TELEPATHOLOGY

James E. Madory, D.O.
Assistant Professor
Medical Director of Pathology Informatics
Department of Pathology and Laboratory Medicine
Medical University of South Carolina
Charleston, SC
madoryje@musc.edu
I have financial interests in any of the companies or technologies to be discussed today.
Telepathology is the transmission of digital images by way of a network data stream to enable a remote user or users to view images to aid in the diagnosis of the patient's tissue samples. Images may be microscopic or macroscopic. Depending on the technology available and the needs of both the local and remote pathologist images may also be static or dynamic. Telepathology may be as simple as capturing images of a gross specimen with a hand held digital camera to whole slide imaging with 24 hour availability. Budgets, bandwidth, remote user expertise and storage capabilities are often components that dictate which systems are utilized. The Medical University of South Carolina Department of Pathology and Laboratory Medicine is currently utilizing several different systems to fulfill their telepathology needs at the local institution as well as at affiliated laboratories across the state.
What is telepathology?

- **Multiple definitions:**
  
  - *Practical Pathology Informatics* by John Sinard: "the use of any of the telemicroscopy technologies to make the *primary diagnosis* for the specimen (as opposed to consultation or case presentation) from a remote site."
  
  - Telepathology by Sajeesh Kumar: "Telepathology is a branch of telemedicine and pathology that use telecommunication technology to facilitate the transfer of image-rich pathology data between remote locations for the purposes of diagnosis, education, and research."
College of American Pathologists - “Telepathology is the practice of pathology, in which the pathologist views digitized, analog video or still images(s), and renders an interpretation that is included in a formal diagnostic report or documented in the patient record”
Uses of telepathology

- Conferencing and collaboration
- Second pathologist agreement for new malignant diagnosis
- Diagnostic assistance including subspecialty consultation
- Training new pathologists
- Assisting and training pathologists in developing countries
- Performing pathological diagnosis at remote locations
Telepathology vs. Telemicroscopy

- Telepathology:
  - Gross images
  - Chart Reviews
  - Electrophoretic Gels
  - Microscopic images

- Telemicroscopy
  - Remote viewing of microscopic images
How can telepathology be accomplished?

- Three major methods for remote diagnosis
  - Static image systems
  - Dynamic systems
    - Non-Robotic
    - Robotic
  - Whole slide imaging systems
Static Image Systems

- **Pros**
  - Most reasonably priced for transmitting location
  - Technically simple
  - Can be used in a wide range of settings
  - No special hardware or software needed at the remote location
  - Images can viewed at anytime and stored for later review
  - Very low network demands

- **Cons**
  - Capture only a portion of the slide (sampling error)
  - High diagnostic skill needed at the transmitting location.
  - Lack of depth of field
Static Image Systems
Static Image Systems

4 Megapixel Camera

12.1 Megapixel Camera
Static Images
**Dynamic Images**

**Non Robotic Systems**

- **Pros**
  - Reasonably priced for transmitting location
  - Requires a minimal amount of training
  - Allows real time discussion while viewing images
  - No special hardware or software needed at the remote location
  - Moderate network demands

- **Cons**
  - Generally only a portion of the slide is reviewed
  - Moderate level of skill needed at transmitting site
  - Requires coordinated timing of remote and local site pathologists
  - Images must be captured individually for review later.

*Currently in use in the Department of Pathology and Laboratory Medicine at the Medical University of South Carolina.*
Pros:
• Completely Contained System
• Portability

Cons:
• Proprietary Interface Card
• Additional Software Licenses
Dynamic Image Systems
Transmitting Systems

Pros:
• High Resolution – 12 megapixels
• High Refresh Rate – 30 fps

Cons:
• Lower Resolution – 4 megapixels
• Slower Refresh Rate – 4 fps
## Telepathology

Slides can be reviewed via telepathology from various locations throughout not only the MUSC campus but the additional laboratories staffed by MUSC pathologists including Oconee Medical Center in Seneca, SC and soon, Stevens County Hospital in Toccoa, GA.

In order to view slides at the following locations the pathologist at that location must turn on the transmitters to allow the images to be streamed. The pathologist transmitting images and the remote pathologist communicate by standard telephone. No HIPAA protected patient is transmitted via telepathology.

<table>
<thead>
<tr>
<th>Location</th>
<th>Camera Type</th>
<th>Transmitting Instructions</th>
<th>Viewing Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen Section Signout</td>
<td>Olympus DP71</td>
<td>To Transmit</td>
<td>To View</td>
</tr>
<tr>
<td>Cytology Fellow Desk</td>
<td>Olympus DP71</td>
<td>To Transmit</td>
<td>To View</td>
</tr>
<tr>
<td>Endoscopic Ultrasound</td>
<td>Nikon L2</td>
<td>To Transmit</td>
<td>To View</td>
</tr>
<tr>
<td>Interventional CT Scan</td>
<td>Nikon L2</td>
<td>To Transmit</td>
<td>To View</td>
</tr>
<tr>
<td><strong>Main Hospital</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dermatopathology Signout</td>
<td>Olympus DP70</td>
<td>To Transmit</td>
<td>To View</td>
</tr>
<tr>
<td>Hematopathology Signout</td>
<td>Olympus DP70</td>
<td>To Transmit</td>
<td>To View</td>
</tr>
<tr>
<td><strong>Oconee Medical Center</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr. Lage's Office</td>
<td>Olympus DP70</td>
<td>To Transmit</td>
<td>To View</td>
</tr>
<tr>
<td>Dr. Carrick's Office</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr. Dimushitch's Office</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Message from the Chairman

- Department Newsletter
  - Updated October 2010
- Welcome Dr. Maria Gallopo
  - Affia
- Clinical Chemistry Wins Award
- New 2009-2010 Residents

News and Events

[Link to MUSC Medical University of South Carolina website]
Receiving Images
Receiving Images
"Telecytopathology for immediate evaluation of fine-needle aspiration specimens“

RESULTS:
- A total of 429 telecytopathology cases and 363 conventional on-site cases were compared. Adequacy rate was 94.0% for telecytopathology and 97.7% for conventional cases. Preliminary and final diagnoses were discrepant in 7 (1.8%) of 371 telecytopathology cases, and in 8 (3.1%) of 252 conventional cases.
Dynamic Images Robotic Systems

- **Pros**
  - Requires training
  - Allows remote pathologist to choose areas to view
  - No special hardware or software needed at the remote location
  - Low level of skill needed at transmitting site

- **Cons**
  - Moderately expensive for transmitting location
  - Images of all areas viewed are generally not captured
  - Generally a limited number of slides are available for review
Whole Slide Imagers

- **Pros**
  - Allows remote pathologist to choose areas to view
  - No special hardware or software needed at the remote location
  - Low level of skill needed at transmitting site
  - Images can be viewed at anytime and can be retained as long as space is available.

- **Cons**
  - Very expensive for transmitting location
  - Acquisition of a whole slide image can be very slow.
    *We would require two slide scanners running 24 hours to keep up with our slide output at MUSC.*
  - Moderate to High network demands
Whole Slide Viewing

http://vslides.musc.edu/
## Comparison of Systems

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
<th>Images</th>
<th>Focus Plane</th>
<th>Image Selection</th>
<th>Expertise at remote site</th>
<th>Bandwidth Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Static Images</strong></td>
<td>Low</td>
<td>Still</td>
<td>Flat</td>
<td>Local Host</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Dynamic Images - Non Robotic</strong></td>
<td>Medium</td>
<td>Live</td>
<td>Variable</td>
<td>Local Host</td>
<td>Moderate</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Dynamic Images - Robotic</strong></td>
<td>High</td>
<td>Live</td>
<td>Variable</td>
<td>Remote Viewer</td>
<td>Low</td>
<td>Medium-High</td>
</tr>
<tr>
<td><strong>Virtual Microscopy</strong></td>
<td>Very High</td>
<td>Stored</td>
<td>Variable</td>
<td>Remote Viewer</td>
<td>Low</td>
<td>Medium-High</td>
</tr>
</tbody>
</table>
Telepathology in the future

- The use of telepathology will likely expand
  - Network bandwidth more readily available
  - Storage space for whole slide images cheaper
  - The speed of whole slide scanners is increasing while the cost is decreasing.
References

- Pantanowitz, L. Telepathology – Alternative Platforms [Powerpoint slides]
- Kumar, S. and Dunn, B. Telepathology. 2009. Springer-Verlag Berlin Heidelberg
- "Telecytopathology for immediate evaluation of fine-needle aspiration specimens" Mariam Alsharif, MD, Jamie Carlo-Demovich, MD, Caroline Massey, MD, James E. Madory, DO, David Lewin, MD, Ana-Maria Medina, MD, Rosemary Recavarren, MD, Patricia M. Houser, MHS, CT (ASCP), Jack Yang, MD Cancer Cytopathology 2010 May 28.
Questions?