How to Best Prepare for Digital Pathology: A Primer on Technologies, Applications, and Clinical Contributions

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Disclosures

- Clariant, Inc. – Consulting agreement
- Digital Pathology Blog – Educational sponsors
  - Aperio
  - Aurora MSC
  - BioImagene
  - Definiens
  - Digital Pathology Consultants
  - i-Path
  - MEDTING
  - Omnyx
  - SlidePath
  - Ventana
Goals

- Digital pathology applications – defined and use
- ROI
- Cost-effectiveness
- Models
Digital Pathology is

- Direct patient care
- Education and clinical conferences at a distance
- Administrative/organizational meetings at a distance
- Image enhanced pathology
- Integration with LIS/EMR
- Part of Pathology 2.0
Projected Whole-Slide Scan Times with Evolving Platforms

- **2009:**
  - Best Possible: 1:30 (minutes)
  - Typical: 5:00-8:00

- **2012**
  - Best Possible: 0:12
  - Typical: 2:00

- **2018**
  - Best Possible: 0:03
  - Typical: 0:20
  - Worst Case: 4:00

  With high compression algorithms for clinical use

### Applications

- **Workflow management**
- **Viewing**
- **Security**

**Information Management Software**

- **Picture Archiving and Communication System (Pathology PACS)**
  - **Data management**
  - **Reporting**
  - **Image Analysis/CAD**

- **Camera**
- **Scanner**
- **Dynamic**

- **Server**
- **LIS/HIS/RIS**
- **EMR**
- **Billing**
Changes in Technology

- Images diagnostically equivalent to conventional light microscopy
- Disk space, network speed and processing power cost lower and more efficient
Why telepathology?

- Rapid consultation on cases
- Provide capability to have subspecialty experts review challenging cases (added value)
- Provide a peer review capability for single/isolated pathologist
- Distance independent diagnoses
- Manpower shortages and wide spread geography
- Pathology 2.0

Established Practices

- Frozen section
- Routine surgical pathology
- Consultation (second, expert, QA/QC)
- GME/CME (ABP, USCAP, CAP, ASC)

Provisional Practices

- Cytopathology (Z-stack focusing)
- Clinical microscopy
Special Section on Telepathology

Primary frozen section diagnosis by robotic microscopy and virtual slide telepathology: the University Health Network experience

Andrew J. Evans MD, PhD*, Runjan Chetty MB, BCh, DPhil, Blaise A. Clarke MB, ChB, Sidney Croul MD, Danny M. Ghazarian MD, PhD, Tim-Rasmus Kiehl MD, Bayardo Perez Ordonez MD, Suganthi Ilaalagan BSc, MLT, Sylvia L. Asa MD, PhD

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Why Telepathology at UHN?

- No on-site at AP frozen section service at TWH for ~10 years
- Tissue sent to TGH – up 1 hour TAT
- Lack of timely intraoperative frozen section support.
- Small volume frozen section requirement

Telepathology QS Procedure

- Only when the result will directly influence intraoperative management
- The pathologist can give the surgeon the answer they are looking for
- The information sought at frozen section cannot be obtained by other means
Telepathology QS Procedure

- *Single pieces of tissue EIT*
  - Tissue Identification
  - Tissue for Intraoperative Staging
  - Resection Margins
- > 3 separate specimens or complicated dissection/orientation

UHN Telepathology Experience/Outcomes

- 674 primary FS diagnoses (350 by RM and 314 by WSI)
- 95% of which were for neurosurgical cases.
- Average of 9.98 minutes RM decreased to 2.71 minutes with WSI
  - 26% of cases requiring < 1 minute/slide and
  - 43% of cases < 2 minutes/slide.
  - Smears were examined in addition to FS slides in 30% of the WSI cases.
- Diagnostic accuracy was 98% for both WSI and RM, however the use of WSI has markedly improved pathologist satisfaction.
UHN Telepathology: Due Diligence Before Going Live

- Medical Malpractice Insurance Provider
  - Canadian Medical Protective Association (CMPA)
  - Telepathology will not affect coverage
- UHN Medical Advisory Committee
  - SOP presented for approval
- Federal Health Protection Branch - Ottawa
  - Telepathology does not involve “medical devices” (no direct contact between instrument and patient) – no HPB approval required
- Surgeon Education
  - Demonstrating the robotic microscope/slide scanner
    - Essential to get surgeon buy-in!

From the conventional microscope to the digital slide scanner in routine diagnostic histopathology

Sten Thorstenson, MD
Medical Director
Department of Pathology and Cytology
Kalmar County Hospital
Kalmar, Sweden

Presented @ Pathology Visions 2009, San Diego
Kalmar today

- >60000 histopathology slides have been scanned
- 24 hr scanning (2 Aperio Scanscope XT)
- 1.5 years of routine histopathology diagnostics
- >75% of the routine histopathology is diagnosed digitally
- 10 years experience of digital telepathology frozen section service.
- Some clinicopathological conferences digitally
- Individual digital slide conferencing (on demand from clinicians)

The modern pathologist´s cockpit

- Picsara interface
  - (image database)
- SymPathy interface
- Imagescope interface

(Old fashioned microscope)
Clearly improved ergonomics!

The modern pathologist

Coffee!

Anyone wants to work as a pathologist in Kalmar? Phone +46 480 448019

Virtual IHC Business Model

- Large laboratories partnering with pathologists or pathology groups
- Large laboratory performs technical component
- Pathologists performs professional component
Need help…
IHC stain that is rare or unavailable

Express mail to reference lab

Slides/blocks returned

Stain is performed

24/7 scanning (20x)
1 day TAT possible

Resulting slide imaged

Image available on web application

Consultation possible

Central Lab  Referring Pathologist

Capital investment  Yes
Large menu  Yes
Research and Development  Yes
Primary Pathologist
Anywhere in the 50 US states

Secondary Pathologist
Lab performing IHC, Consultation

Tertiary Pathologist
“Glass-Less” virtual Microscopy consultation

Other Pathologists
“Glass-Less” virtual Microscopy consultation
Image Analysis

- Image analysis for quantitative immunohistochemical stains
  - Machines are good at counting
  - They are not very good at thinking
  - Good reproducibility
  - Better information
  - Associated increase in billing codes relative to manual IHC

Inconsistency of HER2 Test Raises Questions


Archives of Pathology and Laboratory Medicine: Vol. 131, No. 1, pp. 18–43.
Conclusions

- IA appears to be more accurate than MA in HER2 IHC, particularly for 2+ cases (FISH non-amplified)
- Algorithms appeared to overscore or underscore a minority of cases, particularly 1+ IHC cases (FISH non-amplified)
- Pilot study suggests a role for IA in 2+ cases to avoid unnecessary FISH testing in overscored cases
- Cost and time required for WSI analysis may still be prohibitive for routine clinical use without added resources in the laboratory for IA.
Reimbursement

- CPT 88360 – Morphometric analysis, tumor immunohistochemistry (e.g., Her2/neu, estrogen/progesterone receptor), quantitative, semiquantitative, each antibody; manual
  - PC+TC=$147.95

- CPT 88361 – Morphometric analysis, tumor immunohistochemistry (e.g., Her2/neu, estrogen/progesterone receptor), quantitative, semiquantitative, each antibody; using computer assisted technology
  - 88361 PC+TC=$229.16 Δ(TC+PC)=$81.21

- HER2 FISH
  - 88368 PC+TC=$710.00
Technology: For Nations That Lack the Expertise, an Automated System for Detecting TB


Is it worth it?
The ‘Stage’

- Pathology practice
  - 5 pathologists
  - Sacred Heart Hospital
    - 300 beds
  - Willmar, MN
    - Rural practice
  - Hospital and Outpatient Procedure Clinic
    - 20,000 surgicals/year
    - Bone marrows, pap smears, FNAs
  - Fully staffed histology lab (IHCs)
  - Pathology assistant
The ‘Scenario’

- Watertown, SD
  - Solo pathologist retiring
  - 110 miles away
  - Low frozen section volume
    - 5,000 surgicals/year
    - 20 frozen section slides/week
  - Histology lab fully staffed (No IHC)
  - Pathology assistant
Whole slide imaging scanner

- Scanner
  - $120,000
  - 1-yr warranty
  - Expected use 5 yrs
  - $10,000 after 5 yrs
  - $2,000 maintenance/yr
Cost Scenario 1: Hire Pathologist

- **Fixed cost**
  - Pathologist: $230,000
  - Pathology assistant: $65,000
  - Histotech: $36,000
  - Secretary: $30,000
  - Courier service: $6,000
  - Histology lab: $8,000
  - Frozen section lab: $1,000

- **Variable cost**
  - Frozen section supp: $5,000
  - Histology supplies: $50,000

- **Total**: $431,000

Cost Scenario 2: Driving

- **Gas**: $9,000
- **Loss of productivity**: $115,000
- **Time lost**: *priceless*

**Total** = #2 + (#1 – pathologist’s salary)

= $124,000 + $201,000

= $325,000
Cost Scenario 3: Buy Scanner

- **Fixed cost**
  - Scanner: $24,000
  - Pathologist assistant: $65,000
  - Courier service: $12,000
  - Frozen section lab: $1,000

- **Variable cost**
  - Frozen section supplies: $5,000

- **Total**: $107,000

Savings

- **Hire Pathologist**
  - Fixed cost
    - Pathologist: $230,000
    - PA: $65,000
    - Histotech: $36,000
    - Secretary: $30,000
    - Courier service: $6,000
    - Histology lab: $8,000
    - Frozen section lab: $1,000
  - Variable cost
    - Frozen section supplies: $5,000
    - Histology supplies: $50,000

  - Total: $431,000

- **Buy Scanner**
  - Fixed cost
    - Scanner: $24,000
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  - Variable cost
    - Frozen section supp: $5,000

  - Total: $107,000

**Savings**: $324,000
Additional Benefits to Integrating Digital Pathology into Practice

- Tumor boards/Conferences/Teaching

Additional Benefits to Integrating Digital Pathology into Practice

- Model for further expansion/acquisitions
Additional Benefits to Integrating Digital Pathology into Practice

- Consults
  - No slides sent through mail
  - Possibly faster TAT
  - However, additional stains = old way

Quick Review of Groups Goals

- Provide excellent service to clinicians
  - Frozen section interpretation
  - Quick turn around time
- Harness combined knowledge of staff
- Use pathologists’ time efficiently
- Use technology to improve service
  - Additional tests
  - Faster TAT
  - Expansion
Limitations/Weaknesses

- Fewer (same) people doing more
- Technical cost considerations
- Use may not justify expense (# of FS)
- Back up plan
  - A difficult case is a difficult case
  - Technical problems
- Intangible benefits
  - Face on the lab/Morale
  - Clinical laboratory functions
  - Direct communication/interaction with clinicians

Is it worth it?

- It depends – volume/cost & time of travel
- Utilize existing personnel to manage risk
  - Negate solo-pathologist/risk management
  - Consult with colleagues
  - Rapid subspecialty consultation
- Lose intangible benefits
  - PR – Face-to-face discussion with clinicians
  - Morale
Is it worth it?

- Leverage technology into clinical business practice
- Transplant biopsy services
- Toronto General Hospital brain frozens
- Canadian provincial services networks
- DOD/VA
- Scandinavia/Europe
- Emerging markets – Asia/India

Lessons learned
General

- Technology diffusion & adaptation
  - “Technology is the easy part, changing hearts and minds is the hard part.”
- IT issues
- Human resources/personnel
- Sustainability
  - “Almost as good as light microscopy”
  - Not exactly the same – human user interface
  - As fast as glass

Insurance & Medicolegal Issues

- Check with local carriers and providers
- Telemedicine law and lawyers
- Nuances of clinical practice will dictate

It is agreed that no coverage is provided for liability arising out of the insured’s activities performed for or in conjunction with Walter Reed Army Medical Center, telepathology, or the State of Pennsylvania.
3. Malpractice and liability

There is little case law that addresses the unique liability issues that could arise in telemedicine. Indeed, the state regulation of torts and medical malpractice usually leads to administrative remedies prior to adjudication by the courts. Thus, it is unlikely that a case would rise to the level of an appellate court in order to establish such case law.

The traditional tort or malpractice analysis should be performed in evaluating telemedicine liability:

- Duty
  - Is there a PPR? Foreseeable plaintiff?
- Breach of the duty
  - (Has standard of care been met?)
- Damage caused by Breach
  - (Is there a remedy at law or equity?)
- Proximate Cause
  - (1. Actual “but for...”, substantial factor? 2. Foreseeable injury?)

Seven states have general exceptions to their state licensure laws that applied specifically to telemedicine. Alabama, Indiana, and Minnesota do not require out-of-state physicians to obtain a license to practice medicine from their home states if the physician does not practice in their state frequently. However, only Alabama provides a definition of “frequent” in its regulations:

if such practice occurs less than ten (10) times in a calendar year or involves fewer than ten (10) patients in a calendar year or comprises less than one percent (1%) of the physician’s diagnostic or therapeutic practice [11].

Illinois and Tennessee do not require a license if the physician is merely providing a second opinion. New Jersey and Washington do not require a license if the physician does not open a physical practice in the state or accept calls in the state. Thus, it would seem that in Illinois, Tennessee, New Jersey, or Washington state, the practice of telepathology, in an exclusively consultative role as a pathologist providing a second opinion to another pathologist in the state where the patient resides, would fall under such exceptions. However, all 7 states require that the out-of-state physician has an unrestricted license to practice medicine in the location of the distant physician in order to qualify for these exceptions.
Niche Adoption – Whole Slide

Resources

- VIC Telepathology & Whole Slide Imaging Course – Updated March 2010
- CAP Futurescape series
- Digital Pathology Association
- APIII-LITS
Pathologic Diagnosis:
Skin, back, shave biopsy - Comedo
dysplastic nevus

Microscopic Description:
There is lentiginous epidermal h
with bridging. Junctional nevus
laterally for a distance of at least
ridges past the lateral limit of the
population. Junctional nevus ce
present singly as well as in nest
the sides, as well as at the tips,
ridges. Nevus cells display mod
enlargement, hyperchromasia, a
pleomorphism, and abundant, di
cytoplasm. In the papillary den
chronic inflammation, neovascular
fibrosis. Margins of the shw
specimen are uninvolved in the :
available for examination.
Conclusions

- Digital pathology functional performance is adequate and improving
- Those who gain entry now are less likely to fall behind
- Gain a competitive advantage

Thank You

"Well, yes, we could fix it in Photoshop, but your arm would still be broken."