

**SUPPLEMENTAL MATERIAL****Hospital-level Variation in Idiopathic Pulmonary Fibrosis Outcomes and Practices in the Intensive Care Unit**Divya Shankar MD<sup>1</sup>, Allan Walkey MD MSc<sup>1</sup>, Finn Hawkins MBBCh<sup>1</sup>, Daniel Peterson MS<sup>1</sup>, Anica Law MD MS<sup>1</sup>

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## Appendix 1: ICD-10 Codes and Premier Charge Codes Used in Study

### I. Supplemental Table 1: ICD-10 Codes Used for Inclusion Criteria

| Description  | ICD-10 Code   |
|--|---|
| Admission or principle diagnosis of IPF (idiopathic interstitial pneumonia, idiopathic pulmonary fibrosis) | J84.111, J84.112  |
| Admission or principle diagnosis of acute or chronic respiratory failure + IPF as secondary                | J96x + J84.11 OR J84.112  |
| Admission or principle diagnosis Pneumonia + IPF   | J09.x , J10.x, J11.x, J12.x, J13.x, J14.x, J15.x, J16.x, J17.x, J18.x, OR J22.x + J84.11 OR J84.112 |
| Admission or principle diagnosis ARDS +IPF   | J80 OR R0603 + J84.11 OR J84.112  |

### II. Supplemental Table 2: ICD-10 and Premier Charge Codes Used for Exclusion Criteria

| Diagnosis   | ICD-10 Code | Premier Charge Code |
|---|-------------|---------------------|
| Alveolar and parieto-alveolar conditions (Alveolar proteinosis, pulmonary alveolar microlithiasis, idiopathic pulmonary hemosiderosis, other alveolar and parieto-alveolar conditions)  | J84.0       |                     |
|   | J84.01      |                     |
|   | J84.01      |                     |
|   | J84.03      |                     |
|   | J84.09      |                     |
| Idiopathic non-specific interstitial pneumonitis  | J84.113     |                     |
| Acute interstitial pneumonitis  | J84.114     |                     |
| Respiratory bronchiolitis interstitial lung disease   | J84.115     |                     |
| Cryptogenic organizing pneumonia  | J84.116     |                     |
| Desquamative interstitial pneumonia   | J84.117     |                     |
| Lymphoid interstitial pneumonia   | J84.2       |                     |
| Lymphangioliomyomatosis   | J84.81      |                     |
| Adult pulmonary Langerhans cell histiocytosis   | J84.82      |                     |
| Surfactant mutations of the lung  | J84.83      |                     |
| Other interstitial lung diseases of childhood (Neuroendocrine cell hyperplasia of infancy, pulmonary interstitial glycogenosis, alveolar capillary dysplasia with vein misalignments, other interstitial diseases of childhood)   | J84.84      |                     |
|   | J84.841     |                     |
|   | J84.842     |                     |
|   | J84.843     |                     |
|   | J84.848     |                     |
| Sarcoidosis   | D86.0       |                     |
|   | D86.2       |                     |
| Hypersensitivity pneumonitis  | J67         |                     |
| Occupational lung injuries (Coalworker's , pneumoconiosis due to asbestos and other mineral fibers, pneumoconiosis due to dust containing silica, pneumoconiosis due to other inorganic dusts, airway disease due to specific organic dust, respiratory conditions due to inhalation of chemicals, gases, fumes and vapors, respiratory conditions due to other external agents ) | J60         |                     |
|   | J61         |                     |
|   | J62         |                     |
|   | J63         |                     |
|   | J66         |                     |
|   | J68         |                     |
|   | J70         |                     |
| Acute pulmonary manifestations due to radiation   | J70.0       |                     |
| Neurofibromatosis   | Q85.00      |                     |
| Lipidoses   | E75.6       |                     |
| Amyloidosis   | E85.9       |                     |
| Goodpasture's syndrome  | M31.0       |                     |
| Wegner's granulomatosis   | M31.31      |                     |
| Lupus, Lupus with pulmonary involvement   | M32         |                     |

|   |  |  |
|---|--|--|
|   | M32.13   |  |
| Polymyositis, Polymyositis with respiratory involvement   | M33.2<br>M33.21  |  |
| Dermatopolymyositis , Dermatopolymyositis with respiratory involvement  | M33.1<br>M33.11<br>M33.9<br>M33.91                             |  |
| Systemic sclerosis , Systemic sclerosis with lung involvement   | M34<br>M34.81  |  |
| Rheumatoid arthritis, Rheumatoid lung disease with rheumatoid arthritis   | M05<br>M05.1   |  |
| Pulmonary eosinophilia ( Pulmonary eosinophilia, not elsewhere classified, chronic eosinophilic pneumonia, acute eosinophilic pneumonia, eosinophilic asthma, other pulmonary eosinophilia, not elsewhere classified) | J82<br>J82.8<br>J82.81<br>J82.21<br>J82.83<br>J82.89           |  |
| Other systemic involvement of connective tissue, Sjogren's disease, other overlap syndromes   | M35<br>M35.0<br>M35.1  |  |
| Ankylosing spondylitis  | M45  |  |
| Tuberous sclerosis  | Q85.1  |  |
| Chronic Obstructive Pulmonary Disease (primary or admitting diagnosis)  | J40<br>J41.x<br>J42<br>J43.x<br>J44.x                          |  |
| Congestive Heart Failure (primary or admitting diagnosis)   | I11.0<br>I13.0<br>I50.1<br>I50.2x<br>I50.3x<br>I50.4x<br>I50.9 |  |
| Lung Transplant during days 0-2 of admission  | OBYK0Z0<br>OBYK0Z1<br>OBYL0Z0<br>OBYL0Z1<br>OBYM0Z0<br>OBYM0Z1 | 360490328510000<br>360490328520000<br>360490328530000<br>360490328540000<br>360490339350000<br>360360328510000<br>360360328520000<br>360360328530000<br>360360328540000<br>360360339350000 |

### III. Supplemental Table 3: ICD-10 Codes and Premier Codes Used to Identify Outcomes

| Outcome                | ICD-10 Code | Premier Code  |
|------------------------|-------------|---|
| Mechanical Ventilation |             | Charge Codes:<br>270270013950000<br>270270057050000<br>270270086600000<br>270270088900000 |

|                         |   |  |            |   |                  |  |
|-------------------------|---|--|------------|---|------------------|--|
|                         |   | 270270089300000<br>290290093620000<br>410412946560000<br>410412946560001<br>410412946570000<br>410412946570004<br>410412946570005<br>410412946570007<br>410412946570009<br>970976946560000<br>970976946570000  |            |   |                  |  |
| Noninvasive Ventilation |   | Charge Codes:<br>270270013920000<br>270270086700000<br>270270106380000<br>270270106390000<br>270270106400000<br>270270990130000<br>410412000060000<br>410412000070000<br>410412000080000<br>410412000090000<br>270270032500000<br>270270087800000<br>410412946600000<br>410412946600001<br>410412946600003<br>410412946600004<br>410412946600005<br>410412946600007<br>410412946600008<br>410412946600009  |            |   |                  |  |
| Corticosteroids         |   | Charge Codes:<br><table border="1"> <tr> <td>Prednisone</td> <td>250250054510000,<br/>250250054520000,<br/>250250054530000,<br/>250250054540000,<br/>250250054550000,<br/>250250054560000,<br/>250250054570000,<br/>250250054580000,<br/>250250054590000,<br/>250250054600000,<br/>250250054610000,<br/>250250054620000,<br/>250250068150000,<br/>250888017480000,<br/>250999014690000</td> </tr> <tr> <td>Methylprednisone</td> <td>250250042160000,<br/>250250042170000,<br/>250250042180000,<br/>250250042190000,</td> </tr> </table> | Prednisone | 250250054510000,<br>250250054520000,<br>250250054530000,<br>250250054540000,<br>250250054550000,<br>250250054560000,<br>250250054570000,<br>250250054580000,<br>250250054590000,<br>250250054600000,<br>250250054610000,<br>250250054620000,<br>250250068150000,<br>250888017480000,<br>250999014690000 | Methylprednisone | 250250042160000,<br>250250042170000,<br>250250042180000,<br>250250042190000, |
| Prednisone              | 250250054510000,<br>250250054520000,<br>250250054530000,<br>250250054540000,<br>250250054550000,<br>250250054560000,<br>250250054570000,<br>250250054580000,<br>250250054590000,<br>250250054600000,<br>250250054610000,<br>250250054620000,<br>250250068150000,<br>250888017480000,<br>250999014690000 |  |            |   |                  |  |
| Methylprednisone        | 250250042160000,<br>250250042170000,<br>250250042180000,<br>250250042190000,  |  |            |   |                  |  |

|  |  |               |  |  |
|--|--|---------------|--|--|
|  |  |               | 250250042200000,<br>250250042210000,<br>250250042220000,<br>250250042230000,<br>250250042240000,<br>250250042250000,<br>250250042260000,<br>250250042270000,<br>250250042280000,<br>250250042290000,<br>250250042300000,<br>250250042310000,<br>250250042320000,<br>250250042330000,<br>250250042340000,<br>250250042350000,<br>250888013660000,<br>250888013670000,<br>250888013680000,<br>250999011390000,<br>250999011400000,<br>250999011410000  |  |
|  |  | Dexamethasone | 250250017060000,<br>250250017070000,<br>250250017080000,<br>250250017090000,<br>250250017100000,<br>250250017110000,<br>250250017120000,<br>250250017130000,<br>250250017140000,<br>250250017150000,<br>250250017210000,<br>250250017220000,<br>250250017230000,<br>250250017240000,<br>250250017250000,<br>250250017260000,<br>250250017270000,<br>250250017280000,<br>250250017290000,<br>250250017300000,<br>250250017310000,<br>250250017320000,<br>250250017330000,<br>250250017340000,<br>250250017360000,<br>250250017370000,<br>250250017380000,<br>250250017390000,<br>250250017400000,<br>250250017410000, |  |

|  |  |                |  |  |
|--|--|----------------|--|--|
|  |  |                | 250250017420000,<br>250250017580000,<br>250250118750000,<br>250250120700000,<br>250888005850000,<br>250888005860000,<br>250999004750000  |  |
|  |  | Hydrocortisone | 250250031460000<br>250250031470000,<br>250250031480000,<br>250250031490000,<br>250250031510000,<br>250250031520000,<br>250250031530000,<br>250250031540000,<br>250250031550000,<br>250250031560000,<br>250250031570000,<br>250250031580000,<br>250250031590000,<br>250250031750000,<br>250250032030000,<br>250250032040000,<br>250250032050000,<br>250888010260000,<br>250888010270000,<br>250888010280000,<br>250888010290000,<br>250999008270000,<br>250999008280000,<br>250999008290000,<br>250999008300000 |  |
|  |  | Prednisolone   | 250250054170000,<br>250250054180000,<br>250250054190000,<br>250250054200000,<br>250250054210000,<br>250250054220000,<br>250250054230000,<br>250250054240000,<br>250250054250000,<br>250250054260000,<br>250250054270000,<br>250250054310000,<br>250250054320000,<br>250250054410000,<br>250250054420000,<br>250250054430000,<br>250250054640000,<br>250250109680000,<br>250250109690000,<br>250250109700000,   |  |

|  |  |                 |   |  |
|--|--|-----------------|---|--|
|  |  |                 | 250888017460000,<br>250888017470000,<br>250999014630000   |  |
|  |  | Betamethasone   | 250250006780000,<br>250250006790000,<br>250250006800000,<br>250250007050000,<br>250250007050000,<br>250888002280000,<br>250999001750000,<br>250999001760000   |  |
|  |  | Budesonide      | 250250101300000<br>250250122770000<br>250888002680000   |  |
|  |  | Cortisone       | 250250015760000,<br>250250015770000,<br>250250015780000,<br>250250015790000,<br>250250015800000,<br>250888004950000,<br>250888004960000   |  |
|  |  | Fludrocortisone | 250250026600000<br>250888008760000<br>250999006910000   |  |
| Immunomodulatory and Antioxidant Therapy |  | Charge Codes:   |   |  |
|  |  | Azathioprine    | 250250005170000,<br>250250005180000,<br>250250125660000,<br>250250125670000,<br>250888001780000,<br>250888001790000,<br>250999001320000   |  |
|  |  | Methotrexate    | 250636041640000,<br>250636041650000,<br>250636041660000,<br>250636041670000,<br>250636041680000,<br>250636041690000,<br>250636041700000,<br>250636041710000,<br>250636041720000,<br>250636041730000,<br>250636041740000,<br>250636041750000,<br>250636041760000,<br>250888013440000,<br>250888013450000,<br>250999011220000 |  |
|  |  | Mycophenolate   | 250250044960000,<br>250250044970000,<br>250250045200000,<br>250250101660000,  |  |

|       |  |  |   |  |
|-------|--|--|---|--|
|       |  |  | 250250109470000,<br>250250109480000,<br>250888014380000,<br>250888014390000,<br>250999011990000   |  |
|       |  | Rituximab  | 250250129690000,<br>250250131170000,<br>250250131180000,<br>250250131190000,<br>250250132000000,<br>250250132010000,<br>250250132020000,<br>250636057610000,<br>250636057620000,<br>250888018860000,<br>250888027490000,<br>250888027790000,<br>250999015830000   |  |
|       |  | Cyclophosphamide   | 250636016220000,<br>250636016230000,<br>250636016240000,<br>250636016250000,<br>250636016260000,<br>250636016270000,<br>250636016280000,<br>250636016290000,<br>250636016300000,<br>250636016310000,<br>250636016320000,<br>250636016330000,<br>250888005100000,<br>250888005110000,<br>250999004240000 |  |
|       |  | NAC  | 250250000790000,<br>250250121430000   |  |
| Death |  | Discharge Status Description:<br>20 – Expired<br>41 – Expired, in medical facility (for hospice) |   |  |

**IV. Supplemental Table 4: ICD-10 Codes and Premier-Charge Codes Used to Identify Patient-Level Covariables**

| Covariate   | ICD-10 Code      | Premier Charge Code |
|---|------------------|---------------------|
| Prior Admission with IPF as primary diagnosis within Premier database | J84.111, J84.112 |                     |



|  |   |   |
|--|---|---|
| Comorbidities<br>(present on<br>admission) | Alcohol<br>abuse  | F10.x, E52, G62.1, I42.6, K29.2x, K70.0,<br>K70.3x, K70.9, T51.x, Z71.4x, Z65.8   |
|  | Any tumor   | C00.x-C26.x, C30.x-C34.x, C37.x-C41.x,<br>C43.x, C45.x-C58.x, C60.x- C75.x, C76.x,<br>C81.x-94.3x, C94.8x, C95.x, C96.0-C96.4,<br>C96.9, C96.A, C96.Z, D45, D89, Z85.46                                   |
|  | Cardiac<br>arrhythmias  | I44.0, I44.1, I44.3x-145.2, I45.4-I45.8x,<br>I45.9, I47.x-I49.x, R00.0, R00.1, R00.8,<br>T82.1x, Z45.0x, Z95.0, Z95.810, Z95.818,<br>Z95.9  |
|  | Chronic<br>pulmonary<br>disease   | I26.0x, I27.2-I27.9, J40.x-I47.x, J60.x-<br>J67.x, J68.4, J70.1, J70.3  |
|  | Coagulopathy  | D65.x-D68.x, D69.1, D69.3- D69.6  |
|  | Complicated<br>diabetes   | E10.2x-E10.8, E11.2x-E11.8, E12.2x-<br>E12.8, E13.2x-E13.8x   |
|  | Congestive<br>heart failure   | A18.84, I09.9, I11.0, I13.0, I13.2, I25.5,<br>I42.x, I43.x, I50.x, I51.7, P29.0   |
|  | Deficiency<br>anemia  | D50.1-D50.9, D51.x-D53.x, D64.9   |
|  | Dementia  | F01.x-F03.x, F05, G30.x, G31.01, G31.09,<br>G31.1   |
|  | Fluid and<br>electrolyte<br>disorders   | E22.2, E86.x, E87.x   |
|  | Hemiplegia  | G04.1, G11.4, G80.1, G80.2, G81.x, G82.x,<br>G83.x  |
|  | HIV/AIDS  | B20.x   |
|  | Hypertension  | I10.x, I11.x-I13.x, I15.x, N26.2  |
|  | Liver disease   | B18.x, I85.x, I86.4, K70.x, K71.1, K71.3-<br>K71.5, K71.7, K72.1x, K72.9.x, K73.x-<br>K74.x, K75.4, K75.81, K76.0, , K76.2-<br>K76.9, Z48.23, Z94.4   |
|  | Metastatic<br>cancer  | C45.9, C77.x-C80.x  |
|  | Peripheral<br>vascular<br>disease   | E08.51, E08.52, E09.51, E09.52, E10.51,<br>E10.52, E11.51, E13.51, E13.52, I67.0,<br>I70.x, I71.x, I73.1, I73.8x, I73.9, I77.1,<br>I77.71- I77.74, I177.79, I79.x, K55.1,<br>K55.8, K55.9, Z95.82x, Z95.9 |
| Psychosis                                  | F20.x, F22-25.x, F28.x, F29.x, F30.x-F33.x,<br>F34.8, F34.9, F39.x, F44.89, F84.3 |   |
| Pulmonary<br>circulation<br>disorders      | I26.x, I27.x, I28.0, I28.8, I28.9   |   |

|  |                |  |  |
|--|----------------|--|--|
|  | Renal failure  | I12.0, I13.x, N03.2–N03.7, N05.2– N05.7, N18.x, N19.x, N25.0, Z39.32, Z48.22, Z49.0x, Z49.31, Z91.15, Z94.0, Z99.2 |  |
|  | Weight loss    | E40.x-E46.x, E64.0, R63.4, R64   |  |
| Acute organ dysfunction (present on admission) | Cardiovascular | R579   |  |
|  |                | R570   |  |
|  |                | R6521  |  |
|  |                | R571   |  |
|  |                | R578   |  |
|  |                | I951   |  |
|  |                | I952   |  |
|  |                | I953   |  |
|  |                | I9581  |  |
|  |                | I9589  |  |
|  |                | I959   |  |
|  | Respiratory    | J96  |  |
|  |                | R0603  |  |
|  |                | R092   |  |
|  |                | 5A1935Z  |  |
|  |                | 5A1945Z  |  |
|  |                | 5A1955Z  |  |
|  | Neurologic     | G9340  |  |
|  |                | G9341  |  |
|  |                | G9349  |  |
|  |                | I6783  |  |
|  |                | F05  |  |
|  |                | F062   |  |
|  |                | F060   |  |
|  |                | F0630  |  |
|  |                | F0631  |  |
|  |                | F0632  |  |
|  |                | F0633  |  |
|  |                | F0634  |  |
|  |                | F064   |  |
|  |                | F061   |  |
|  |                | F53  |  |
|  |                | F068   |  |
|  | G931           |  |  |
| Hematologic                                    | D6959          |  |  |

|                                       |         |       |   |
|---------------------------------------|---------|-------|---|
|                                       |         | D6951 |   |
|                                       |         | D696  |   |
|                                       |         | D65   |   |
|                                       |         | D688  |   |
|                                       |         | D689  |   |
|                                       | Hepatic | K7200 |   |
|                                       |         | K7201 |   |
|                                       |         | K762  |   |
|                                       |         | K763  |   |
|                                       | Renal   | N170  |   |
|                                       |         | N171  |   |
|                                       |         | N172  |   |
|                                       |         | N178  |   |
|                                       |         | N179  |   |
| MV within first 24 hours of admission |         |       | 270270013950000<br>270270057050000<br>270270086600000<br>270270088900000<br>270270089300000<br>290290093620000<br>410412946560000<br>410412946560001<br>410412946570000<br>410412946570004<br>410412946570005<br>410412946570007<br>410412946570009<br>970976946560000<br>970976946570000 |

**V. Supplemental Table 5: ICD-10 Codes and Premier-Charge Codes Used to Identify Hospital-Level Covariables**

| Covariate              | Definition   | ICD-10 Code  | Premier Codes   |
|------------------------|--|--|---|
| Lung Transplant Center | Centers with any charge for an ICD-10 procedure or Premier   | OBYK0Z0<br>OBYK0Z1<br>OBYL0Z0<br>OBYL0Z1<br>OBYM0Z0<br>OBYM0Z1 | Charge Codes:<br>360490328510000<br>360490328520000<br>360490328530000<br>360490328540000<br>360490339350000<br>360360328510000<br>360360328520000<br>360360328530000<br>360360328540000<br>360360339350000 |
| Safety-Net Hospital    | Hospitals in highest quartile per US region, ranked by proportion of Medicaid and uninsured patients |  | Standard payor codes:<br>330<br>340<br>350  |

|  |  |  |     |
|--|--|--|-----|
|  |  |  | 390 |
|  |  |  | 400 |
|  |  |  | 410 |

## Appendix 2: Formulas Used for Hierarchical Modelling

### I. Median Odds Ratio

$$MOR = \exp[(\sqrt{2 \times V_A}) \times 0.6745] \approx \exp(0.95\sqrt{V_A})$$

$V_A$ = area level variance

### II. Intraclass Correlation Coefficient

$$ICC = \frac{V_A}{(V_A + 3.29)}$$

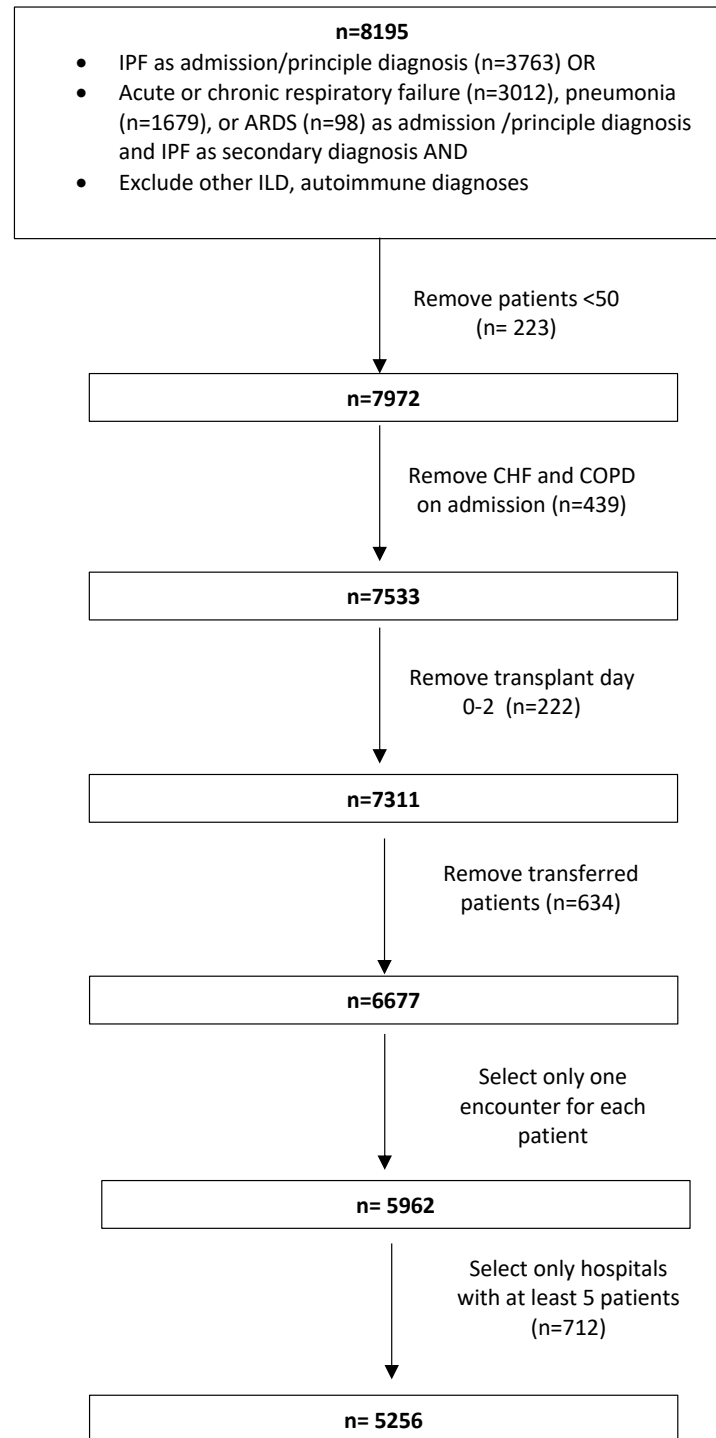
$V_A$ = area level variance

### III. Proportional Change in Variance

$$PCV = \frac{(V_A - V_B)}{(V_A)} \times 100$$

$V_A$ = variance of the initial model

$V_B$ = variance of the model with more terms

**Appendix 3: Consort Diagram**

**Appendix 4: Associations between exposures and outcomes in severe IPF exacerbations****I. Supplemental Table 1: Adjusted Odds Ratios for Practices in Severe IPF Exacerbations**

| Variable  | Mechanical Ventilation<br>aOR (95% CI) | Noninvasive<br>Ventilation<br>aOR (95% CI) | Corticosteroid<br>aOR (95% CI)** | Adjunctive<br>Medications<br>aOR (95% CI)** |
|---|--|--|----------------------------------|---|
| Intercept   | 0.11 (0.07-0.18)                       | 0.41 (0.27-0.61)                           | 3.69 (2.24-6.09)                 | 0.03 (0.01-0.07)                            |
| Lung Transplant Center                                    | 0.91 (0.46-1.81)                       | 0.63 (0.36-1.13)                           | 0.56 (0.33-0.96)                 | 3.70 (2.02-6.77)                            |
| Age   | 0.69 (0.63-0.76)                       | 0.82 (0.76-0.89)                           | 0.69 (0.62-0.77)                 | 0.54 (0.46-0.64)                            |
| Female (ref=Male)   | 0.82 (0.70-0.97)                       | 0.89 (0.78-1.01)                           | 0.97 (0.81-1.16)                 | 1.53 (1.17-2.01)                            |
| Asian (ref=white)   | 1.15 (0.69-1.90)                       | 1.11 (0.74-1.65)                           | 1.05 (0.62-1.78)                 | 1.62 (0.84-3.10)                            |
| Black (ref=white)   | 1.05 (0.77-1.44)                       | 1.01 (0.77-1.31)                           | 0.90 (0.63-1.29)                 | 0.89 (0.53-1.48)                            |
| Other Race (ref=white)                                    | 1.34 (0.95-1.87)                       | 1.2 (0.91-1.58)                            | 1.00 (0.69-1.46)                 | 1.13 (0.69-1.88)                            |
| Unknown Race (ref=white)                                  | 1.07 (0.62-1.83)                       | 1.02 (0.66-1.60)                           | 0.85 (0.49-1.48)                 | 0.61 (0.23-1.65)                            |
| Hispanic (ref= non-Hispanic)                              | 1.20 (0.86-1.68)                       | 1.09 (0.84-1.42)                           | 1.07 (0.76-1.51)                 | 1.16 (0.69-1.96)                            |
| Unknown Hispanic (ref= non-Hispanic)                      | 1.15 (0.77-1.72)                       | 1.26 (0.91-1.73)                           | 1.09 (0.73-1.62)                 | 1.30 (0.72-2.35)                            |
| Non-teaching hospital (ref=teaching hospital)             | 0.64 (0.48-0.84)                       | 1.05 (0.84-1.32)                           | 1.29 (1.01-1.64)                 | 0.83 (0.59-1.15)                            |
| Midwest Region (ref=South)                                | 0.61 (0.44-0.86)                       | 0.92 (0.71-1.20)                           | 0.88 (0.66-1.18)                 | 0.69 (0.44-1.07)                            |
| Northeast Region (ref=South)                              | 0.89 (0.59-1.36)                       | 1.06 (0.76-1.49)                           | 0.96 (0.66-1.38)                 | 1.16 (0.71-1.91)                            |
| West Region (ref=South)                                   | 0.92 (0.64-1.33)                       | 0.67 (0.50-0.91)                           | 0.93 (0.67-1.3)                  | 1.12 (0.72-1.75)                            |
| Medicaid or uninsured (ref=private)                       | 0.93 (0.64-1.36)                       | 0.88 (0.64-1.21)                           | 1.09 (0.69-1.72)                 | 0.55 (0.30-1.02)                            |
| Medicare (ref=private)                                    | 0.94 (0.73-1.21)                       | 0.98 (0.80-1.21)                           | 1.49 (1.11-1.99)                 | 1.01 (0.69-1.49)                            |
| Other insurance (ref=private)                             | 1.02 (0.61-1.68)                       | 0.93 (0.61-1.42)                           | 1.47 (0.80-2.71)                 | 0.81 (0.34-1.91)                            |
| Acute organ dysfunction: cardiovascular                   | 3.26 (2.56-4.17)                       | 1.03 (0.83-1.29)                           | 0.53 (0.40-0.71)                 | 0.67 (0.40-1.14)                            |
| Acute organ dysfunction: respiratory                      | 1.78 (1.47-2.15)                       | 1.14 (0.98-1.34)                           | 1.21 (0.97-1.52)                 | 1.10 (0.78-1.53)                            |
| Acute organ dysfunction: neurologic                       | 2.85 (2.07-3.91)                       | 1.02 (0.77-1.35)                           | 0.59 (0.42-0.84)                 | 1.59 (0.90-2.81)                            |
| Acute organ dysfunction: hematologic                      | 0.82 (0.40-1.72)                       | 1.13 (0.60-2.12)                           | 0.41 (0.14-1.22)                 | 0.31 (0.09-0.99)                            |
| Acute organ dysfunction: hepatic                          | 5.87 (1.39-24.85)                      | 0.59 (0.18-1.91)                           | 2.82 (0.34-23.19)                | 0.98 (0.11-8.86)                            |
| Acute organ dysfunction: renal                            | 1.52 (1.21-1.90)                       | 1.26 (1.04-1.52)                           | 1.06 (0.82-1.37)                 | 1.21 (0.82-1.78)                            |
| Mechanical ventilation within first 24 hours of admission | *                                      | *  | 1.12 (0.81-1.55)                 | 1.31 (0.84-2.03)                            |
| Safety-net hospital in region                             | 1.28 (0.95-1.73)                       | 1.07 (0.84-1.37)                           | 0.80 (0.62-1.03)                 | 0.57 (0.38-0.84)                            |
| Comorbidity: Alcohol Abuse                                | 0.88 (0.49-1.58)                       | 1.11 (0.69-1.80)                           | 0.63 (0.34-1.16)                 | 0.68 (0.23-1.99)                            |
| Comorbidity: Any tumor                                    | 1.28 (0.92-1.77)                       | 1.20 (0.92-1.56)                           | 0.83 (0.58-1.18)                 | 0.46 (0.21-0.99)                            |
| Comorbidity: cardiac arrhythmia                           | 1.14 (0.96-1.36)                       | 1.26 (1.10-1.44)                           | 1.07 (0.89-1.29)                 | 1.13 (0.84-1.53)                            |
| Comorbidity: chronic pulmonary disease                    | 1.07 (0.88-1.30)                       | 1.29 (1.11-1.50)                           | 1.52 (1.24-1.86)                 | 0.64 (0.46-0.89)                            |

|  |                  |                  |                  |                   |
|--|------------------|------------------|------------------|-------------------|
| Comorbidity: coagulopathy                    | 1.78 (0.91-3.51) | 1.14 (0.64-2.05) | 2.16 (0.76-6.18) | 2.20 (0.81-5.99)  |
| Comorbidity: complicated diabetes            | 1.36 (1.11-1.66) | 1.14 (0.97-1.35) | 1.23 (0.97-1.56) | 1.09 (0.78-1.52)  |
| Comorbidity: congestive heart failure        | 1.23 (1.03-1.46) | 1.23 (1.08-1.41) | 1.03 (0.85-1.24) | 0.90 (0.67-1.20)  |
| Comorbidity: deficiency anemia               | 1.32 (1.07-1.62) | 1.06 (0.90-1.25) | 1.11 (0.88-1.41) | 1.34 (0.95-1.87)  |
| Comorbidity: dementia                        | 0.87 (0.60-1.25) | 0.96 (0.72-1.27) | 0.78 (0.56-1.09) | 1.01 (0.50-2.03)  |
| Comorbidity: fluid and electrolyte disorders | 1.44 (1.22-1.69) | 1.28 (1.13-1.46) | 1.32 (1.09-1.59) | 1.22 (0.93-1.60)  |
| Comorbidity: HIV/AIDS                        | 0.43 (0.08-2.42) | 0.21 (0.04-1.22) | 0.90 (0.10-7.71) | ***               |
| Comorbidity: hemiplegia                      | 1.92 (0.55-6.71) | 2.25 (0.67-7.55) | 0.85 (0.18-4.06) | 2.62 (0.51-13.35) |
| Comorbidity: hypertension                    | 1.10 (0.92-1.32) | 1.07 (0.93-1.23) | 1.09 (0.90-1.33) | 1.08 (0.80-1.46)  |
| Comorbidity: liver disease                   | 1.19 (0.82-1.73) | 1.05 (0.76-1.44) | 0.85 (0.55-1.31) | 1.35 (0.74-2.48)  |
| Comorbidity: metastatic cancer               | 0.61 (0.34-1.09) | 0.88 (0.56-1.39) | 0.92 (0.50-1.68) | 1.14 (0.36-3.64)  |
| Comorbidity: peripheral vascular disease     | 1.02 (0.77-1.34) | 0.93 (0.75-1.16) | 0.86 (0.64-1.16) | 0.85 (0.50-1.44)  |
| Comorbidity: psychosis                       | 0.90 (0.73-1.11) | 1.18 (0.99-1.39) | 1.14 (0.89-1.45) | 0.84 (0.59-1.21)  |
| Comorbidity: pulmonary circulatory disorder  | 1.06 (0.88-1.27) | 1.09 (0.94-1.26) | 0.98 (0.80-1.22) | 1.32 (0.94-1.84)  |
| Comorbidity: renal failure                   | 0.72 (0.58-0.91) | 0.90 (0.76-1.08) | 0.71 (0.56-0.89) | 1.54 (1.06-2.22)  |
| Comorbidity: weight loss                     | 1.44 (1.16-1.79) | 1.22 (1.02-1.45) | 0.94 (0.74-1.19) | 0.84 (0.56-1.27)  |
| Prior IPF admission                          | 0.69 (0.42-1.13) | 0.70 (0.48-1.01) | 1.40 (0.81-2.42) | 1.11 (0.55-2.23)  |

\* Mechanical ventilation present on admission was not included as a covariable in model for use of mechanical ventilation

\*\*Patients who received a transplant during index hospitalization were not included in model for steroids or immunosuppressive/antioxidant use

\*\*\*HIV/AIDS was removed as a covariate from the immunosuppressive/antioxidant model to allow for model convergence



## II. Supplemental Table 2: Adjusted Odds Ratios for Mortality in Severe IPF Exacerbations

| Variable  | Mortality (all patients) aOR (95% CI) | Mortality (MV patients) aOR (95% CI) |
|---|---------------------------------------|--------------------------------------|
| Intercept   | 0.12 (0.08-0.20)                      | 1.1 (0.51-2.37)                      |
| Lung Transplant Center                                    | 0.81 (0.49-1.33)                      | 0.43 (0.22-0.85)                     |
| Age   | 0.97 (0.88-1.06)                      | 1.06 (0.89-1.27)                     |
| Female (ref=Male)   | 0.89 (0.76-1.04)                      | 0.81 (0.61-1.08)                     |
| Asian (ref=white)   | 1.19 (0.76-1.86)                      | 0.51 (0.21-1.21)                     |
| Black (ref=white)   | 0.77 (0.56-1.06)                      | 0.86 (0.51-1.43)                     |
| Other Race (ref=white)                                    | 1.02 (0.74-1.42)                      | 0.81 (0.47-1.41)                     |
| Unknown Race (ref=white)                                  | 1.72 (1.05-2.80)                      | 3.17 (1.17-8.58)                     |
| Hispanic (ref= non-Hispanic)                              | 1.38 (1.00-1.91)                      | 1.49 (0.88-2.54)                     |
| Unknown Hispanic (ref= non-Hispanic)                      | 1.07 (0.74-1.56)                      | 1.06 (0.57-1.97)                     |
| Non-teaching hospital (ref=teaching hospital)             | 0.73 (0.59-0.89)                      | 0.80 (0.57-1.11)                     |
| Midwest Region (ref=South)                                | 0.93 (0.72-1.20)                      | 1.20 (0.79-1.83)                     |
| Northeast Region (ref=South)                              | 1.22 (0.89-1.67)                      | 1.33 (0.79-2.24)                     |
| West Region (ref=South)                                   | 1.14 (0.86-1.50)                      | 1.13 (0.72-1.77)                     |
| Medicaid or uninsured (ref=private)                       | 1.22 (0.84-1.76)                      | 1.18 (0.63-2.22)                     |
| Medicare (ref=private)                                    | 0.89 (0.69-1.15)                      | 0.98 (0.63-1.52)                     |
| Other insurance (ref=private)                             | 1.33 (0.83-2.15)                      | 0.66 (0.28-1.55)                     |
| Acute organ dysfunction: cardiovascular                   | 1.69 (1.33-2.14)                      | 1.79 (1.23-2.59)                     |
| Acute organ dysfunction: respiratory                      | 1.39 (1.16-1.68)                      | 1.40 (1.02-1.92)                     |
| Acute organ dysfunction: neurologic                       | 1.56 (1.14-2.13)                      | 1.08 (0.68-1.74)                     |
| Acute organ dysfunction: hematologic                      | 1.37 (0.67-2.83)                      | 1.35 (0.39-4.67)                     |
| Acute organ dysfunction: hepatic                          | 4.00 (1.05-15.25)                     | 4.00 (0.76-21.08)                    |
| Acute organ dysfunction: renal                            | 1.48 (1.20-1.82)                      | 1.27 (0.88-1.82)                     |
| Mechanical ventilation within first 24 hours of admission | 2.59 (2.05-3.27)                      | 0.49 (0.37-0.66)                     |
| Safety-net hospital in region                             | 0.82 (0.65-1.03)                      | 0.88 (0.62-1.25)                     |
| Comorbidity: Alcohol Abuse                                | 1.15 (0.66-2.00)                      | 0.87 (0.34-2.26)                     |
| Comorbidity: any tumor                                    | 1.38 (1.02-1.86)                      | 1.05 (0.60-1.84)                     |
| Comorbidity: cardiac arrhythmia                           | 1.32 (1.12-1.55)                      | 0.89 (0.66-1.19)                     |
| Comorbidity: chronic pulmonary disease                    | 0.87 (0.72-1.05)                      | 0.96 (0.68-1.35)                     |
| Comorbidity: coagulopathy                                 | 1.08 (0.55-2.11)                      | 0.91 (0.29-2.89)                     |

|  |                  |                   |
|--|------------------|-------------------|
| Comorbidity: complicated diabetes            | 0.94 (0.77-1.15) | 1.21 (0.87-1.68)  |
| Comorbidity: congestive heart failure        | 1.09 (0.92-1.28) | 0.94 (0.70-1.26)  |
| Comorbidity: deficiency anemia               | 0.94 (0.77-1.15) | 0.95 (0.67-1.33)  |
| Comorbidity: dementia                        | 0.67 (0.47-0.96) | 0.36 (0.19-0.71)  |
| Comorbidity: fluid and electrolyte disorders | 1.36 (1.17-1.59) | 1.07 (0.80-1.42)  |
| Comorbidity: HIV/AIDS                        | 0.48 (0.05-4.45) | 0.43 (0.02-10.01) |
| Comorbidity: hemiplegia                      | 2.66 (0.81-8.72) | 1.31 (0.20-8.44)  |
| Comorbidity: hypertension                    | 1.12 (0.95-1.34) | 0.94 (0.68-1.29)  |
| Comorbidity: liver disease                   | 0.88 (0.60-1.30) | 0.63 (0.34-1.15)  |
| Comorbidity: metastatic cancer               | 0.80 (0.47-1.35) | 0.56 (0.21-1.53)  |
| Comorbidity: peripheral vascular disease     | 0.97 (0.74-1.26) | 0.62 (0.38-1.00)  |
| Comorbidity: psychosis                       | 0.98 (0.80-1.20) | 0.88 (0.61-1.27)  |
| Comorbidity: pulmonary circulatory disorder  | 1.42 (1.19-1.70) | 1.09 (0.79-1.51)  |
| Comorbidity: renal failure                   | 0.82 (0.67-1.02) | 0.95 (0.65-1.39)  |
| Comorbidity: weight loss                     | 1.61 (1.32-1.96) | 1.44 (0.99-2.08)  |
| Prior IPF admission                          | 0.51 (0.29-0.88) | 0.28 (0.10-0.82)  |

**Appendix 5: Sensitivity Analysis with Primary or Admitting Diagnosis of IPF (J84.111 or J84.112, n=2382 patients)**

| Analysis                       | Number of Patients (%) | Median rate (IQR)  | ICC (95% CI)       |
|--------------------------------|------------------------|--------------------|--------------------|
| Mechanical Ventilation         | 364 (15)               | 10.7% (6.4-18.3%)  | 15.7% (14.0-17.4%) |
| Noninvasive Ventilation        | 879 (37)               | 34.8% (25.3-46.3%) | 14.2% (12.0-15.5%) |
| Corticosteroid                 | 2040 (87)              | 90.8 (83.7-94.8%)  | 12.9% (11.2-13.5%) |
| Immunosuppression/Antioxidants | 124 (5.3)              | 3.1% (1.6-5.7%)    | 10.2% (8.6%-11.7%) |
| Mortality                      | 394 (17)               | 12.7% (8.2%-20.1%) | 9.2% (7.6%-10.6%)  |