Enabling Path of Digital Pathology to Personalized Medicine

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Conflict of Interest

Matthew Hanna, MD
Advisory Board, PathPresenter

Rajendra Singh, MD
Founder, PathPresenter

Have no real or apparent conflicts of interest to report
Agenda

Intro
- Digital Pathology
- Ecosystem
- Educational Initiatives

AI/ML
- PathPresenter
- Current Landscape

Pathology
- Personalized medicine
- FUTURE
- Q/A

end
Learning Objectives

Define what is digital pathology and what is its promise

Design an effective program that will train the pathologists of today and tomorrow in digital pathology

Practice using digital pathology for educational, research, and clinical purposes

Outline path of pathology to digital pathology to computational pathology and finally to personalized medicine for patients
Film photography is now a niche field.


Failed to innovate a digital solution. Netflix added streaming services in 2010.

Failed to identify digital photography as a disruptive technology, had to sell film, patents, scanners to stay alive.
Life of Patients’ Specimens
Digital Pathology Basics
THE FIVE RIGHTs OF DIGITAL PATHOLOGY

RIGHT PATIENT

RIGHT SLIDE

RIGHT PATHOLOGIST

RIGHT TIME
“Telepathology”

RIGHT DIAGNOSIS
Digital Pathology Ecosystem

Information Systems

- HIS
- PACS
- LIS
- EMR
- RIS

Digital Pathology System

Whole slide scanner
Whole slide viewer

System Tools

- pCAD
- Native Applications
- 3rd party applications
- Image analysis

Digital Pathology Subsystems

Hardware
- Slide scanning
- Robotics/slide handling
- Optics/Lighting
- Tissue detection

Software
- WSI acquisition
- WSI viewer
- WSI repository
- File format
- Compression
- Image analysis

Slide Scanner
Whole slide image
Digital Pathology Process

ARMS

Acquisition

Retrieval/Storage

Manipulation

Sharing
Digital Pathology Benefits
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On-demand Archive/Case management
Glass slides storage

Move slides from local to remote ↓ Costs

To remote

Move slides from local
Archival glass slide requisitions had a 93% decrease in requests from 2014 to 2017.
- Slide storage costs projected savings of $274,000/year
- Due to decreased vendor services
  - (i.e. asset retrieval, storage proximity, labor)
Image Analysis

- Area Quantification
- Cell Quantification
- Tissue Pattern Recognition
- Feature Quantification

Diagram showing the overlap of different quantitative analysis techniques in image analysis.
Machine Learning

Train
- whole slide image
- sample
- normal
- tumor
- training data
- deep model
- P(tumor)

Test
- whole slide image
- overlapping image patches
- tumor prob. map

Massive volume of digital data generated from WSI & bioinformatics/molecular data

Critical for personalized medicine, health systems, basic research and “Big data”

Dataset sizes: Computer vision vs. computational pathology

From Fuchs, 2017

1 whole slide = 100 X 60,000 = 6 billion pixels
Why is this possible now?

Image datasets

Fast computing/GPUs

Cognitive algorithms
Challenges

Not always being done with pathologist involvement, mostly being done in computer science departments

No universal platform to aggregate and share the vast amount of data generated by pathology across thousands of hospitals, medical centers and reference laboratories

Available solutions are often scanner specific, lack useful apps/tools for Pathologists, lack active participation of pathologists and lack high quality aggregated data
You would feel comfortable providing primary diagnosis using digital pathology, with retrieval of glass slides available upon request.

You would feel comfortable providing primary diagnosis using digital pathology, without availability of glass slides.
What can be accomplished?

• Education
  – Trainee/faculty education/CME

• Clinical
  – Create efficiencies for pathologists

• Research
  – Identify digital prognostic markers
Education
Why is there a need?

Lack of open-access to digital slides or are restricted by firewalls to download software

Learning from digital slides is not only having access to digital slides; it should also simulate current teaching techniques
CURRENT TEACHING TECHNIQUE

Outdated, Unscalable, Limited

http://www.teachingmicroscopes.com
Current landscape of Digital Educational Resources
Thank you for visiting the DPA’s Whole Slide Imaging Repository. This web page lists whole slide and static image examples. Our goal is to create a resource of image repositories.

If you have comments or suggested additions, please email the DPA here.

Academic
Independent
Industry
Static
CAP Case of the Month

Case History

Clinical Summary:
A 45-year-old healthy construction worker sustains a superficial laceration to his arm at his work. He does not receive any immediate medical attention for the cut. Several weeks later he develops erythema and discoloration of the skin of the upper extremity in the region of previous trauma. He requests medical attention due to pain and stiffness that prevents him from working. He requires extensive surgical debridement of the skin and subcutaneous tissue for control of disease. At the surgery, material from the soft tissue wound is submitted for culture.

Specimen Source:
Skin and soft tissue of right forearm

Stain:
H&E
PathXL

http://www.pathxl.com/pathology-education-tutor
PathPresenter

• Digital pathology company built by pathologists for pathologists

• Focused on building software to enhance and standardize the learning and teaching experience in pathology

• Provide a multidisciplinary educational environment
Current PathPresenter Apps for education

• Developed Applications for Public or Institutional Use

MySlideBox
Manage your digital slides and folders.

My Presentations
Create and manage your presentations using our extensive Slide library or by uploading your own slides.

Slide Library
Search, view, or share from thousands of cases covering all medical subspecialties.

High Yield
Learn and study from hand-picked cases to prepare for board examinations, or to brush up on must-know diagnoses.

Quiz
Search, view, or share from thousands of cases covering all medical subspecialties.

Group Chat
Create group with other members and discuss slides.

Analysis
Create Analysis and collaborate to add annotations and discussions in Groups.

QA
Cross check the Quality of Diagnosis by assigning to the expert reviewers.
Every effort has been made to present you with the most accurate diagnosis and information. However because of the vast variations that can occur for every diagnosis, PathPresenter cannot be held responsible or accountable for the accuracy of the content. Path Presenter assumes no liability for errors or omissions on the website. Users should independently verify the accuracy, completeness and relevance of the diagnosis and other information.
Interesting Case Conference

Matthew Hanna, MD
Quiz Module

Question 1: What is your diagnosis?

36 year old female with nodule identified in clinic visit, biopsy of the upper outer quadrant

Performance

Quiz Performance
Steps to Facilitate Education

• Provide an easy to use platform for trainees, faculty, and pathology departments

• Provide high quality content

• Content validated by experts

• Publicized on social media
Path of Pathology to Personalized Medicine

- Bring digital pathology to the world
- Provide a new standard medical presentation platform
- High quality curated digital images
- Make pathologist comfortable using digital pathology
- Growth in pCAD
- Pathology to personalized medicine
Use Cases

• **Physicians**
  Ready access to a wealth of data and images, with seamless medical presentations

• **Institutions**
  Branded platforms with site specific content, monetized to the medical community

• **Pharma**
  Agnostic platform coupled with pathology data and AI apps for real time analysis

LEARN, TEACH, CONSULT, RESEARCH, PUBLISH, CME
Is it really working?

- Usage by country/continent

- >162 Countries
- >62,000 Users
- >10,000 Digital Images
- 8 Apps
Why this will only increase

Number of cancer cases → 70% ↑

Future Pathologists → 30% ↓
How will AI affect Pathology Education

De-skilling

Access to resources
Clinical & Research
Digital Pathology & Personalized Medicine
THE DOCTOR WILL SEE YOU NOW
HOW AI IS GOING TO CURE OUR SICK HEALTH CARE SYSTEM

Digital Diagnosis: Intelligent Machines Do a Better Job Than Humans

AI Can Diagnose Heart Disease and Lung Cancer More Accurately Than Doctors
Digital Pathology Slide
Cancer registry data
Digital image analysis outperforms manual biomarker assessment in breast cancer

Gustav Ståhlman1,2, Nelson Fuentes Martínez1,3, Michael Lippert4, Nicholas P Tobin5, Ida Melholm1,4, Lorand Kis7, Gustaf Rosin1, Mattias Rantalainen5, Lars Pedersen1, Jonas Bergh1,5,6, Michael Grunkin4 and Johan Hartman1,5,7

1Department of Oncology and Pathology, Karolinska Institute, Stockholm, Sweden; 2St Erik Eye Hospital, Stockholm, Sweden; 3Södersjukhuset, Stockholm, Sweden; 4Visipharm A/S, Hørsholm, Denmark; 5Cancer Center Karolinska, Stockholm, Sweden; 6Department of Applied Mathematics and Computer Science, Technical University of Denmark, Kongens Lyngby, Denmark; 7Department of Clinical Pathology, Karolinska University Hospital, Stockholm, Sweden; 8Department of Medical Epidemiology and Biostatistics, Karolinska Institute, Stockholm, Sweden and 9Department of Oncology, Karolinska University Hospital, Stockholm, Sweden

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<td>84%</td>
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<td>Cutoff ≥ 25.2%*</td>
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Joint analysis of histopathology image features and gene expression in breast cancer

Vlad Popovici, Eva Budinská, Lenka Čápková, Daniel Schwarz, Ladislav Dušek, Josef Feit and Rolf Jaggi

Clustering corresponded with molecular gene expressions and prognosis
Survival and Relapse
Assistive screening tools for pathologists

LYNA (LYmph Node Assistant)

ARM (Augmented Reality Microscope)

Resource:
Novel Technologies: Multiplex
(h) autofluorescence
(i) Red = tumor
Green = stroma
(j) Double positivity
yellow = HER2+/Ki-67+
blue = HER2-/Ki-67-
red = HER2-/Ki-67+
Will AI/New tech Lead to Better Patient Care?
Digital pathology is increasingly being used and will be a key enabler of personalized medicine.

Many areas of medicine including clinical, education, and research are creating and utilizing digital imaging applications including AI/machine learning.

Pathologists’ current routines is transforming and being impacted by digital pathology.

We need to continue to partner with industry vendors and continue to build applications of WSI for clinical use including primary diagnosis and image analysis to help drive personalized medicine.
The Road to Personalized Medicine
Questions

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• Rajendra Singh, MD
  • skinpathology@gmail.com

• Please remember to complete online session evaluation