Science Panel Discussion presentation: "Data Management in Biomedical Engineering: Needs and Implementation"

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Data Management in Biomedical Engineering: Needs and Implementation

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Biomedical Engineering

- Discipline that improves human health through cross-disciplinary activities that integrate principles from:
  - Engineering
  - Mathematics
  - material science
  - computational sciences
  - life sciences
  - clinical practice

- Fastest growing engineering field
- 3rd fastest growing occupation (US Labor Dept)
Heart Disease

- Coronary heart disease can lead to ischemia
  - Affects ~ 16 million Americans
- Heart attack (myocardial infarction) results in muscle tissue death
  - Affects ~ 8 million Americans
- Heart does not repair itself
- Cell therapy may improve cardiac function
- Methods to deliver cell therapy are inefficient

Loading Cells on Biological Sutures

1.98 mm I.D. Silastic Tubing

27G Syringe Needle

Suture Needle

Side Clamp

Biological Suture
Stem Cells on Microthreads
Efficient Cell Delivery with Biological Sutures

- Microthread Implantation (n = 5)
- Intramyocardial Injection (n = 4)

Delivery efficiency %

<table>
<thead>
<tr>
<th>Method</th>
<th>Cell Delivery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microthread Implantation</td>
<td>80.0 ± 5</td>
</tr>
<tr>
<td>Intramyocardial Injection</td>
<td>20.0 ± 3</td>
</tr>
</tbody>
</table>

* p < 0.05
Biological Sutures Delivery
Cells to the Beating Heart

• Histology images (400x)
Data Collection

- High frame rate (~250 fps) videos
  - Target: >=30 Frames per cardiac cycle
- 8-bit grayscale
- Speckle application
  - Silicon carbide nanoparticles with retro-reflective beads
  - Increases light intensity distribution
HDM Can Determine Regional Mechanical Function in the Infarcted Rat Heart
Typical Data Sets for One Experiment – Pre-Experiment

- Pre-operative record
  - Weight, heart rate, oxygen saturation
  - Drug dosage
- Images of cells loaded on suture
- Time of procedure
  - Incisions
  - Cell delivery
- Images of cell delivery
Typical Data Sets for One Experiment – Raw Data

- Images of Heart (mechanical function)
  - 1,000 images/data set
  - ~10 data sets/experiment
- A/D inputs (correspond to images)
- General images
- Histological sections
  - ~3/slide
  - ~500 per experiment
Typical Data Sets for One Experiment – Analyzed Data

• U and V displacement data between 2 images
  – Summary sheet for each heart beat
  – Regional analysis

• Histology
  – H&E; trichrome; phase contrast
  – Immunohistochemistry
    • Actinin, troponin, actin, calcium channels, Qdots
    • Images
      – 5x, 10x, 40x
      – Panorama
      – confocal
Trichrome Staining
Immunohistochemistry

Region E

Region A
Data Management: Images for Mechanical Function

- File names must be uniform
  - Exp#_DS#_frame#
- Example:
  - 0231_ds2_0008.tif
Data Management: Images for Histology

• File names must be uniform
  – Exp#A(or B)_section#_stain
• Example:
  – 0231A_216_act
Cells on Suture

0402_001_qd

0402_001_act

0402_001_ho

0402_001_merge
How to Educate Students

• In lab:
  – Mention it once per semester
  – Files with naming conventions

• In courses:
  – Seminar series (mandatory for grad students)
  – Need “buy in” from colleagues
Data Sharing/Management Plans

**Data Sharing Plan.** The investigators agree to participate in a data sharing plan consistent with NIH guidelines. These data would be made available to interested researchers as data become available. Any model organisms developed in the course of these studies would likewise be made available. In later years of the proposal, we have requested funding to present our preliminary data at a national meeting, such as the American Heart Association, Society for Thoracic Surgery or American College of Cardiology, as appropriate. Additionally, a manuscript of the results of this project will be submitted to an appropriate peer reviewed journal.
Thank You