Lung transplant 101
*a primer for ICU*

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Objectives

- Review the indications lung transplantation
- Learn what they do in the OR
- Learn how to recognize and manage the unique post-operative complications
- Learn how to recognize and treat the long-term complications
Lung transplantation
NUMBER OF LUNG TRANSPLANTS REPORTED BY YEAR AND PROCEDURE TYPE

ISHLT

Adult Lung Transplants
Indications for Single Lung Transplants
(Transplants: January 1995 – June 2013)

*Other includes:
- Pulmonary Fibrosis, Other: 4.4%
- Bronchiectasis: 0.4%
- Sarcoidosis: 1.8%
- Connective Tissue Disease: 1.2%
- OB (non-Retx): 0.7%
- LAM: 0.9%
- Congenital Heart Disease: 0.4%
- Miscellaneous: 1.7%
Adult Lung Transplants
Indications for Bilateral/Double Lung Transplants
(Transplants: January 1995 – June 2013)

*Other includes:
- Pulmonary Fibrosis, Other: 3.6%
- Bronchiectasis: 4.0%
- Sarcoidosis: 2.9%
- Connective Tissue Disease: 1.5%
- OB (non-Retx): 1.3%
- LAM: 1.1%
- Congenital Heart Disease: 1.1%
- Miscellaneous: 2.0%
Adult and Pediatric Lung Transplants
Donor Age by Year (Transplants: January 1987 – June 2013)
Normothermic Ex Vivo Lung Perfusion in Clinical Lung Transplantation

(A) PaO₂:FiO₂ Ratio (mm Hg) vs Hours of EVLP
(B) Pulmonary Vascular Resistance (dynes·sec·cm⁻⁵) vs Hours of EVLP
(C) Dynamic Compliance (mL/cm H₂O) vs Hours of EVLP
(D) Peak Inspiratory Pressure (cm H₂O) vs Hours of EVLP
Adult and Pediatric Lung Transplants
Average Center Volume by Location
(Transplants: January 2008 – June 2013)

Number of Centers

Average number of lung transplants per year

- Other
- North America
- Europe

<table>
<thead>
<tr>
<th>Category</th>
<th>1-4</th>
<th>5-9</th>
<th>10-19</th>
<th>20-29</th>
<th>30-39</th>
<th>40-49</th>
<th>50+</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>14</td>
<td>10</td>
<td>16</td>
<td>12</td>
<td>9</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Europe</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
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Rules

- Generic surgical / medical complications
- Specific graft / surgical issues
- They still have their underlying disease (e.g. CF, autoimmune disease)
- They have comorbidities
## Antimicrobial prophylaxis

<table>
<thead>
<tr>
<th></th>
<th>Lung</th>
<th>Liver</th>
<th>Heart</th>
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</thead>
<tbody>
<tr>
<td><strong>CMV</strong></td>
<td><strong>CMV positivity or mismatch</strong></td>
<td><strong>CMV positivity or mismatch</strong></td>
<td><strong>CMV positivity or mismatch</strong></td>
</tr>
<tr>
<td><strong>PJP</strong></td>
<td><strong>All recipients</strong></td>
<td><strong>All recipients</strong></td>
<td><strong>All recipients</strong></td>
</tr>
<tr>
<td><strong>Bacterial</strong></td>
<td><strong>Empiric broad spectrum until cultures from transplant, the tailor</strong></td>
<td><strong>Routine surgical prophylaxis</strong></td>
<td><strong>Routine surgical prophylaxis; if donor + for infection then pathogen specific empiric coverage; if chronically infected device pre-transplant, empiric coverage based upon pathogen</strong></td>
</tr>
<tr>
<td></td>
<td><em>(CF: based upon previous colonizing organisms and resistance patterns)</em></td>
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<tr>
<td><strong>Fungal</strong></td>
<td><strong>If previously colonized</strong></td>
<td><strong>Consider if risk factors</strong>*</td>
<td><strong>Oral candida prophylaxis</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Oral candida prophylaxis</strong></td>
<td><strong>Oral candida prophylaxis</strong></td>
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*Risk factors: > 2 OR, retransplant, renal failure, large number of blood product (>40 units)*
Modulation of immune function

**Goals**
- Reduce humoral mediated immunity
- Reduce cell mediated rejection
- Reduce chronic lung dysfunction

**Risks**
- Infections
- Cancers
- PTLD
- Non-immune mediated organ injury
Phases of immunosuppression

- Induction phase
- Maintenance phase
- Rejection
- Infection
- PTLD
Patient develops progressive hypoxemia 12 hours after returning to the ICU following SLTx for emphysema.
Patient develops hypoxemia 6 hours after returning to the ICU following SLTx for emphysema. The most likely cause for this x-ray is...

1. Acute rejection
2. Primary graft dysfunction
3. Donor acquired pneumonia
4. Pulmonary venous anastamotic narrowing
5. None of the above
Organs subject to injury during brain death and pre-brain death patient management

- Activate a central pathways of inflammation

- Hypotension
- Trauma
- Pneumonia
- Aspiration
- Cold Ischemia

Activation of Inflammation

4-8 Degrees Celsius

Ischemia-reperfusion induced lung injury

Morbidity and Mortality
Patient develops hypoxemia 6 hours after returning to the ICU following SLTx for emphysema. The most likely cause for this x-ray is…

1. Acute rejection
2. Primary graft dysfunction
3. Donor acquired pneumonia
4. Pulmonary venous anastamotic narrowing
5. None of the above
Primary graft dysfunction

- Lung protective strategy
- Minimize lung water
- Reduce PA pressures
Day 5 your patient reduced LOC and has a generalized complex seizure. Initial investigations should include all of the following except

1. Serum ammonia level
2. CSA level
3. EEG
4. CT scan
5. Lumbar puncture
### Early causes of reduced LOC post organ transplantation

<table>
<thead>
<tr>
<th>Cause</th>
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<tbody>
<tr>
<td>Cerebral oedema (fulminant liver failure)</td>
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<tr>
<td>Nonconvulsive status</td>
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<tr>
<td>Hypoactive delirium</td>
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<tr>
<td>Metabolic (sodium, renal failure, ammonia)</td>
</tr>
<tr>
<td>Medication (sedatives, narcotics, CNI)</td>
</tr>
<tr>
<td>Sepsis</td>
</tr>
<tr>
<td>Structural (bleed, stroke, post-bypass)</td>
</tr>
</tbody>
</table>
Day 5 develops reduced LOC and has a generalized complex seizure. Initial investigations should include all of the following except

1. Serum ammonia level
2. CSA level
3. EEG
4. CT scan
5. Lumbar puncture
Day 11 post transplant she develops worsening oxygenation, fever and new focal opacity on CXR. Empiric antibiotics should cover

1. Enteric gram negative bacteria
2. Cytomegalovirus
3. Aspergillus
4. PJP
5. All of the above
C difficile
Day 11 post transplant
Worsening oxygenation, fever and new focal opacity on CXR. Empiric therapy should cover

1. **Enteric gram negative bacteria**
2. **Cytomegalovirus**
3. **Aspergillus**
4. **PJP**
5. **All of the above**
Late complications

- Infection
  - Bacterial
  - Viral
  - Fungal
- Malignancy
  - PTLD
- Renal failure
- Diabetes
ADULT LUNG TRANSPLANTS
Kaplan-Meier Survival by Diagnosis
(Transplants: January 1990 - June 2010)

HALF-LIFE
Alpha-1: 6.2 Years; CF: 7.5 Years; COPD: 5.3 Years; IPF: 4.4 Years; IPAH: 5.0 Years; Sarcoidosis: 5.3 Years

All comparisons with Alpha-1 and CF are statistically significant at < 0.05

COPD vs. IPF: p < 0.0001

ISHLT
Chronic lung allograft dysfunction (CLAD)

- Obliterative bronchiolitis
- Restrictive allograft dysfunction
Bronchiolitis pattern in 41-year-old male double lung transplant recipient with bronchiolitis obliterans syndrome