Laryngeal Bioreactor
Mid-semester Presentation

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Outline

• Problem motivation
• Background- anatomy of larynx
• Previous work & current devices
• Design Specifications
• Design Alternatives
• Design Matrix
• Final Design
• Future Work
Problem Motivation

• Potential clinical benefits:

• Larynx transplant [1,2]
  – Few (2) have been successful → remove need for immunosuppressants [2]
  – Laryngeal cancer
    • May require laryngectomy
  – Bilateral laryngeal paralysis

• Adapt to tools and resources available
Background- Larynx

http://www.fpnotebook.com/_media/entLarynxAnteriorVesselsGrayBB1174.gif
http://www.edoctoronline.com/media/19/photos_040EAD64-F02E-4068-A04D-1B1C94AFDB10.jpg
Previous Work & Current Devices

• Whole organs grown in bioreactors:
  – Heart, lung [3]
• Implantation of trachea [4]
• Matrix + stem cells + media + bioreactor → organ

• No laryngeal bioreactor commercially available

http://www.businessinsider.com/lab-grown-organs-2012-8?op=1
Asnagni 2009 Biomaterials
Design Specifications

- Sterilizable or replaceable components
- Continuous function for days at a time
- Operational in incubator environment
- Single unit for decellularization and recellularization
- Physiological pressure values
- Easy access to larynx
- Separate environment for lumen
  - Air exposure
Design Alternative 1

- Removable top, support tube
- Dimensions: 10x10x20 cm
- Inflatable balloon
  - Two separate culture environments
Design Alternative 1- Spray

• 2 Environments:
  • Outside
    – Added manually
    – Media is perfused through vasculature system
  • Inside
    – Media sprayed through nozzle
    – Air and media
Design Alternative 2 - Fill-Refill

- 2 Environments:
  - Outside
    - Added manually
    - Media is perfused through vasculature system
  - Inside
    - Inner lumen will be full of media or air
    - Automated by a pump
Design Alternative 3- Rotation

• Rotating
  – Inner lumen half full with media

• Larynx exterior is completely surrounded by media

• Perfusion of media through the vasculature
## Design Matrix

<table>
<thead>
<tr>
<th>Weight</th>
<th>Design 1-Spray</th>
<th>Design 2-Fill-Refill</th>
<th>Design 3-Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>0.1</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td><strong>Decellularization/recellularization</strong></td>
<td>0.3</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td><strong>Physiological accuracy</strong></td>
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<td>6</td>
<td>8</td>
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<tr>
<td><strong>Adaptability</strong></td>
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<td>9</td>
<td>9</td>
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<tr>
<td><strong>Maintenance</strong></td>
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<tr>
<td><strong>Total</strong></td>
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<td>0.75</td>
<td>0.80</td>
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</tbody>
</table>
Final Design
Future Work

• Test sealing techniques for separation of lumen
• Obtain materials
• Assemble prototype
• Test prototype under expected conditions
• Modify prototype based on results
Acknowledgments

• Dr. Thomas Yen and Dr. Nathan Welham
References


• Images:
  – Laryngeal Vasculature: http://www.fpnotebook.com/_media/entLarynxAnteriorVesselsGrayBB1174.gif
  – Anatomy of larynx: http://www.edoctoronline.com/media/19/photos_040EAD64-F02E-4068-A04D-1B1C94AFDB10.jpg
  – Pump image: http://www.coleparmer.com/Product/Masterflex_L_S_Easy_Load_II_pump_head_for_precision_tubing_fixed_occlusion_CRS_rotor/EW-77200-50
Questions?