134	0.991012	183	0.988021	232	0.984396
37	0.997181	86	0.994297	135	0.991012	184	0.987934	233	0.984324
38	0.997137	87	0.994297	136	0.990978	185	0.987885	234	0.984280
39	0.997121	88	0.994181	137	0.990978	186	0.987885	235	0.984079
40	0.997121	89	0.994077	138	0.990978	187	0.987885	236	0.984079
41	0.997019	90	0.994035	139	0.990936	188	0.987885	237	0.984015
42	0.996946	91	0.994008	140	0.990901	189	0.987856	238	0.984015
43	0.996916	92	0.993866	141	0.990901	190	0.987856	239	0.984015
44	0.996849	93	0.993831	142	0.990811	191	0.987856	240	0.984015
45	0.996849	94	0.993807	143	0.990739	192	0.987856	241	0.983835
46	0.996820	95	0.993715	144	0.990595	193	0.987856	242	0.983835
47	0.996780	96	0.993308	145	0.990595	194	0.987608	243	0.983792
48	0.996731	97	0.993220	146	0.990540	195	0.987359	244	0.983753

Table 3: Baseline Waiting List Survival ($S_{WL}(t)$) Probability (Continued)

Time (days): t	$S_{WL}(t)$	Time (days): t	$S_{WL}(t)$	Time (days): t	$S_{WL}(t)$	Time (days): t	$S_{WL}(t)$	Time (days): t	$S_{WL}(t)$
245	0.983753	269	0.982960	293	0.981827	317	0.980218	341	0.978597
246	0.983753	270	0.982960	294	0.981827	318	0.980129	342	0.978597
247	0.983697	271	0.982797	295	0.981573	319	0.980129	343	0.978301
248	0.983636	272	0.982797	296	0.981319	320	0.980016	344	0.978250
249	0.983636	273	0.982797	297	0.980775	321	0.980016	345	0.978250
250	0.983636	274	0.982797	298	0.980775	322	0.980016	346	0.978250
251	0.983636	275	0.982700	299	0.980519	323	0.979773	347	0.978117
252	0.983243	276	0.982603	300	0.980397	324	0.979773	348	0.978037
253	0.983243	277	0.982603	301	0.980397	325	0.979671	349	0.978037
254	0.983243	278	0.982511	302	0.980397	326	0.979671	350	0.978037
255	0.983097	279	0.982457	303	0.980397	327	0.979164	351	0.978037
256	0.983097	280	0.982457	304	0.980397	328	0.979164	352	0.977937
257	0.983097	281	0.982457	305	0.980397	329	0.979164	353	0.977937
258	0.983097	282	0.982413	306	0.980397	330	0.979164	354	0.977937
259	0.983097	283	0.982323	307	0.980339	331	0.979100	355	0.977855
260	0.983097	284	0.982323	308	0.980339	332	0.979100	356	0.977855
261	0.983097	285	0.982323	309	0.980339	333	0.978935	357	0.977855
262	0.983052	286	0.982323	310	0.980339	334	0.978935	358	0.977710
263	0.983052	287	0.982323	311	0.980339	335	0.978817	359	0.977710
264	0.983052	288	0.982323	312	0.980339	336	0.978817	360	0.976881
265	0.983052	289	0.982323	313	0.980339	337	0.978817	361	0.976881
266	0.983052	290	0.982323	314	0.980339	338	0.978817	362	0.976881
267	0.983052	291	0.981916	315	0.980218	339	0.978817	363	0.976709
268	0.982960	292	0.981878	316	0.980218	340	0.978817	364	0.976709

Table 4: Baseline Post-Transplant Survival ($S_{TX}(t)$) Probability

Time (days): t	$S_{TX}(t)$	Time (days): t	$S_{TX}(t)$	Time (days): t	$S_{TX}(t)$	Time (days): t	$S_{TX}(t)$	Time (days): t	$S_{TX}(t)$
0	1.000000	48	0.981882	97	0.972415	146	0.965165	195	0.958585
0	0.998946	49	0.981394	98	0.972415	147	0.965018	196	0.958585
1	0.997558	50	0.981115	99	0.972128	148	0.965018	197	0.958511
2	0.996895	51	0.980836	100	0.971984	149	0.964724	198	0.958361
3	0.996364	52	0.980416	101	0.971769	150	0.964651	199	0.958062
4	0.995498	53	0.980207	102	0.971697	151	0.964504	200	0.958062
5	0.995165	54	0.980137	103	0.971553	152	0.964357	201	0.957987
6	0.994565	55	0.979926	104	0.971337	153	0.964063	202	0.957987
7	0.994164	56	0.979646	105	0.971265	154	0.963843	203	0.957913
8	0.993963	57	0.979436	106	0.971193	155	0.963696	204	0.957763
9	0.993360	58	0.979085	107	0.971121	156	0.963475	205	0.957613
10	0.993159	59	0.978874	108	0.971049	157	0.963328	206	0.957538
11	0.992487	60	0.978733	109	0.970977	158	0.963107	207	0.957388
12	0.992353	61	0.978452	110	0.970761	159	0.962738	208	0.957313
13	0.991949	62	0.978382	111	0.970689	160	0.962517	209	0.957238
14	0.991679	63	0.978170	112	0.970617	161	0.962443	210	0.957163
15	0.991207	64	0.978100	113	0.970545	162	0.962296	211	0.957163
16	0.990531	65	0.977959	114	0.970473	163	0.962074	212	0.956938
17	0.990260	66	0.977818	115	0.970329	164	0.961927	213	0.956863
18	0.989921	67	0.977818	116	0.969968	165	0.961705	214	0.956788
19	0.989582	68	0.977536	117	0.969824	166	0.961631	215	0.956713
20	0.989514	69	0.977254	118	0.969679	167	0.961557	216	0.956638
21	0.988902	70	0.977042	119	0.969607	168	0.961483	217	0.956488
22	0.988220	71	0.976971	120	0.969390	169	0.961483	218	0.956263
23	0.987810	72	0.976901	121	0.969101	170	0.961409	219	0.956263
24	0.987469	73	0.976759	122	0.968956	171	0.961113	220	0.956187
25	0.987263	74	0.976547	123	0.968667	172	0.961113	221	0.956112
26	0.987058	75	0.976476	124	0.968594	173	0.961039	222	0.956037
27	0.986578	76	0.976193	125	0.968377	174	0.960965	223	0.955887
28	0.986304	77	0.975909	126	0.968159	175	0.960891	224	0.955736
29	0.986030	78	0.975767	127	0.968086	176	0.960743	225	0.955736
30	0.985961	79	0.975625	128	0.967868	177	0.960595	226	0.955736
31	0.985755	80	0.975483	129	0.967796	178	0.960446	227	0.955661
32	0.985480	81	0.975483	130	0.967504	179	0.960446	228	0.955661
33	0.985136	82	0.975483	131	0.967359	180	0.960372	229	0.955510
34	0.984929	83	0.974985	132	0.967140	181	0.960298	230	0.955510
35	0.984515	84	0.974985	133	0.967140	182	0.960149	231	0.955209
36	0.984446	85	0.974700	134	0.966994	183	0.960075	232	0.955209
37	0.984170	86	0.974700	135	0.966702	184	0.959852	233	0.955134
38	0.983825	87	0.974415	136	0.966483	185	0.959778	234	0.954983
39	0.983479	88	0.973987	137	0.966483	186	0.959703	235	0.954832
40	0.983202	89	0.973845	138	0.966410	187	0.959629	236	0.954681
41	0.983063	90	0.973630	139	0.966263	188	0.959554	237	0.954530
42	0.982855	91	0.973416	140	0.966190	189	0.959480	238	0.954455
43	0.982716	92	0.973416	141	0.966190	190	0.959256	239	0.954228
44	0.982578	93	0.973202	142	0.965971	191	0.959107	240	0.954228
45	0.982300	94	0.973059	143	0.965751	192	0.959033	241	0.954077
46	0.982160	95	0.972916	144	0.965678	193	0.959033	242	0.954077
47	0.981952	96	0.972629	145	0.965311	194	0.958735	243	0.953925

Table 4: Baseline Post-Transplant Survival ($S_{TX}(t)$) Probability (Continued)

Time (days): t	$S_{TX}(t)$	Time (days): t	$S_{TX}(t)$	Time (days): t	$S_{TX}(t)$	Time (days): t	$S_{TX}(t)$	Time (days): t	$S_{TX}(t)$
244	0.953850	269	0.951190	293	0.948589	317	0.946359	341	0.943729
245	0.953850	270	0.950961	294	0.948359	318	0.946359	342	0.943651
246	0.953774	271	0.950656	295	0.948282	319	0.946204	343	0.943573
247	0.953774	272	0.950579	296	0.948128	320	0.946204	344	0.943418
248	0.953698	273	0.950427	297	0.948052	321	0.946127	345	0.943341
249	0.953623	274	0.950274	298	0.947975	322	0.946050	346	0.943108
250	0.953395	275	0.950121	299	0.947821	323	0.946050	347	0.943030
251	0.953319	276	0.950121	300	0.947667	324	0.945896	348	0.943030
252	0.953016	277	0.949815	301	0.947667	325	0.945818	349	0.942952
253	0.953016	278	0.949662	302	0.947360	326	0.945587	350	0.942719
254	0.952712	279	0.949662	303	0.947360	327	0.945432	351	0.942719
255	0.952712	280	0.949585	304	0.947360	328	0.945432	352	0.942719
256	0.952712	281	0.949585	305	0.947360	329	0.945355	353	0.942641
257	0.952484	282	0.949432	306	0.947283	330	0.945278	354	0.942485
258	0.952408	283	0.949355	307	0.947283	331	0.945123	355	0.942485
259	0.952332	284	0.949279	308	0.947206	332	0.945123	356	0.942173
260	0.952256	285	0.949279	309	0.947129	333	0.944968	357	0.942017
261	0.952180	286	0.949202	310	0.946975	334	0.944891	358	0.941783
262	0.952104	287	0.949202	311	0.946821	335	0.944736	359	0.941705
263	0.951876	288	0.949126	312	0.946821	336	0.944581	360	0.941627
264	0.951800	289	0.949049	313	0.946821	337	0.944504	361	0.941549
265	0.951648	290	0.948896	314	0.946744	338	0.944194	362	0.941549
266	0.951648	291	0.948819	315	0.946590	339	0.944039	363	0.941315
267	0.951572	292	0.948819	316	0.946436	340	0.943961	364	0.941315
268	0.951495								

b) Lung Disease Diagnosis and its Group Classification

The LAS calculation makes use of diagnosis groups A, B, C, and D. The diagnoses that comprise each group are:

(i) Group A
- Allergic bronchopulmonary aspergillosis
- Alpha-1 antitrypsin deficiency
- Bronchiectasis
- Bronchopulmonary dysplasia
- Chronic obstructive pulmonary disease/emphysema
- Ehlers-Danlos syndrome
- Granulomatous lung disease
- Inhalation burns/trauma
- Kartagener's syndrome
- Lymphangioleiomyomatosis
- Obstructive lung disease
- Primary ciliary dyskinesia;
- Sarcoidosis with mean pulmonary artery pressure of 30 mm Hg or less
- Tuberous sclerosis
- Wegener's granuloma – bronchiectasis

(ii) Group B
- Congenital malformation
- CREST – pulmonary hypertension
- Eisenmenger's syndrome: atrial septal defect
- Eisenmenger's syndrome: multi-congenital anomalies
- Eisenmenger's syndrome: other specify
- Eisenmenger's syndrome: Patent ductus arteriosus (PDA)
- Eisenmenger's syndrome: Ventricular septal defect (VSD)
- Portopulmonary hypertension
- Primary pulmonary hypertension/pulmonary arterial hypertension
- Pulmonary capillary hemangiomatosis
- Pulmonary telangiectasia – pulmonary hypertension
- Pulmonary thromboembolic disease
- Pulmonary vascular disease
- Pulmonary veno-occlusive disease
- Pulmonic stenosis
- Right hypoplastic lung
- Scleroderma – pulmonary hypertension
- Secondary pulmonary hypertension
- Thromboembolic pulmonary hypertension

(iii) Group C
- Common variable immune deficiency
- Cystic fibrosis
- Fibrocavitary lung disease
- Hypogammaglobulinemia
- Schwachman-Diamond syndrome

(iv) Group D
- ABCA3 transporter mutation

- Alveolar proteinosis
- Amyloidosis
- Acute respiratory distress syndrome or pneumonia
- Bronchoalveolar carcinoma (BAC)
- Carcinoid tumorlets
- Chronic pneumonitis of infancy
- Constrictive bronchiolitis
- CREST – Restrictive
- Eosinophilic granuloma
- Fibrosing Mediastinitis
- Graft versus host disease (GVHD)
- Hermansky Pudlak syndrome
- Hypersensitivity pneumonitis
- Idiopathic interstitial pneumonia, with one or more of the following disease entities
    - Acute interstitial pneumonia
    - Cryptogenic organizing pneumonia/Bronchiolitis obliterans with organizing pneumonia (BOOP)
    - Desquamative interstitial pneumonia
    - Idiopathic pulmonary fibrosis
    - Nonspecific interstitial pneumonia
    - Lymphocytic interstitial pneumonia
    - Respiratory bronchiolitis-associated interstitial lung disease
- Idiopathic pulmonary hemosiderosis
- Lung retransplant or graft failure: acute rejection
- Lung retransplant or graft failure: non-specific
- Lung retransplant or graft failure: obliterative bronchiolitis-obstructive
- Lung retransplant or graft failure: obliterative bronchiolitis-restrictive
- Lung retransplant or graft failure: obstructive
- Lung retransplant or graft failure: other specify
- Lung retransplant or graft failure: primary graft failure
- Lung retransplant or graft failure: restrictive
- Lupus
- Mixed connective tissue disease
- Obliterative bronchiolitis: non-retransplant
- Occupational lung disease: other specify
- Paraneoplastic pemphigus associated Castleman's disease
- Polymyositis
- Pulmonary fibrosis other specify cause
- Pulmonary hyalinizing granuloma
- Pulmonary telangiectasia – restrictive
- Rheumatoid disease
- Sarcoidosis with mean pulmonary artery pressure higher than 30 mm Hg
- Scleroderma – restrictive
- Secondary pulmonary fibrosis (specify cause)
- Silicosis
- Sjogren's syndrome
- Surfactant protein B mutation
- Surfactant protein C mutation

- Teratoma
- Wegener's granuloma – restrictive

~~a. Lung Disease Diagnosis Groups~~

~~The following are some of the diagnoses included in groups A, B, C, and D.~~

~~(i) *Group A*~~

~~Includes candidates with obstructive lung disease, including without limitation, chronic obstructive pulmonary disease (COPD), alpha-1 antitrypsin deficiency, emphysema, lymphangioleiomyomatosis, bronchiectasis, and sarcoidosis with mean pulmonary artery (PA) pressure ≤ 30 mmHg~~

~~(ii) *Group B*~~

~~Includes candidates with pulmonary vascular disease, including without limitation, primary pulmonary hypertension (PPH), Eisenmenger's syndrome, and other uncommon pulmonary vascular diseases~~

~~(iii) *Group C*~~

~~Includes, without limitation, candidates with cystic fibrosis (CF) and immunodeficiency disorders such as hypogammaglobulinemia~~

~~(iv) *Group D*~~

~~Includes candidates with restrictive lung diseases, including without limitation, idiopathic pulmonary fibrosis (IPF), pulmonary fibrosis (other causes), sarcoidosis with mean PA pressure > 30 mmHg, and obliterative bronchiolitis (non-retransplant)~~

c) PCO_2 in the Lung Allocation Score

[Except for the change in this policy's number – from 3.7.6.1.b to 3.7.6.1.c – there are no further changes to this policy.]

d) Bilirubin in the Lung Allocation Score

[Except for the change in this policy's number – from 3.7.6.1.c to 3.7.6.1.d – there are no further changes to this policy.]

e) Creatinine in the LAS Calculation

The LAS calculation uses two measures of creatinine: current creatinine (only for candidates who are at least 18 years of age), and increase in creatinine (for all candidates).

(i) Current Creatinine
Current creatinine is the serum creatinine value at the most recent test date and time reported to the OPTN Contractor. The LAS calculation only uses current creatinine for candidates who are at least 18 years of age.

(ii) Increase in Creatinine
An increase in creatinine will influence a candidate's LAS only if it is

at least 150%. The increase-in-creatinine calculation uses the highest and lowest values of creatinine. For this variable to impact a candidate's LAS, the test date of the lowest value must be earlier than the test date of the highest value. The highest value must be at least 1.0 mg/dL. Test dates of these highest and lowest values cannot be more than 6 months apart. The increase-in-creatinine calculation could use an expired lowest value, but not an expired highest value. The equation for this increase-in-creatinine calculation is: (highest creatinine – lowest creatinine)/lowest creatinine.

If a candidate's LAS is influenced by an increase in creatinine, then the LAS calculation will assess whether to maintain that influence. To maintain the influence of the increase in creatinine, the candidate's current creatinine value must be at least 150% higher than the lowest value used in the increase-in-creatinine calculation. The equation for this maintenance calculation is: (current creatinine – lowest creatinine)/lowest creatinine

If the current creatinine value expires (Policy 3.7.6.3) or a new creatinine value is entered, then the increase maintenance calculation will occur.

[There are no changes to Policy 3.7.6.2.]

3.7.6.3 Reporting Data for Candidates Who Receive Lung Allocation Scores.

When listing a candidate who is at least 12 years of age for lung transplantation, transplant programs must report to the OPTN Contractor clinical data corresponding to the covariates shown in Tables 1 and 2 in Policy 3.7.6.1, as well as other data required by the OPTN Contractor, pursuant to Policy 7.0 (Data Submission Requirements). The transplant program must maintain source documentation in the candidate's chart.

Except as noted in Policy 3.7.6.3.1, transplant programs must report to the OPTN Contractor each element of a candidate's clinical data in UNet^{SM} by every "six-month anniversary date". The LAS system defines a "six -month anniversary date," which first occurs six months from the date of initial listing, then every six months thereafter. The LAS system will consider a covariate's value to be expired if the covariate's test date is six-months older than the most recent anniversary date. The LAS system will consider actual values or estimated values for pulmonary pressures to be valid until the transplant program updates them with new actual values or new estimated values pursuant to Policy 3.7.6.4.

However, transplant programs do not need to report data obtainable only by heart catheterization every six months; instead, the transplant program may determine the frequency of updating clinical data obtainable through heart catheterization. However, if a transplant program performs a heart catheterization test on the candidate during the six month interval, then it must report the relevant results to the OPTN Contractor. The transplant program must maintain source documentation of all heart catheterization test results in the candidate's chart.

If values for certain covariates are missing, expired, or below a threshold, then the LAS calculation will use a substituted normal or least beneficial value to calculate the candidate's LAS. Table 5 lists the covariates for which the LAS calculation will use substituted data if the actual values are missing, expired, or

below a certain threshold. A normal value is one that a healthy individual is likely to exhibit. A least beneficial value is one that will calculate the lowest LAS for a candidate.

Table 5
Data Substituted for Missing or Expired Actual Values in Calculating the LAS

If this covariate's value is missing, expired, or below the substituted value:	**Then the LAS calculation will use this substituted value:**
Bilirubin: current	1.0 mg/dL if the actual value is missing, expired, or less than 1.0 mg/dL
Body mass index	100 kg/m^2 if the actual value is missing or expired
Cardiac index	3.0 $L/min/m^2$ if the actual value is missing
Central venous pressure	5 mm Hg if the actual value is missing or less than 5 mm Hg
Continuous mechanical ventilation	No mechanical ventilation in the waiting list model if the actual value is missing or expired Continuous mechanical ventilation in the post-transplant model if the actual value is missing or expired
Creatinine: serum	0.1 mg/dL in the waiting list model if the actual value is missing or expired 40 mg/dL in the post transplant model for candidates at least 18 years of age if the actual value is missing or expired 0.00 mg/dL in the post transplant model for candidates less than 18 years of age if the actual value is missing or expired
Diabetes	No diabetes if the actual value is missing or expired
Forced vital capacity (FVC)	150% for Group D if the actual value is missing or expired
Functional Status	No assistance needed in the waiting list model if the actual value is missing or expired Some or total assistance needed in the post-transplant model if the actual value is missing or expired
Oxygen needed at rest	No supplemental oxygen needed in the waiting list model if the actual value is missing or expired 26.33 L/min in the post transplant model if the actual value is missing or expired

If this covariate's value is missing, expired, or below the substituted value:	**Then the LAS calculation will use this substituted value:**
PCO_2: current	40 mm Hg if the actual value is missing, expired, or less than 40 mm Hg
Pulmonary artery (PA) systolic pressure	20 mm Hg if the actual value is missing or less than 20 mm Hg
Six minute walk	4000 feet in the waiting list model if the actual value is missing or expired 0 feet in the post transplant model if the actual value is missing or expired

Programs are permitted to enter a value deemed medically reasonable in the event a test needed to obtain an actual value for a variable cannot be performed due to the medical condition of a specific candidate. Prior to entering such estimated values, programs must request review and approval from the Lung Review Board to determine whether the estimated values are appropriate. Estimated values will remain valid until those values are either updated with an actual value or a new estimated value is entered pursuant to Policy 3.7.6.4.

~~**3.7.6.3 Candidate Variables in UNet^{SM}**. Entry into UNet^{SM} of candidate clinical data corresponding to the variables shown in Tables 1 and 2 in Policy 3.7.6.1 is required when listing a candidate for lung transplantation. Diagnosis, birth date (used to calculate age), height and weight (used to calculate BMI) must be entered for a candidate to be added to the waitlist. Candidates will receive a Lung Allocation Score of zero if the Functional Status class or assisted ventilation variable is missing a value at any time.~~

~~If values for pulmonary artery systolic pressure, pulmonary capillary wedge pressure, or pulmonary artery mean pressure are missing, then a default value will be assigned that represents a normal clinical value for these missing pulmonary pressure variables. A default value of 20 mm Hg will be assigned for missing pulmonary artery systolic pressure, a default value of 5 mm Hg will be assigned for missing pulmonary capillary wedge pressure, and a default value of 15 mm Hg will be assigned for missing pulmonary artery mean pressure. The default values for pulmonary pressures will also be used in the calculation of Lung Allocation Scores for those candidates whose actual values are provided, but are lower than the default value. If any other candidate variables are missing, then a default value, which will be the value that results in the lowest contribution to the Lung Allocation Score for that variable field ("Least Beneficial Value"), will be selected for the candidate.~~

~~Programs are permitted to enter a value deemed medically reasonable in the event a test needed to obtain an actual value for a variable cannot be performed due to the medical condition of a specific candidate. Prior to entering such estimated values, programs must request review and approval from the Lung Review Board to determine whether the estimated values are appropriate. Estimated values will remain valid until those values are either updated with an actual value or a new estimated value is entered pursuant to Policy 3.7.6.4.~~

3.7.6.3.1 Reporting Data for Candidates with LASs of 50 or Higher.

A program must update three key variables in UNet^{SM} no more than 14 days after a candidate's LAS becomes greater than 50: assisted

ventilation, supplemental oxygen, and current PCO_2. If a program does not perform a PCO_2 test in that time, then it does not need to update this value in UNet[SM]. While the candidate's score remains 50 or higher, a program must continue to assess and report any observed change in the three clinical variables no less frequently than 14 days from the date of the previous assessment.

The transplant program must maintain source documentation for each assessment in the candidate's chart.

~~**3.7.6.3.1 Updating Candidate Variables.** Programs may update their candidates' clinical data at any time they believe a change in candidate medical condition warrants such modification. Programs must update each element of a candidate's clinical data in UNet[SM] every six months, except those data obtainable only by heart catheterization. Also, as described further below, programs must update three clinical variables more frequently than six months for candidates with LAS of 50 or higher.~~

~~UNet[SM] defines a "six-month anniversary date," which first occurs six months from the date of initial listing, then every six months thereafter. UNet[SM] will consider a variable to be expired if the variable's test date is six months older than the most recent anniversary date.~~

~~If the test dates of the Functional Status or assisted ventilation variable expire, then the candidate's Lung Allocation Score will be zero. If any other candidate variable expires – excluding pulmonary artery systolic pressure, pulmonary capillary wedge pressure, or pulmonary artery mean pressure – then the candidate will receive the Least Beneficial Value for that variable. The transplant center determines the frequency of updating those candidate variables that are required to be obtained by heart catheterization (pulmonary artery pressures and pulmonary capillary wedge pressure) If a transplant center repeats a heart catheterization test, it must report the results in UNet[SM].~~

~~UNet[SM] will consider actual values or estimated values for pulmonary pressures to be valid until the transplant center updates them with new actual values or new estimated values pursuant to Policy 3.7.6.4.~~

~~A program must update three key variables in UNet[SM] no more than 14 days after a candidate's LAS becomes greater than 50: assisted ventilation, supplemental oxygen, and current PCO_2. If a program does not perform a PCO_2 test in that time, then it does not need to update this value in UNet[SM]. While the candidate's score remains 50 or higher, a program must continue to assess and report any observed change in the three clinical variables no less frequently than 14 days from the date of the previous assessment.~~

[There are no changes to Policies 3.7.6.4, 3.7.7, 3.7.8, 3.7.8.1, 3.7.9, and 3.7.9.1.]

3.7.9.2 Waiting Time Accrual for Lung Candidates Age 12 and Older Following Implementation of Lung Allocation Scores Described in Policy 3.7.6

[There are no changes to text that precede the struck paragraph below.]

~~Candidates that receive a Lung Allocation Score of zero due to missing or expired candidate variables as described in Policy 3.7.6.3 will be screened from the lung match following notification of the listing center, and will not receive isolated lung offers. Upon the entry or update of previously missing or expired candidate variables as described in Policy 3.7.6.3, those candidates will appear on the lung match.~~

[There are no further changes to Policy 3.7.9.2.]

Exhibit A

Tables 1, 2, and 3 present the current and proposed waiting list models (i.e., covariates included in each version of the model) by diagnosis, physiological reserve, and severity, respectively. The tables provide the coefficient, hazard ratio (HR), 95% confidence intervals (CI), and the p-value for each covariate in the current or revised waiting list model. The HR for each covariate is calculated from its corresponding coefficient. In the waiting list mortality model, an HR greater than 1.0 indicates an increased risk for waiting list mortality due to the given covariate, whereas an HR less than 1.0 indicates a decreased risk for waiting list mortality due to the given covariate. In the post transplant model, an HR greater than 1.0 indicates an increased likelihood for post-transplant mortality due to the given covariate, whereas an HR less than 1.0 indicates a decreased likelihood for post-transplant mortality due to the given covariate.

The effect of each covariate on the revised LAS system is presented in Appendix A.

To read Table 1, 2, or 3, consider the example shown in Figure 1 below. In the "Current LAS Waiting List Model," the covariate "Group B" has the coefficient of 2.38. In the "Revised LAS Waiting List Model," the Group B covariate has the coefficient of 1.58.

Covariates	Current LAS Waiting List Model (Cohort 11/1/2000 – 10/31/2003)				Revised LAS Waiting List Model (Cohort 9/1/2006 – 9/30/2008)			
	Coefficient	HR	95% CI	p-value	Coefficient	HR	95% CI	p-value
Diagnosis group (reference = Group A)								
Group B (idiopathic pulmonary hypertension and others)	2.38	10.77	(7.08, 16.37)	<0.0001	1.58	4.84	(1.49, 15.75)	0.0088
Group C (cystic fibrosis and others)	0.94	2.57	(1.76, 3.74)	<0.0001	1.23	3.43	(1.45, 8.08)	0.0049
Group D (idiopathic pulmonary fibrosis and others)	1.00	2.71	(1.27, 5.77)	0.0097	0.63	1.87	(0.85, 4.14)	0.1223

Figure 1: Snapshot of Table 1 (Covariates in the Current and Revised Waiting List Models – Diagnoses)

Table 1: Covariates in the Current and Revised Waiting List Models – Diagnoses

Covariates	Current LAS Waiting List Model (Cohort 11/1/2000 – 10/31/2003)				Revised LAS Waiting List Model (Cohort 9/1/2006 – 9/30/2008)			
	Coefficient	HR	95% CI	p-value	Coefficient	HR	95% CI	p-value
Diagnosis group (reference = Group A)								
Group B (idiopathic pulmonary hypertension and others)	2.38	10.77	(7.08, 16.37)	<0.0001	1.58	4.84	(1.49, 15.75)	0.0088
Group C (cystic fibrosis and others)	0.94	2.57	(1.76, 3.74)	<0.0001	1.23	3.43	(1.45, 8.08)	0.0049
Group D (idiopathic pulmonary fibrosis and others)	1.00	2.71	(1.27, 5.77)	0.0097	0.63	1.87	(0.85, 4.14)	0.1223
Detailed Diagnosis								
Bronchiectasis	0.16	1.17	(0.70, 1.95)	0.5448	0.67	1.95	(0.68, 5.60)	0.2144
Eisenmenger's syndrome	-0.63	0.53	(0.28, 1.03)	0.0617	-0.63	0.53[F]	(0.28, 1.03)	0.0617
Lymphangioleiomyomatosis	-0.20	0.82	(0.34, 2.01)	0.6656	-0.32	0.73	(0.12, 4.26)	0.7256
Obliterative bronchiolitis (not-retransplant)	-0.26	0.77	(0.39, 1.53)	0.4593	0.45	1.56	(0.31, 7.74)	0.5856
Pulmonary fibrosis, not idiopathic	-0.27	0.77	(0.55, 1.07)	0.1180	-0.21	0.81	(0.35, 1.90)	0.6297
Sarcoidosis with PA mean pressure greater than 30 mm Hg	-0.71	0.49	(0.34, 0.72)	0.0003	-0.46	0.63	(0.31, 1.29)	0.2103
Sarcoidosis with PA mean pressure of 30 mm Hg or less	0.46	1.58	(0.87, 2.85)	0.1308	0.93	2.54	(1.12, 5.76)	0.0255

[F] There weren't sufficient numbers to calculate this hazard ratio; therefore, the Committee proposes the current hazard ratio (0.53) for use in the revised waiting list model.

Table 2: Covariates in the Current and Revised Waiting List Models – Physiological Reserve

Covariates	Current LAS Waiting List Model (Cohort 11/1/2000 – 10/31/2003)				Revised LAS Waiting List Model (Cohort 9/1/2006 – 9/30/2008)			
	Coefficient	HR	95% CI	p-value	Coefficient	HR	95% CI	p-value
Diagnosis group (reference = Group A)								
Physiological reserve								
Age for diagnosis groups A, B, C (per 10 years)	0.15	1.16	(1.06, 1.28)	0.0020				
Age for diagnosis group D (per 10 years)	0.21	1.24	(1.12, 1.36)	<0.0001				
Age (per 10 years)					0.01	1.01	(1.00, 1.02)	0.2131
BMI (kg/ m^2)	-0.05	0.95	(0.94, 0.96)	<0.0001				
BMI less than 20 kg/m^2					-0.13	0.88	(0.78, 0.99)	0.0368
Diabetes (versus none)	0.16	1.17	(0.97, 1.42)	0.1045	0.47	1.60	(1.16, 2.20)	0.0042
Functional status, total assistance needed	0.12	1.12	(0.65, 1.94)	0.6817				
Functional status, some assistance needed	0.18	1.20	(1.04, 1.39)	0.0135				
Functional status, no assistance (versus some or total assistance needed)					-0.45	0.64	(0.40, 1.02)	0.0615
Six-minute–walk-distance of less than 150 feet	0.33	1.39	(1.10, 1.77)	0.0066				
Six minute walk (per 100 ft)					-0.08	0.92	(0.88, 0.95)	<.0001

Table 3: Covariates in the Current and Revised Waiting List Models – Severity

Covariates	Current LAS Waiting List Model (Cohort 11/1/2000 – 10/31/2003)				Revised LAS Waiting List Model (Cohort 9/1/2006 – 9/30/2008)			
	Coefficient	HR	95% CI	p-value	Coefficient	HR	95% CI	p-value
Diagnosis group (ref = Group A)								
Severity								
FVC (% predicted, per 10% points)	-0.20	0.82	(0.79, 0.86)	<0.0001				
FVC less than 80%, per 10%, group D					-0.18	0.83	(0.73, 0.95)	0.0064
Resting O_2 (L/min), Groups A and D	0.19	1.21	(1.16, 1.25)	<0.0001				
Resting oxygen (O_2) (L/min), Group C	0.13	1.13	(1.08, 1.19)	<0.0001				
Resting O_2 (L/min), Group B	0.04	1.04	(0.94, 1.15)	0.4135	0.02	1.02	(0.93, 1.13)	0.6662
Resting O_2 (L/min), Groups A, C, and D					0.01	1.13	(1.10, 1.15)	<.0001
PA systolic (per 10 mm Hg), groups A, C, D	0.16	1.17	(1.12, 1.23)	<0.0001				
PA systolic greater than 40 mm Hg (per 10 mm Hg), Group A					0.42	1.52	(1.22, 1.89)	0.0002
PA systolic (per 10 mm Hg), Groups B, C, and D					0.05	1.05	(0.95, 1.15)	0.3499
PCO_2 greater than 40 mm Hg (per 10 mm Hg)	0.05	1.18	(1.03, 1.35)	0.0120	0.11	1.12	(1.00, 1.25)	0.0546
PCO_2 increase of at least 15% within past 6 months	0.07	1.85	(0.98, 3.40)	0.0520	0.23	1.26	(0.74, 2.15)	0.3914
Continuous mechanical ventilation	1.21	3.37	(2.02, 5.60)	<0.0001	1.68	5.35	(3.10, 9.25)	<.0001
Creatinine (mg/dL), age 18 or older					0.50	1.65	(1.07, 2.55)	0.0228
Cardiac index (coefficient used					0.54	1.72	(1.05, 2.83)	0.0325

in the LAS calculation if cardiac index is less than 2 L/min/m^2)								
Central venous pressure (CVP) (coefficient used in the LAS calculation if it CVP is greater than 7 mm Hg for Group B)					0.02	1.02	(0.95, 1.10)	0.6438
Bilirubin of at least 1 mg/dL					0.04	1.04[G]	(1.04, 1.50)	0.0417
Bilirubin increase of at least 50% within past 6 months, Group B					1.41	4.11[7]	(4.11, 13.28)	<.0001

[G] In the revised LAS Model, bilirubin parameters were estimated in the Lung Retrospective Project cohort, and the lower limits of the 90% confidence intervals are used as conservative estimates.

Tables 4 and 5 present the current and proposed post-transplant survival models by diagnosis and severity. The tables provide the coefficient, HR, 95% CI, and the p-value for each covariate in the current or revised waiting list model. Refer to page 38 for an explanation of the column headings.

To read Table 4 or 5, consider the example shown in Figure 2 below. The covariate "Group B" has the coefficient of 0.62 in the "Current LAS post-transplant model," and 0.61 in the "Revised LAS post-transplant model."

Covariates	Current LAS Post-Transplant Model (Cohort 11/1/2000 – 10/31/2003)				Revised LAS Post-Transplant Model (Cohort 5/4/05 – 9/30/2008)			
	Coefficient	HR	95% CI	p-value	Coefficient	HR	95% CI	p-value
Diagnosis group (reference = Group A)								
Group B (idiopathic pulmonary hypertension and others)	0.62	1.86	(0.94, 3.70)	0.0747	0.61	1.84	(1.21, 2.82)	0.0046
Group C (cystic fibrosis and others)	0.01	1.01	(0.74, 1.38)	0.9571	0.36	1.44	(1.04, 1.99)	0.0289
Group D (idiopathic pulmonary fibrosis and others)	0.41	1.51	(1.00, 2.28)	0.0488	0.46	1.59	(1.25, 2.02)	0.0001

Figure 2: Snapshot of Table 4 (Covariates in the Current and Proposed Post-Transplant Survival Models – Diagnosis)

Table 4: Covariates in the Current and Proposed Post-Transplant Survival Models – Diagnosis

Covariates	Current LAS Post-Transplant Model (Cohort 11/1/2000 – 10/31/2003)				Revised LAS Post-Transplant Model (Cohort 5/4/05 – 9/30/2008)			
	Coefficient	HR	95% CI	p-value	Coefficient	HR	95% CI	p-value
Diagnosis group (reference = Group A)								
Group B (idiopathic pulmonary hypertension and others)	0.62	1.86	(0.94, 3.70)	0.0747	0.61	1.84	(1.21, 2.82)	0.0046
Group C (cystic fibrosis and others)	0.01	1.01	(0.74, 1.38)	0.9571	0.36	1.44	(1.04, 1.99)	0.0289
Group D (idiopathic pulmonary fibrosis and others)	0.41	1.51	(1.00, 2.28)	0.0488	0.46	1.59	(1.25, 2.02)	0.0001
Detailed Diagnosis								
Bronchiectasis	0.06	1.06	(0.63, 1.78)	0.8329	0.19	1.21	(0.70, 2.08)	0.4965
Eisenmenger's syndrome	0.39	1.48	(0.69, 3.18)	0.3115	0.91	2.50	(0.34, 18.45)	0.3702
Lymphangioleiomyomatosis	-0.62	0.54	(0.22, 1.30)	0.1684	-1.52	0.22	(0.03, 1.57)	0.1310
Obliterative bronchiolitis (not retransplant)	-0.44	0.64	(0.26, 1.57)	0.3324	-1.21	0.30	(0.07, 1.21)	0.0900
Pulmonary fibrosis, not idiopathic	0.17	1.19	(0.80, 1.77)	0.3976	-0.07	0.93	(0.68, 1.28)	0.6549
Sarcoidosis, PA mean pressure greater than 30 mm Hg	-0.12	0.88	(0.48, 1.64)	0.6962	-0.04	0.96	(0.59, 1.54)	0.8575
Sarcoidosis, PA mean pressure of 30 mm Hg or less	-0.02	0.98	(0.44, 2.21)	0.9681	-0.14	0.87	(0.43, 1.77)	0.7019
Physiological reserve								
Age at transplant (years)	0.004	1.004	(1.00, 1.01)	0.4102				
Age greater than 45 years					0.02	1.02	(1.01, 1.04)	<.0001
Functional status, no assistance or some needed	-0.49	0.61	(0.52, 0.73)	<0.0001				
Functional status, no assistance					-0.19	0.83	(0.64, 1.07)	0.1435
Six-minute-walk less than 1200 feet					-0.00	1.00	(1.00, 1.00)	<.0001

Table 5: Covariates in the Current and Proposed Post-Transplant Survival Models – Severity

Covariates	Current LAS Post-Transplant Model (Cohort 11/1/2000 – 10/31/2003				Revised LAS Post-Transplant Model (Cohort 5/4/05 – 9/30/2008)			
	Coefficient	HR	95% CI	p-value	Coefficient	HR	95% CI	p-value
Severity								
Creatinine at transplant (per mg/dl)	0.06	1.06	(1.00, 1.13)	0.0364				
Creatinine at transplant (mg/dl) if candidate is at least 18 years of age					0.09	1.09	(0.99, 1.21)	0.0766
Increase in creatinine of at least 150% (in the prior 6 months, for candidates with maximum value of 1 mg/dl or greater)					0.77	2.16	(1.27, 3.67)	0.0043
FVC for groups B, D (percent predicted)	-0.003	0.997	(0.99, 1.00)	0.4726				
Pulmonary capillary wedge mean pressure of at least 20 mm Hg for Group D (per mm Hg)	0.03	1.03	(0.57, 1.86)	0.9123				
Continuous mechanical ventilation at transplant	0.31	1.37	(0.85, 2.21)	0.1999	0.61	1.84	(1.36, 2.48)	<.0001
Cardiac Index less than 2 L/min/m^2					0.35	1.42	(1.01, 2.00)	0.0442
Oxygen (O_2) at rest for group A (per L/min)					0.07	1.08	(1.03, 1.13)	0.0020
O_2 at rest for groups B, C, D (per L/min)					0.02	1.02	(0.99, 1.04)	0.1700

Work Cited:

1. American Thoracic Society. (2002). American Thoracic Society/European Respiratory Society International Multidisciplinary Consensus Classification of the Idiopathic Interstitial Pneumonias. *American Journal of Respiratory and Critical Care Medicine, 165, 277-304.*