Whole Slide Imaging: Efficiencies and Costs
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Introduction
While the advantages of whole slide imaging (WSI) for digital pathology and telepathology are well established (1-4), formal evaluation of the parameters that impact the costs and benefits of various digital pathology activities based on WSI have not been rigorously evaluated. Analyses based on cost have traditionally focused on direct costs (for both hardware and software) and indirect costs (support personnel), while evaluations of the opportunities provided by WSI have usually focused on operational factors such as ease of use, scalability, etc. (1-3). However, analyses of these types largely ignore a fundamental workflow issue in diagnostic surgical pathology that is part of routine practice, namely that the histological sections on glass slides that are a necessary and intrinsic component of diagnostic surgical pathology must be produced as part of any WSI process. This presentation discusses a rigorous "value added" approach we developed that focuses on specific operational measures (cost, time, and accuracy) and the various clinical settings in which they can provide enhancement to determine the settings in which WSI is able to improve our surgical pathology practice.

Setting
The perspective for our value added analysis is a tertiary care medical center surgical pathology practice characterized by a high volume of high complexity cases; a subspecialty emphasis sign-out model; multiple sign-out areas; numerous training programs; and an academic pathology department. The results of the value added approach we report necessarily depend on our practice setting.

Value Added Components
Value added is defined by purely operational measures, specifically cost savings, time savings, or improvements in accuracy (5,6). Value added can be assessed on a number of different scales; this presentation focuses on the analysis for patient care activities, although in parallel we also evaluated how WSI could add value to our educational activities and research.

Note that some aspects of digital pathology based on WSI are specifically not value added in our practice setting. For example, the mere capability to produce a digital image that can be used for primary diagnosis (digital sign out) in and of itself is not value added, since diagnosis based on the routine histological section is already possible based on traditional light microscopy. However, aspects of digital sign out that are not value added in our model may well provide a benefit in other practice settings (such as support of subspecialty consultation or the opportunity to view special stains produced by outside laboratories).
Marginal Costs
The cost of WSI in routine clinical practice involves not only traditional direct costs, but indirect costs that are often overlooked, including pre-scan, scan, and post-scan costs. Significant costs are introduced by necessary quality control and IT processes. In our practice, were we to scan every slide, it would require an additional initial capital investment of approximately $2M (for hardware and software), a yearly direct cost of approximately $10,000 (for memory to store the digital images), and a yearly indirect cost of approximately $650,000 (for support personnel).

Areas Where WSI is Value Added
There are five specific areas in which WSI provides capabilities which enhance daily practice, which are either superior to currently existing workflow processes or are not currently available, specifically availability, timeliness, portability, permanence, and for production of a substrate for digital image analysis. Using these five specific capabilities, we identified several settings in our patient care activities which WSI was advantageous.

- WSI of selected slides from cases sent to us in consultation
  - Directly enhances patient care through the availability, portability, and permanence of the images for patient care conferences
  - Provides a QA function
- WSI of slides that will be destroyed by ancillary testing
- WSI of slides that will be sent out
- WSI of legal cases
- WSI of cases for digital image analysis

Problems in Implementation
It became clear in our evaluation of WSI that the faculty and trainees at our institution vary in their comfort level and experience with the various software packages for image analysis, and also show marked variation in their willingness to incorporate digital image analysis into their routine practice. The faculties were unanimous in their unwillingness to incorporate a digital imaging process that required that they move back and forth between different software packages; many faculty were unwilling to have two computer monitors so that both software packages could be open at the same time; and the faculty demanded that any WSI process was operational both locally and remotely.
In collaboration with several vendors, we therefore pursued a model of one-stop-shopping in which there was an automatic interface between the imaging software (Aperio Spectrum) and our lab information system (Cerner Copath). Development of this new functionality required both system architecture design and new software code, and was associated with a significant additional investment in time and money. The need for development of this custom interface emphasizes additional costs that are often overlooked in evaluation of the utility of WSI in routine pathology workflow. Off-the-shelf hardware and software packages, regardless of the vendor, have generic functionality and integration into specific practice environments will often require custom software changes.

Outcomes

The value added approach appears to have been successful in identifying settings in which WSI adds utility to our surgical pathology practice, based on several metrics. Over the last three years there has been continued growth both in the number of slides scanned and the number of cases which utilize WSI; there has been increased faculty interest in expanding WSI applications locally (inclusion of in-house cases) as well as remotely (implementation on laptops and iPads); and we are extending WSI applications into education and research activities (7).

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Disclosure

no conflicts of interest to disclose
Perspective for this talk: practice environment

- Academic tertiary care medical center
- Academic department
- High volume of high complexity cases
- Large number of surgical pathologists
- Large number of consult cases
- More than one signout area; more than one frozen section area
- Large number of trainees
Characteristics of a WSI system with clinical utility

• Operational: easy to use

• Cost: low direct costs (hardware and software) and low indirect costs (support personnel)

• Value added
The “value added” component is the critical piece for evaluating the efficiencies and costs of WSI.

- “value added” can be defined broadly by any number of operational measures; we tend to focus on:
  - Cost
  - Time
  - Accuracy

- “value added” can apply to:
  - Patient care
  - Educational activities
  - Research

- things that are not “value added”
  - Mere capability of being able to do it
  - Novelty factor
Digital signout is not “value added” in our patient care activities

- We are a high volume practice
- We already have the glass slides
- We have a subspecialty emphasis practice model
- WSI adds significant time and costs
We have this...
And this…

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WSI adds time

20X scan

- Enter histology, label slide with barcode = 1 minute
- Prep slide for scanning = 1 minute
- Scan slide = 6 minutes
- Verify slide information in CoPath = 4 minutes
- Total = 12 minutes per slide

After the slides are scanned

- Un-assign and delete bad scans
- Open case in CoPath and Spectrum to assure correct patient information has been transferred and slides are associated with the correct case
- Assign/Resend slides that did not automatically cross
- Total = 4 minutes per case
WSI costs money

- Process 200,000 blocks per year (about 800 blocks per day) and produce at least 380,000 slides per year (about 1,500 slides per day), not including consultation slides.

- In 2009 we scanned 9,454 slides (<3% of slides), for which we needed one scanner (30% max utilization), one digital imaging technician (<30% utilization), and one IT support person (<30% utilization).

- To scan all slides would add an additional initial direct cost of +/- $2M (hardware and software), yearly direct cost of +/- $10K (memory), and yearly indirect cost of +/- $650K (personnel).
Things that *are* “value added” in our patient care activities

- **Availability** (don’t need to go to the slide file; don’t need to request slides from outside institution again)
- **Timeliness** (get images in seconds)
- **Portability** (can access images from anywhere in the medical center)
- **Permanence** (save image of slide that will be destroyed during ancillary testing, or sent to an outside institution)
- **Production of a substrate for digital image analysis**
“value added” applications we have identified in patient care

- WSI of selected slides from cases sent to us in consultation
  - Directly enhances patient care through the availability, portability, and permanence of the images for patient care conferences
  - Provides a QA function
- WSI of slides that will be destroyed by ancillary testing
- WSI of slides that will be sent out
- WSI of legal cases
- WSI of cases for digital image analysis
To capture the “value added” in patient care, we needed to develop an interface between the imaging software and our LIS because…

• Our surgical pathology faculty is comprised of 35 lone wolves, and…

• The lone wolves are not all equally tech savvy, and…

• It turns out that you can’t teach old lone wolves new tricks
More generally…

- **Multiple users with different interest and ability**
  - Attendings (about 30)
  - Residents (about 40)
  - Fellows (about 20, from ten different programs)

- **Multiple sites**
  - Office
  - Home
  - Road

- There is only one opportunity to make a first impression
Our solution...

One Stop Shopping
Locations: WIC 1 East
Submitter: Unknown
Service: WIC Surgery
Primary Pathologist: Joan G. Rosset, CT(ASCP)

Signed Out: 11/2/2009 15:11

Part Description(s):
Sigmoid Colon, Rectum and Anal

Worklist For Final
Staff
Memo

*Attachments exist for this case*
Welcome

Please log in

To log in, enter the credentials required, and then click Log In.

If you do not know your log in information, please contact your help desk or system administrator.

Message Center

⚠️ Current browser security restrictions may prevent you from launching applications, or may require your explicit permission to proceed. To launch an application successfully, save the launch file if prompted and double-click the file to start the application.
Costs for “one stop shopping” functionality

• **Time**
  o Architecture (9 months)
  o Implementation (2 months)

• **Money**
  o Aperio Interface ($15K)
  o CoPath HL7 Interface ($12K)
  o Advanced Bar Coding & Tracking (AB&T) module for Cerner CoPath ($45K)
Outcome of our “value added” approach for evaluating efficiencies and costs to identify settings in which WSI would have utility in the surgical pathology laboratory

Over the last three years...

• **Growth**
  - 2008: 4,457 scans from 2,749 I/O cases
  - 2009: 9,454 scans from 7,541 I/O cases
  - 2010 (projected): 12,000 scans from 11,000 I/O cases

• **Faculty Acceptance**
  - Interest in implementation on laptops and iPads
  - Interest in inclusion of in-house cases

• **Extension of “one stop shopping” model to educational and research applications**
Collaborators

• Department of Pathology
  o Mike Isaacs
  o Emily Brophy
  o Walter Clermont
  o Stacey Yates

• Barnes Jewish Hospital
  o Joan Rossi
  o Kevin Selle
Summary

• A “value added” approach can be used to evaluate the efficiencies and costs of WSI in order to identify settings in which WSI will have utility in the surgical pathology laboratory.

• The efficiencies and costs of WSI “at the margin” must be considered when evaluating the utility of WSI in routine surgical pathology practice.

• Practice environment and political issues unique to each surgical pathology laboratory dictate many of the indirect costs.