DICOM in Pathology

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Future
Pathology Overview

- Anatomic Pathology involves rendering diagnoses based on examination and of tissue and fluid samples.
- Examination may be gross, microscopic or by instrument.
- Majority of diagnoses are visual, using light microscopy.
Outline

- History of DICOM Visible Light supplement
- Current state of DICOM use in Pathology
- Pathology workflow and barriers to adoption
- Whole slide imaging
- LDIP project
- Next Steps
Visible Light Supplement 15

- Ratified in 1999
- Defined four new image types (IOD’s)
  - endoscopic image
  - microscopic image
  - stage microscopy image
  - external camera image
Visible Light Supplement 15

- Support for
  - gross images
  - microscopic images
  - lab accession numbers
  - case history
  - SNOMED™ nomenclature and others
  - imaging system information
  - x, y, and z source position of images
Current State in Pathology

- Many PACS vendors are compliant with Visible Light images for pathology, endoscopy, etc.
- Growing number of imaging products targeted at pathology are DICOM compliant
- Anatomic pathology laboratory information systems offer limited image management
- Veteran’s Administration:
  - Pathology imaging vendors must be DICOM compliant and store images in VISTA PACS
- Small, but growing adoption of DICOM
Path PACS

- Humin Tec (Korea)
  - PACS system for pathology departments
  - 21 installations, all in Korea
  - Communicates with standard radiology PACS
  - Also offers station for specimen photography

- Apollo Telemedicine (USA)
  - PACS system allows acquisition and storage of images
  - Installed at Milwaukee Veterans Administration Hospitals
  - Images can be stored in VISTA imaging system
Other Vendor Activity

- **Visual-med**
  - Working with VA in Georgia and Washington to allow acquisition and forwarding of pathology images to VISTA PACS
  - Has stand alone product that can DICOMize digital images for forwarding to PACS

- **Olympus**
  - Working on a product to capture images and send to PACS

- **Aurora Interactive**
  - Grant from government of Canada
  - Researching feasibility of using DICOM for whole slide imaging and JPEG 2000 formats
  - Considering what forms of metadata are appropriate or feasible to include
Academic Center Efforts

- Univ. of Pittsburgh
  - AP LIS is image aware
  - Gross specimen photos and single field microscopic images saved
  - Transmitted to Enterprise Image Archive
  - Clinicians can see only selected images on completed cases
  - Main clinician interest is specimen photos
  - Main pathologist use is conferences
European Examples

- Otto von Guericke University in Magdeburg, Germany
  - Installed combined PACS and departmental information system in pathology

- University of Trieste, Italy
  - Has integrated pathology into their PACS implementation
Anatomic Pathology Workflow

- Tissue sample examined grossly (+/- photos)
- Small portions are selected and chemically processed (fixed) and embedded in paraffin
- Paraffin blocks are used to make microscope slides
- Slides are stained using various chemicals
- Slides are examined microscopically by pathologist (+/- photos)
Pathology Workflow
Diagnosis and Imaging

Current State

Future State?
Storage and Retrieval
Barriers to Adoption of Current Products

- **Turf**
  - PACS systems have traditionally been the domain of Radiology
  - Movement toward storing all medical images in a central location with a single viewing mechanism still in infancy

- **Workflow**
  - May need to manually annotate files with image description, accession number, etc.
  - If sending to PACS, need to order study first

- **Cost**
  - Image acquisition and annotation takes time – no extra reimbursement currently
  - Slide scanners and storage are costly
Imaging Comparison

- **Radiology**
  - digital acquisition
  - automatic image capture
  - clinician interpretable
  - many patient requests
  - large storage needs
  - digital images save money
  - large budgets
  - strong standards for storage and transfer

- **Pathology**
  - analog primary data
  - manual image capture
  - hard to interpret for non-pathologists
  - few patient requests
  - extreme storage needs
  - digital imaging costs more
  - modest budgets
  - limited pathology specific standards
Whole Slide Imaging

- Technically feasible
- Long scan times currently
- Enormous files
- Proprietary compression methods
- Mainly practical for research currently
- Allows remote slide reading
- Routine use soon?
Multiple companies working on scanners
Challenge is speed, file size, compression
Current speed is around 5 minutes per slide for conventional scanners
Matrix scanners claim <1 minute per slide
Whole Slide Imaging

- Typical glass slide is 2.6 x 7.6 cm
- Tissue often occupies 1.9 x 2.75 cm
- Scanning at medium power 21,260 pixels/cm
  \[40,394 \times 58,465 = 2.4 \text{ billion pixels}\]
  \[\times 24 \text{ bits color/pixel} = 7 \text{ GB image file}\]
- High power gives twice the resolution
  \[7 \text{ GB} \times 2 \times 2 = 28 \text{ GB}\]
  This is only in a single plane of focus!
Whole Slide Imaging

- Compression (lossy) may reduce file size to 100 MB – 1 GB
- Assume cases have 5 slides on average
- Assume a volume of 30,000 cases per year

\[
0.5 \text{ GB} \times 5 \times 30,000 = 75 \text{ Terabytes per year!}
\]
Laboratory Digital Imaging Project

- Mission: create a pathology image data exchange specification
- Concept: self-describing image files in XML
- Considering use of Open Microscopy Environment framework
- Initiated: May 2004
- First draft: 2007?
LDIP Goals

- Allow anyone who uses pathology images to exchange images and accompanying annotations in a format that can be completely understood by anyone.
- Allow vendors to write simple software that will port their proprietary images into or out of the data exchange standard.
- Allow easy interchange to and from DICOM.
- Allow the integration of metadata/data pairs with related data in other databases.
Metadata of Images

- Specimen / patient demographics / prior history
- Accession / slide / block number
- Anatomic location
- Stain / antibody / procedure
- Magnification / capture equipment
- Pathology report / diagnosis
- Description of image or slide contents
- Research protocol information
- Other characterization of tissue (genotype etc.)
# LDIP Participants

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<tr>
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<th>Academic &amp; Other</th>
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<td>Trestle</td>
<td>Ohio State Univ.</td>
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<td>dmetrix.com</td>
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Roadmap

- **DICOM**
  - WG-10 (strategic advisory) looking into pathology
  - Submit updated work item proposal for pathology
  - Build relationships with pathology vendors and LDIP

- **LDIP**
  - Continue work on data specification
  - Ensure DICOM compatibility
  - Liaison with DICOM and others

- **Other organizations?**
Support for whole-slide microscopic images
Support for navigating and selecting a region of interest from within entire slide image
Support for multi-resolution formats including multiple pyramid voxel conventions
Support for multispectral and hyperspectral modality images
Workflow model for pathology
Selected References

- Whole slide imaging
  - Aperio  [www.aperio.com](http://www.aperio.com)
  - Bacus  [www.bacuslabs.com](http://www.bacuslabs.com)
  - Trestle  [www.trestlecorp.com](http://www.trestlecorp.com)
  - Dmetrix  [www.dmetrix.net](http://www.dmetrix.net)

- Laboratory Digital Imaging Project
  [www.ldip.org](http://www.ldip.org)
  [www.openmicroscopy.org](http://www.openmicroscopy.org)
Selected References

Pathology implementations

Magdeburg: Pathology Research and Practice, Nov. 2002. 198:679-684

Trieste: Medicon 2001
http://www.tbs.ts.it/archives/medicon01-belloni.pdf