Defining the Role of Anatomic Pathology Images in the Multimedia Electronic Medical Record – A Preliminary Report

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ABSTRACT

The development of the Multimedia Electronic Medical Record System (MEMRS) offers new opportunities for integrating medical imaging data with text-based clinical data. The effective integration of pathology images into the patient’s medical record poses some significant technical and organizational challenges. Before these challenges can be met, it is imperative that we investigate the value and utility of providing these images to clinicians. In this study we examined attitudes towards use of pathology images in Image Engine, a MEMRS under development at the University of Pittsburgh Cancer Institute (UPCI). We conducted semi-structured standardized interviews with a cohort of practicing oncologists, all of whom had significant experience with Image Engine. This study is a first step towards elucidating the potential barriers, uses, and value of anatomic pathology images in the MEMRS.

INTRODUCTION

As the quantity and diversity of medical information grows, the patient record is becoming increasingly fragmented, with important data spread across many different data repositories. Medical imaging data is particularly susceptible to this fragmentation. For example, a single patient with esophageal carcinoma may have a chest CT scan stored in a radiology PACS, an EGD video archived in the endoscopy laboratory, and gross and microscopic images of the esophageal biopsy and resection stored in the pathology department’s image database.

Multimedia electronic medical record systems (MEMRS) have the potential to combine these disparate forms of data, juxtaposing text with images and video to present an integrated view of the patient record. In 1991, the Institute of Medicine of the US National Academy of Sciences issued its landmark report entitled “The computer based patient record—An essential technology for Health Care. They recognized the importance of the multimedia aspect of the EMR, stating that “the future patient record will be a computer-based, multimedia record capable of including free-text, high resolution images, sound, full motion video, and elaborate coding schemes”.

Medical images are often critical to patient care. This is particularly true in oncology, where decisions regarding cancer staging, grading, and therapeutic planning are routinely based on information generated from anatomic pathology and diagnostic radiology examinations. Radiology images make up a large fraction of images presented in most MEMRS, and include images from X-ray, CT, MRI, PET, and isotope scans. Images derived from other sources (pathology images, electrocardiograms, endoscopy images) represent a smaller percentage of MEMRS images. Although information derived from anatomic pathology examination is often of paramount importance in patient care, we are aware of no previous work investigating the utility of presenting pathology images within a MEMRS.

BACKGROUND

The Image Engine project is a National Library of Medicine funded research effort at the Center for Biomedical Informatics (CBMI) at the University of Pittsburgh. Image Engine is a prototype MEMRS, which provides an integrated multimedia view by employing agent-based retrieval from heterologous biomedical databases. At the time this study was performed, Image Engine was in active use by six medical oncology teams, who were able to access patient data on several hundred clinically active UPCI patients. A new version of the prototype, called Chart Engine, offers a chart-based view of the Multimedia EMR. Chart Engine is currently being deployed throughout UPCI, and plans are underway to significantly increase the numbers of patient records and users that the system supports. Pathology images have been included in Image Engine, since
January, 1997. There are currently over 20,000 image studies available through Image Engine, approximately 5% of these represent microscopic pathology images.

Audit logs have shown only sparse use of pathology images – less than 20% have ever been accessed. The purpose of this study was to investigate possible reasons for this finding. More generally, we also sought to explore opinions on the role of anatomic pathology images among a group of pilot MEMRS users.

RESEARCH QUESTIONS
1. Are there barriers to the use of pathology images in Image Engine? If so, what are they, and how can they be alleviated?
2. For what purposes are oncologists interested in using pathology images?
3. Are there particular types of cases where pathology images are needed? If so, what features define these cases?
4. What is the value of anatomic pathology images in a MEMRS?

METHODS
Five of six pilot users of Image Engine were interviewed for this study. All were practicing academic oncologists, with a range of specialty interests including genitourinary cancer, head and neck cancer, melanoma, and neuro-oncology. Users interviewed had an average of 25 months of experience using Image Engine.

Using standard methods, we developed a 50 question semi-structured standardized interview instrument to elicit information specific to each of the four research questions. Interview lengths ranged from 40-75 minutes. All interviews were tape-recorded, transcribed verbatim, and coded according to a standardized coding scheme. Data was then aggregated across users to derive the various counted measures. Due to a limited number of subjects in the population studied, no statistical testing was deemed appropriate.

RESULTS

Barriers to use of pathology images in Image Engine

Users identified a number of barriers to pathology image use in Image Engine (Table 1). At the time of this study, access to Image Engine was available only through workstations in the oncology clinics – clinicians did not have access from personal computers in their offices. This was noted by several users as a significant barrier to pathology image use, because clinicians reported that they were most interested in viewing these images outside of busy clinic hours.

Another barrier was lack of timely access to pathology images. During early work on pathology images in Image Engine, our resources were directed towards resolving technical issues including digital acquisition, compression, representation, retrieval and display. Timely access was not a primary goal, and the interval between patient presentation and image capture was frequently in the range of 3-6 months. Most clinicians interviewed indicated that pathology images are only of interest during a relatively short interval following the first consultation, or after a subsequent biopsy, aspiration or resection.

<table>
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<tr>
<th>Table 1: Barriers to use of pathology images</th>
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<td>IE not accessible from office</td>
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<td>Images not available when needed</td>
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<tr>
<td>Unable to interpret images</td>
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<tr>
<td>Physician time constraints</td>
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<td>Types or number of images insufficient</td>
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<tr>
<td>Unaware that they were available</td>
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<td>Images not of sufficient interest</td>
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Some oncologists indicated that an important barrier was their own difficulty in interpreting images without a pathologist present. In fact, when asked to estimate their level of confidence on a scale of 1-10, the average confidence level in viewing digital pathology images without a pathologist was 2.0 ± 1.7 as compared to a confidence level of 7.6 ± 0.9 for viewing digital images of CT or MRI without a radiologist. Some of those interviewed considered viewing of pathology images less critical for patient management than viewing radiology images, and therefore it was low on their priority list of clinic activities.

One oncologist commented on the absence of sufficient numbers of images (i.e. both high and low power views) and another reported that he was unaware that pathology images were available at all.
Current and potential uses of pathology images in the MEMRS

Users who had accessed pathology images previously (4/5) reported that they chiefly used them for teaching house staff and medical students. Three users indicated that they had looked at images on their patients for clinical purposes, primarily to save the time required to go to the Pathology Department to see the slides. None had used these images for research purposes or for patient education.

We also asked users about potential uses for these images. In addition to clinical use and teaching, three users saw a potential for using these images in their own research. Most users stated they saw no potential for gross or microscopic pathology images in patient education.

Features of cases with high potential for use

We asked users to define key features of cases in which they are likely to want to see the pathology, either by reviewing the slides with a pathologist, or seeing digital images on their own. Users responded that they were most likely to seek pathology images or look at the slides when the pathology diagnosis did not match the clinical diagnosis, when the case represented a rare diagnostic entity, and when there was information missing from the pathology report. Some users suggested that they were unlikely to want to review pathology images for routine cases in their subspecialty area.

We specifically questioned users about differences in how much they tended to want to see pathology on patients who came to them from another institution, where an initial work-up had already been done, including pathologic examination. Users universally suggested that they were more likely to try to see these “outside” cases than those that had been initially seen in their own institution. This is despite the fact that slides from “outside” are routinely reviewed by a pathologist at their own institution, who issues a report agreeing or disagreeing with the preceding diagnosis.

Value of anatomic pathology images in the MEMRS

Most users suggested that pathology images are of high educational value, and that much of their utility resides in teaching medical students, house staff and oncology fellows. Several users suggested that the availability of digital pathology images might replace the need to walk over to the Pathology Department in another building, in order to see slides on some of their patients. However, most users suggested that this availability of digital images would not replace direct consultation in all cases.

Four of five users indicated that seeing pathology on a subset of their patients was a routine part of their clinical practice. When probed to describe the value of this practice, several users suggested that there was diagnostic and prognostic information in seeing the case that could not always be gleaned from the report alone. One physician who sees a large number of patients with Malignant Melanoma described it this way:

“In melanoma it’s very important. Because you look at the depth of the lesion, you look at other factors like mitotic rate. And you know we’ve looked at so many of them. I don’t think we’re as good as pathologists but we can look at a lesion sometimes and get a feel for...this guy’s going to do poorly or not, and although you don’t make clinical decisions based on that...I never treat a melanoma patient without looking at pathology”

A GU oncologist described another potential value – the possibility of making novel observations by correlating pathology images with the clinician’s intimate knowledge of the patient’s clinical course:

“You know one of the questions in kidney cancer is – kidney cancer has an incredibly variable course. Pathologists are sitting over at their microscopes, and they don’t know anything about the patient. And if I were looking at a clear cell carcinoma or 25 consecutive images, or 45, or 50. And I had some flavor for what the clinical course was. There may be observations to be made there.”

CONCLUSIONS

Despite the relatively low usage of pathology images, we found that there was interest in using these images for teaching, patient care, and research. We further identified five potential factors that might, in part, explain the minimal access rates. These include lack of system availability outside of clinic, prolonged latency to image entry, difficulty in interpreting images in the manner they are currently displayed, insufficient numbers and types of images, and physician time constraints.
IMPLICATIONS FOR REDESIGN

Shortly after completion of this study, a secure internet accessible version of Image Engine was deployed, allowing access from oncologists offices. To address the remaining barriers to pathology image use, we are currently evaluating an approach that is markedly different than our previous efforts. In a pilot study currently being designed, we will provide HTML based image-enhanced pathology tele-reports\textsuperscript{6,7} to a single oncology clinic, on a subset of patients. Alterations to previous practice include:

1. **Increased clinical context.** Rather than isolated image studies, pathology images will be presented within the context of the pathology report. Text in the report can be linked to images. (Figure 2).
2. **Annotation.** Expanding the image thumbnail will bring the user to a separate image page, which includes text annotation, and graphical annotation in some cases.
3. **Improved timeliness.** Because of the limited size of this study, it is possible to have tele-reports available at the time of the patient’s visit.
4. **Increased numbers and types of images.** In addition to multiple microscopic images, tele-reports provide gross images, and images of special studies if available.

**Figure 2: Image enhanced pathology tele-report**

A multi-method evaluation approach will include audit log analysis, observation, survey data, and directed interviews. The purpose of this pilot study, and a larger study to follow, is twofold: (1) to determine whether these images are utilized, and how they are utilized in an environment that minimizes barriers to use, and (2) to characterize the perceived value of pathology images in the MEMRS. If the alterations designed are associated with increased use, scalable solutions may be sought.

DISCUSSION

One of the limitations of our study was the limited sample size and the single subspecialty studied. We purposely limited our study to the small population of Image Engine pilot users. But the use of pathology images could be quite different in other specialties. For example, we suspect that surgeons and radiologists might find access to gross images on their patients to be a useful tool. Some clinical specialties, for example hematologists or dermatologists, routinely examine microscopic slides on their patients. For these specialties, access to digital pathology images could be advantageous. Despite these limitations, our study identifies some important factors that should be considered in any MEMRS incorporating pathology images.

Incorporation of pathology images into a multimedia EMR poses some substantial technical and organizational challenges. Before we can address these challenges, we must carefully evaluate whether inclusion of pathology images offers real benefits to patient care, education or research. And as is frequently the case in medical informatics, we must also look forward, trying to assess the information needs ahead of us in an ever changing environment.

If pathology images do add value to the MEMRS, what are the significant challenges to their inclusion? Routine image capture in a large academic pathology department requires multiple imaging stations, image acquisition software, and image database capabilities\textsuperscript{8}. Most importantly, capture of representative fields requires an additional step in the usual case workflow, which can only be accomplished by the pathologist or pathology resident. A significant time cost may be incurred, in order to achieve digital capture of all cases.

There are two potential approaches to this problem. The first approach is to limit digital capture to cases most likely to be viewed by clinicians. For our target population of oncologists, this poses some difficulties. In academic oncology centers, most patients are referred following diagnosis under the care of another physician. This makes it virtually impossible to capture images on only the UPCI patients at the time that the pathology examination is performed. A potential solution to this problem is to limit digital capture to cases in which a neoplastic or
malignant diagnosis is rendered. Our study suggests that outside cases sent to our institution for review, represent another subset of cases with high potential for clinical use. Targeting these cases for digital image capture would have the added benefit of providing a permanent image record, as slides and tissue blocks are typically returned to the referring institution in these cases.

The second approach is to abandon the use of representative fields, in favor of capturing and storing the entire slide as a set of juxtaposed images. Because slides can be captured at several different levels of magnification, this method provides the user with the ability to move around a slide, changing powers as desired. This approach has been termed virtual microscopy. At present, the gigabyte range size of these files limits their applicability. The advantage of the virtual slide is the ability to automate capture of large numbers of slides, because field selection is no longer needed. For clinician users, this may prove to be a disadvantage, as field selection enables the pathologist to direct the attention of viewers to the diagnostic areas.

Two potential advantages of pathology images in the MEMRS were not discussed by users, but should be considered in our analysis – the ability to support remote consultation, and potential uses in bio-informatics.

Our institution continues to grow beyond geographic boundaries. One of the by-products of the distributed enterprise is a physical separation between clinician and consultant. For clinicians who are accustomed to reviewing pathology with the pathologist, digital images accessed from an MEMRS may serve as a useful proxy in some cases. If pathologist and clinician communicate by telephone while reviewing the same case, the result is a mechanism for tele-consultation.

A second trend that may have significant impact on the need for pathology images within clinical data repositories, is the rapid advance in bio-informatics and genomics. In particular, the advent of DNA micro-array processing techniques portends major changes for the way pathology is practiced. In the coming years, batteries of genetic marker expression levels will need to be correlated with histopathologic features and clinical outcomes to establish molecular marker patterns of diagnosis and disease progression. MEMRS that support integrated presentation of histopathologic images and clinical information could be a valuable resource in this endeavor.

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