Digital Cytopathology & Interactive Case Discussion

Marilyn M. Bui, MD, PhD

Senior Member & Scientific Director of Analytic Microscopy Core
Section Head, Bone and Soft Tissue Pathology
Program Leader, Anatomic Pathology Education
Moffitt Cancer Center
Professor & Director of Cytopathology Fellowship
University of South Florida Morsani College of Medicine
Tampa, FL. USA

The mission of Moffitt Cancer Center is to contribute to the prevention and cure of cancer.
Disclosure

• There are no financial conflicts of interest.
• The talk represents my personal and professional opinion only.
• Member of Digital Pathology Association Board of Directors & executive committee, Editorial board member of Journal of Pathology Informatics, Member of Association of Pathology Informatics, CAP Digital Pathology Committee and contributing editor of CAP Digital Pathology Resource Guide 2014-2017, Chair of the CAP Expert Panel of the Quantitative Image Analysis project, Scientific Director of Analytic Microscopy Core at Moffitt Cancer Center, Leader of the departmental digital pathology working group, Member of the institutional Virtual Health Strategy working group, Patent applications, publications and lectures on digital pathology, images analysis, cytopathology and bone and soft tissue pathology.
Outline

• The current concepts of digital pathology
• The practical applications of digital pathology in cytology
• Whole slide image cytology case interactive discussion
• Conclusions
Digital Pathology

**Definition**

- An image-based information environment enabled by computer technology which allows for the management of information to be generated from a digital slide.
- **Digital pathology** is enabled in part by digital microscope, which is the practice of converting glass slides into digital slides that can be viewed, managed, and analyzed on a computer monitor.
- With the advent of **Whole-Slide Imaging (WSI)**, the field of digital pathology has exploded and is currently regarded as one of the most promising avenues of diagnostic medicine in order to achieve even better, faster and cheaper diagnosis, prognosis and prediction of cancer and other important diseases.
Digital Pathology

Environment

- Scan
- View
- Manage
- Analyze
- Integrate
- Share
Digital Pathology

Potential

- The tissue on those slides may be subjected to staining to highlight structures. When those slides are digitalized, they then have the potential to be numerically analyzed using computer algorithms (image analysis).
- Algorithms can be used to automate the manual counting of structures, or for classifying the condition of tissue, like algorithms used in grading tumors.
- This could reduce human error and improve accuracy of diagnoses.
- Digital slides are also, by nature, easier to share than physical slides. This increases the potential of using data for education and consultations.
Digital Pathology

Drivers

• Shortage of pathologists
• Remote access (telepathology)
• Consolidation of health systems, hospitals and laboratories due to accountable care organizations (ACOS)

Total Accountable Care Organizations in US

Source: HealthAffairsBlog by David Muhlestin and Mark McClellan April 21, 2016
Congressional Panel Plans to Increase Medicare Telehealth Reimbursement

Jan. 14, 2015

A work group of the House Committee on Energy and Commerce is drafting a four-year plan to eliminate existing barriers to care for Medicare patients.

The group plans to seek coverage for telehealth services just the same as in-person visits are covered. Eight Committee members, including sponsors of recent major telehealth bills, would direct the Health and Human Services Secretary to implement a new methodology, including capitated rates and bundled payments, for Medicare covered services by telehealth without a net increase to Medicare costs.

ATA has been working with Committee staff on the bill’s specific language. The work group is seeking public comments by Jan. 26, 2015 as part of the Committee’s “21st Century Cures” initiative. Read the draft here.
Digital Pathology

Challenges

• Digital pathology is not yet approved by the FDA for primary diagnosis.

Collaborating for down-classification: An update on the Digital Pathology Association's regulatory efforts
Posted by Mike Montalto, PhD, Senior President-Elect of Digital Pathology Association (DPA) and is on DPA website https://digitalpathologyassociation.org/

• Unlike digital radiology where the elimination of film made return on investment (ROI) clear, the ROI on digital pathology equipment is less obvious.

• The strongest ROI justification includes improved quality of healthcare, increased efficiency for pathologists, improved accessibility to expertises, and reduced costs in handling glass slides.
Outline

• The current concepts of digital pathology
• The practical applications of digital pathology in cytopathology
• Whole slide image cytology case interactive discussion
• Conclusion
Digital Pathology Utility

Courtesy of Dr. Eric Glassy
What is unique about cytology?

- Surgical vs. cytology slide
  - Surgical slide 4-6 µm in thickness.
  - Cytology slide 30 µm in thickness from glass to coverslip with cells positioned anywhere.


- Cytopathologists and cytotechnologists
- Screening, dotting and ergonomic issues
- Rapid On-Site Evaluation (ROSE) and telecytology
- GYN PAP smear and automated analysis
Are we ready?

- Literature on usage of whole-slide images (WSI) in clinical cytology diagnostic application, especially for primary diagnosis, is limited.

- We studied the concordance in primary diagnosis between glass and digital (virtual) slides among diagnosticians with different training profiles to assess our readiness in adoption of digital cytology in clinical practice.

Method

- Digitized 22 de-identified routine cytology cases using Aperio ScanScope XT slide scanner
  - At 20X/NAA 0.75 and 40x (with optical doubler)
  - Image resolution: 0.5 µm per pixel at 20X or 0.25 µm per pixel at 40X
  - Captured in single planes without z-stating or multi-plane imaging
- Images viewed through Spectrum and Imagescope via intranet
  - CPU Speed: 500MHz, 2GHz recommended
  - Hard Drive: 100MB free space
  - Memory: 256MB, 1GB recommended
  - Network Card: 100 megabit network card or faster
  - Video Card: 24-bit color at monitor’s resolution
  - OS: Windows XP Pro (SP2) or Windows Vista Pro

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
Method

• **Diagnosticians:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cytopathologist with Digital Slide Experience</td>
<td>3</td>
</tr>
<tr>
<td>Cytopathologist with no Digital Slide Experience</td>
<td>3</td>
</tr>
<tr>
<td>Cytotechnologist</td>
<td>4</td>
</tr>
<tr>
<td>Pathology Resident</td>
<td>2</td>
</tr>
</tbody>
</table>

• **Gold standard:** The reference glass slide diagnosis.
• **Comparison:** The glass and digital reading of the same diagnostician and among the 4 different groups in time and accuracy
We are ready!

- Less than 10% of the digital slides were considered of poor quality.
- Glass slide interpretations were better and faster; agreement in diagnosis between glass slides and WSI was good (6.6% difference).
- No difference in year of experience in digital diagnosis, excluding residents.
- For a solid diagnostician, lack of digital experience did not compromise one’s diagnosis using digital slides.
- Each diagnostician’s digital diagnosis paralleled their glass slide diagnosis.
- Cytotechnologists are very capable of adopting digital cytology.
- We are talented professionals who have great potential to adopt new technology!
How about the technology?

• WSI should not yet replace glass slides and microscopes in primary diagnosis because WSI has added cost, time, and underperformance in certain areas.

• Challenges are in technology, such as 40X with optical doubler and focus electronically does not gain in resolution.

• Limited by engineering issues of WSI image capture and viewing, such as faster speed, better screening and navigation tool, and better quality of digital slides.

• Cytology WSI imaging application will dramatically increase when technical/engineering issues are resolved.


Technical requirement specific for digital cytopathology

• High resolution and speed

• 3D imaging and real time viewing

• Screening, dotting and ergonomic issues

• Data management and automated analysis
Digital Cytopathology: Are We Ready Yet?

Henderson-Jackson EB1, House J2, Lloyd M1, Dhillon J1, Ahmad N1, Hakam A1, Khalbuss WE1, Mela N1, Quigley B1, Zhang X1, Leen ME1, Pacholke A1, Clanton K1, Grieble J1, Chhieng D1, Centeno B1, Bui MM1

1Moffitt Cancer Center, Department of Anatomic Pathology, Cytology Division; 2Department of Pathology and Cell Biology, University of South Florida College of Medicine; 3Shady Side Hospital, Cytology Division, University of Pittsburgh; 4Department of Pathology, Cytology Division, Yale University

Introduction

- Digital cytopathology is more commonly used for liquid cytology, automated screening of PAP smears, education, proficiency testing, and re-evaluation
- Digital cytopathology methods include slide images, real time communication, and full slide images
- Literature on image of whole-slide images (WSI) in clinical cytopathology diagnostic applications, especially for primary diagnosis, is limited
- We studied the concordance in primary diagnosis between glass and digital (virtual) slides among diagnosticians with different training profiles to assess our readiness in adoption of digital cytopathology in clinical practice

Materials and Methods

- 22 de-identified cytology cases with reference diagnoses (see Table below)
- Previously diagnosed and verified by PI
- Most representative 1-2 slides of each case
- Evaluate: cytology: body fluids, urine, sputum, cerebrospinal fluid, and PAP smears (ThinPrep and conventional)
- Time needs operators: pancreas, lung, thyroid, neck, lymph nodes, and brain
- Preparations: smears, cytospins, ThinPrep, and cell block; Diff-Quik, Papturk (PAP), hematoxylin and eosin (H&E), and fungal stain (GMS)

- Digital 22 de-identified routine cytology cases using Aperio ScanScope XT slide scanner
- At 20X/0.75 and 40X (with optical filters)
- Image resolution: 0.55um per pixel at 20X or 0.25um per pixel at 40X
- Captured in single planes without Z-stacking or multi-plane imaging
- Images viewed through Spectra and ImageScope via internet

Minimum System requirements for viewing digital slides:
- CPU Speed: 500MHz, 2GB recommended
- RAM: 1GB, 1GB recommended
- Network Card: 10/100 network card or faster
- OS: Windows XP Pro (32-bit) or Windows Vista Pro

Results

- Only few requests detailed the use of WSI in cytopathology diagnostic applications (Ref 1)
- PI study with head to head comparison of primary cytopathological diagnosis using a glass vs. digital slide set that included a variety of routine cytopathology specimens

- 1. Compared to the reference: A. Everard, et al. Cytology Division (Ref 2)
- 2. WSI for liquid-based PAP smear evaluation
- No statistical difference in accuracy between WSI and glass slides
- Glass to WSI: more than doubled compared to the glass slide (45 vs. 93%)
- WSI undergraded glass slides when images were captured in single planes without focusing capability and computerized
- 1st study with head to head comparison of a variety of diagnosticians including cytotechnologists with and without digital experience, cytopathology, and residents

- Comparing to the reference: MR. Guarnier, et al. Atrs for longer hours

- PI evaluates the cytologist and 3 resident cytotechnologists (with 10-years of experience who were digital naïve) over 4 sessions
- They were able to reach “correct diagnosis” not intersected with digital cytology differently (students vs. residents, more than 36% vs. 22%)
- Why not 100% concordance between glass slides and the reference diagnosis?
- Realistic expectations of each side
- One observer
- Limited time and information
- Utilities that are equal to real case scenarios
- Specific rule: Multimodal approach in a case including multiple slides of various preparations, multiple observation, and correlation with detailed clinical information are warranted for a better diagnosis

Discussion

- Glass slide interpretations were better and faster
- Less than 10% of the digital slides were considered of poor quality
- Agreement in diagnosis between digital whole-slide and glass was good (7% difference)
- Difference in years of experience in digital diagnosis, excluding residents
- Cytotechnologists are excellent in adapting digital cytopathology
- For a valid diagnosis, lack of digital experience did not compromise one’s diagnosis using digital slides
- Each diagnostician’s digital diagnosis parallel one’s glass slide diagnosis
- We are ready to adopt new technology, surprisingly!
- WSI should not yet replace glass slides and microscopes in primary diagnosis because of WSI has added cost, time, and underperformance in certain areas
- Challenges are in technology
- 4X with optical doubler and focus electronically does not gain in resolution
- Limited by engineering issues of WSI image capture and viewing, such as faster speed and better quality of digital slides
- Real power of digital cytopathology resides in the computer-associated applications
- Not limited by time and space
- Multiple viewers beyond multidemasked microscopes
- Better linkage with other electronical applications
- Data analysis and artificial intelligence applications
- Cytology WSI imaging application will dramatically increase when technical/engineering issues are resolved

Conclusions

- Glass slide interpretations were better and faster
- Less than 10% of the digital slides were considered of poor quality
- Agreement in diagnosis between digital whole-slide and glass was good (7% difference)
- Difference in years of experience in digital diagnosis, excluding residents
- Cytotechnologists are excellent in adapting digital cytopathology
- For a valid diagnosis, lack of digital experience did not compromise one’s diagnosis using digital slides
- Each diagnostician’s digital diagnosis parallel one’s glass slide diagnosis
- We are ready to adopt new technology, surprisingly!
- WSI should not yet replace glass slides and microscopes in primary diagnosis because of WSI has added cost, time, and underperformance in certain areas
- Challenges are in technology
- 4X with optical doubler and focus electronically does not gain in resolution
- Limited by engineering issues of WSI image capture and viewing, such as faster speed and better quality of digital slides
- Real power of digital cytopathology resides in the computer-associated applications
- Not limited by time and space
- Multiple viewers beyond multidemasked microscopes
- Better linkage with other electronic applications
- Data analysis and artificial intelligence applications
- Cytology WSI imaging application will dramatically increase when technical/engineering issues are resolved

References


No relationship exists that represents a possible conflict of interest with respect to the content of this presentation.
A ThinPrep Pap test is shown of melanoma involving the cervix. The large 3D group of tumor cells in the middle is out of focus in the scanned plane of this digital image.
Solution to 3D cell groups

- **Video microscopy**: multi-frame video images (z-axis video).

- **Z-axis scanning (z-stacking)**: scanning the same glass slide at different focal planes along the Z-axis and stacking the images to produce a final composite (z-stack) multiplane image. This allows the cytologist to “zoom up and down” the different planes to find cells and/or structures that are in focus. *Diagnostic Histopathology* 20:12

<table>
<thead>
<tr>
<th>Multilayer stacking</th>
<th>Extended focus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages:</strong></td>
<td><strong>Advantages:</strong></td>
</tr>
<tr>
<td>Maintains some semblance of focusing up and down the z-axis</td>
<td>File size same as with single-layer scans</td>
</tr>
<tr>
<td>All areas are brought into focus on the same image – no need to move up and down the z-axis, therefore increasing the speed of slide evaluation</td>
<td></td>
</tr>
<tr>
<td><strong>Disadvantages:</strong></td>
<td><strong>Disadvantages:</strong></td>
</tr>
<tr>
<td>Longer scanning times compared to scanning only one focal plane scan</td>
<td>Information is discarded permanently: can no longer evaluate a 3D cluster of cells by focusing up and down</td>
</tr>
<tr>
<td>Larger file size, proportional to the number of layers involved</td>
<td>Although resulting files sizes with extended focus are the same size as single focal plane scans, total scanning time is increased due to the multiple focal planes involved</td>
</tr>
</tbody>
</table>

*J Pathol Inform.* 2011: 2:46
(a) Extended focus improves focus (black arrow) for areas out of the plane of focus but sharpness and detail appears to be adversely affected. Nuclear contours (red arrow) and chromatin detail (blue arrow) are harder to assess, and white intranuclear digital artifacts are seen only in extended focus (green arrows). 16 focus planes were used in this example.

(b) Multilayer stack counterpart to (a). At low power (10x), (c) loss of sharp detail can still be seen in extended focus compared to its multilayer stack counterpart. Nuclear detail is blurred compared to the sharply focused, corresponding area within the multilayer stack version (black arrowhead), and cell borders are difficult to assess (red arrow).
<table>
<thead>
<tr>
<th>Vendor</th>
<th>Scanner model</th>
</tr>
</thead>
<tbody>
<tr>
<td>3DHISTECH</td>
<td>Pannoramic Desk II, Pannoramic MIDI II,</td>
</tr>
<tr>
<td></td>
<td>Pannoramic SCAN II, Pannoramic 250 Flash II</td>
</tr>
<tr>
<td>Huron</td>
<td>TISSUEscopeTM 4000, TISSUEscopeTM 4000XT,</td>
</tr>
<tr>
<td></td>
<td>TISSUEscope TM4000XT</td>
</tr>
<tr>
<td>Leica</td>
<td>SCN400</td>
</tr>
<tr>
<td>Ventana</td>
<td>iScan coreo scanner, Ventana iscan HT Scanner</td>
</tr>
<tr>
<td>Sakura</td>
<td>VisionTek</td>
</tr>
<tr>
<td>Olympus</td>
<td>VS120-SL</td>
</tr>
<tr>
<td>Hamamatsu</td>
<td>NanoZommer RS, NanoZommer HT,</td>
</tr>
<tr>
<td></td>
<td>NanoZommer XR</td>
</tr>
<tr>
<td>Leica (Aperio)²</td>
<td>ScanScope AT, Aperio AT2, ScanScope CS,</td>
</tr>
<tr>
<td></td>
<td>ScanScope FL</td>
</tr>
<tr>
<td>Mikroscan</td>
<td>D2</td>
</tr>
</tbody>
</table>

² Z-stack over user selected areas only.
Z-stack WSI without scanning

- Although z-stacking scanning is technically feasible, it consumes large digital file, takes longer time, and carries larger burden on the work flow and network.
- Robotic microscope examines cytology slides in real time with z-stacking ability provide a practical solution. Without scanning, small carbon print.

- VisionTek Digital Microscope from Sakura: hybrid WSI and robotic real time digital microscope
Search maps are shown for cytotechnologists at low, medium and high magnification of (a) a FNA smear and (b) ThinPrep slide. The light green area represents the examined area covered by the user.
**Rapid on site evaluation (ROSE):** For cell adequacy, preliminary diagnosis, or consultation or ancillary testing result

- Video appears to the most practical and popular method; No scanning and z-stack.


- Robotic scope: real time viewing of whole slide with focused examination of area of interest at higher magnification and the ability of focusing up and down; scanning is available but loose the z-stackning.

Need & Opportunities

MINI-SYMPOSIUM: WHOLE-SLIDE IMAGING IN PATHOLOGY
DIAGNOSTIC HISTOPATHOLOGY 20:12

Whole-slide imaging:
widening the scope of cytopathology

Ehab A El-Gabry, Anil V Parwani and Liron Pantanowitz

• WSI can be used for telecytology, quality assurance activities, and teaching.
• Screening digital cytology slides is facilitated by viewing software features, displaying thumbnail images and annotation tools.
• Progress in WSI technology that permits high resolution scanning, z-stacking, and hybrid robotic devices has encouraged the use of WSI in cytology.
Review Article
Screening for Cervical Cancer Using Automated Analysis of PAP-Smears

Ewert Bengtsson and Patrik Malm

- PAP smear is the most effective cancer screening and preventive measure developed so far.
- Numerous attempts at automating this analysis since the test was introduced >60 years ago.
- The purpose of an automated inspection system is to decrease the false negative rate of a screening program and/or decrease the cost.
- The currently commercially available systems marginally increased the quality of the screening without significantly decreased the cost.
- Technical challenges: 1) Specimen preparation, 2) Scanning, 3) Segmenting cells and nuclei, 4) Artifact rejection, and 5) Feature extraction.
- A compact, robust automate screening system could make a big difference in undeveloped country where this is a shortage of cytology expertise.

Computational and Mathematical Methods in Medicine Volume 2014, Article ID 842037, 12 pages
http://dx.doi.org/10.1155/2014/842037
Outline

• The current concepts of digital pathology
• The practical applications of digital pathology in cytology
• Whole slide image cytology case interactive discussion
• Conclusion
Whole Slides Images

- Case #1: Meningioma in a patient with history of breast cancer
- Case #2: Intraductal papillary mucinous neoplasm in a patient with a cystic mass of tail of pancreas and dilated main pancreatic duct
- Case #3: Solid-pseudopapillary neoplasm of pancreas
Outline

• The current concepts of digital pathology
• The practical applications of digital pathology in cytology
• Whole slide image cytology case interactive discussion
• Conclusion: Pathologists are leaders in the changing world of precision medicine
Accurate pathologic diagnosis is essential to ensure the most effective treatment.
Value of a Pathologist

- Pathologists working in partnership with a clinical team can generate as much as 30% of system value, while lab testing represents only 3% of system costs
- 70% of medical decisions made by physicians are based on lab findings
- Pathologists can help physician practices effectively manage their patients by:
  - Patient registry and laboratory data management
  - Interpretation of lab tests and clinical decision-making
  - Patient education and empowerment

© 2011 College of American Pathologists. All rights reserved.
A patient’s medical journey begins with their diagnosis...

...we provide forecast of

Diagnosis

Prognosis

Therapeutic selection and prediction

Courtesy of Dr. Mark Lloyd
Pathologists are Leaders in Precision Medicine

• Uniquely qualified to determine the clinical value of complex (and costly) tests
• Uniquely qualified to interpret the results of genomic and other molecular tests that can predict a patient’s predisposition toward a disease, and yield better results in managing a disease
• At the forefront of advancing personalized medicine with new methods of molecular and genetic analysis for disease diagnosis and management
Bright Future of Digital Pathology

- Disruptive technologies are emerging which will impact clinical diagnostics
  - Genomics
  - Circulating tumor cells and liquid biopsy
  - Digital pathology and image analysis

- These applications will transform Anatomic Pathology
- We must embrace the future with collaborative mentality
- support digital pathology education initiatives
- define best practices
- influence standards and interfaces
- organize an annual conference that addresses diverse needs within the industry
To advance the adoption of digital pathology within the CAP and to serve as a respected resource for information and education for pathologists, patients and the public on the practice and science of digital pathology.
Validating Whole Slide Imaging for Diagnostic Purposes in Pathology

Guideline from the College of American Pathologists Pathology and Laboratory Quality Center

Leo Pantanowitz, MD; John H. Sinard, MD, PhD; Walter H. Henricks, MD; (via A. Fatheree, BS, SCT/ASCP); Alexis B. Carter, MD; Lydia Conte, MD; Bruce A. Beckwith, MD; Andrew J. Evans, MD, PhD; Christopher N. Ols, MD; Antar Lal, MD, PhD; Anil V. Parwani, MD, PhD

Context—There is increasing interest in using whole slide imaging (WSI) for diagnostic purposes (primary and/or consultation). An important consideration is whether WSI can safely replace conventional light microscopy as the method by which pathologists review histologic sections, cytology slides, and/or hematology slides to render diagnoses. Validation of WSI is crucial to ensure that diagnostic performance based on digitized slides is at least equivalent to that of glass slides and light microscopy. Currently, there are no standard guidelines regarding validation of WSI for diagnostic use.

Objective—To recommend validation requirements for WSI systems to be used for diagnostic purposes.

Design—The College of American Pathologists Pathology and Laboratory Quality Center convened a nonvendor panel from North America with expertise in digital pathology to develop these validation recommendations. A literature review was performed in which 767 international publications that met search term requirements were identified. Studies outside the scope of this effort and those related solely to technical elements, education, and image analysis were excluded. A total of 27 publications were graded and underwent data extraction for evidence evaluation. Recommendations were derived from the strength of evidence determined from 23 of these published studies, open comment feedback, and expert panel consensus.

Results—Twelve guideline statements were established to help pathology laboratories validate their own WSI systems intended for clinical use. Validation of the entire WSI system, involving pathologists trained to use the system, should be performed in a manner that emulates the laboratory’s actual clinical environment. It is recommended that such a validation study include at least 60 routine cases per application, comparing intraobserver diagnostic concordance between digitized and glass slides viewed at least 2 weeks apart. It is important that the validation process confirm that all material present on a glass slide to be scanned is included in the digital image.

Conclusions—Validation should demonstrate that the WSI system under review produces acceptable digital slides for diagnostic interpretation. The intention of validating WSI systems is to permit the clinical use of this technology in a manner that does not compromise patient care.


In the last decade, digital imaging in pathology has been significantly impacted by the development and application of whole slide imaging (WSI) technology. The automated WSI scanner is a robotic microscope capable of digitizing an entire glass slide, using software to merge or stitch individually captured images into a composite digital image. The critical components of an automated WSI device system include the hardware (scanner composed of an optical microscope and digital camera connected to a computer), software (responsible for image creation and management, viewing of images, and image analysis where applicable), and network connectivity. Whole slide imaging technology has evolved to the point where digital slide validation is an integral part of the diagnostic process.
Thank you!

THE HEALING ART of Pathology

- Focuses on the discipline of pathology as seen through the lens of art. The artwork and stories presented in the book celebrate the courage of patients, the compassion of physicians, and the strength of the human spirit.
- The art presented represents various media, including paint, fabric, ceramic, glass, and digital images. Original poetry and prose are also represented.
- To order: Best way is to call 1-800-323-4040 option 1. Item PUB315, S/H will apply. Or go to www.cap.org, Shop tab (search Healing Art; you must have a registered account to purchase online).
- To purchase this book is to support pathology community and the CAP Foundation. The editors donate the royalties from the book to CAP Foundation.