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## Introduction

The Integrated Medical Information Technology System (IMITS) Program is focused on implementation of advanced technology solutions that eliminate inefficiencies, increase utilization and improve quality of care for active duty forces. The work on this project has focused on the development and implementation of prototype telemedicine systems and advanced technology applications at United States Air Force bases. Significant effort has been devoted to the DITSCAP security process for the applications developed. Emphasis has been placed on the development of sound evaluation methodologies for each of the sub-projects with special attention to the areas of cost effectiveness and end-user satisfaction within the AFMS.

## Body

### ***Teleradiology***

***Implement a working teleradiology system in the Air Force leveraging the system already in use at University of Pittsburgh Health System (UPMC).***

The Stentor iSite and iVault COTS products have been installed at Wright Patterson AFB in Dayton, Ohio. Procurement of equipment and planning for installation was initiated in the pre-award period in order to implement the system prior to sun setting of the legacy system at Wright Patterson. The Stentor system has successfully completed the DITSCAP process and is the only PACs system in the DoD to have this level of security certification. The security process extended over a protracted period of time. DITSCAP certification was approved in November 2003. (Security documents available upon request). Re-training of staff occurred in December 2003. The system has been "technically" live since July 2003. Clinical "go-live" is scheduled for January 20, 2004.

***Develop and implement a prototype workflow model using a DTS enabled infrastructure.***

Requirements for this project were obtained from Wright Patterson Air Force Base Medical Center (WPMC). Development of the DTS enabled infrastructure prototype for WPMC is currently under way. To date the DTS infrastructure provides the Radiologists at WPMC a more robust and efficient way to view radiological images. UPMC is currently developing the same DTS infrastructure for clinicians beyond the department of radiology at WPMC. The prototype DTS enabled infrastructure is expected to be complete and installed, at WPMC, by the end of May 2004.

***Create a prototype intelligent DICOM dispatcher.***

Requirements for this project were obtained from Wright Patterson Air Force Base Medical Center. Development of the intelligent DICOM dispatcher for WPMC is currently under way. The current requirements include the ability to display nurse units and departmental radiology study work lists to clinicians throughout WPMC and to outsource WPMC radiology studies to a civilian clinic. The prototype intelligent DICOM dispatcher is expected to be complete and installed, at WPMC, by the end of July 2004.

***Develop a prototype reporting and dictation infrastructure.***

Requirements for this project have not yet been defined by Wright Patterson Air Force Base Medical Center. UPMC is developing, for internal purposes, a reporting and dictation infrastructure and plans to use the base source code of the UPMC infrastructure for WPMC. UPMC will assist

WPMC in developing requirements for a reporting and dictation infrastructure during the development of the WPMC intelligent DICOM dispatcher prototype.

***Develop and evaluate a prototype Secondary Capture (SC) DICOM wrapper that will allow incorporation of arbitrary and visible light datasets into the DICOM archive.***

UPMC has developed a Secondary Capture (SC) DICOM wrapper to incorporate visible light datasets into a DICOM archive. UPMC is beta testing the Secondary Capture (SC) DICOM wrapper prototype internally. At this time WPMC has no need for this service.

***Develop and implement a system for transferring images to a civilian location for interpretation.***

This SOW was not contained in the original proposal. The initial intent of the teleradiology project was to put the infrastructure in place so that Wright Patterson could become a hub in a teleradiology network and provide interpretation services for hospitals and clinics with excess demand. In the spring of 2003, Wright Patterson faced the loss of radiologists due to deployment and attrition. The Diagnostic Imaging Flight Commander at Wright Patterson asked UPMC for assistance in establishing a teleradiology link to Kettering Medical Center in nearby Kettering, Ohio to facilitate outsourcing of radiology interpretation. A secure VPN connection was established and a system was put in place in October 2003. Workflow enhancements to this system are expected in May 2004 as noted above.

***Evaluate the impact of implementation and usage of the prototype Stentor Image and Information Management System at Wright Patterson Medical Center.***

A detailed evaluation study was developed and is currently being implemented to assess the impact of implementation and usage of the Stentor Image and Information Management System at Wright Patterson AFB. The research is intended to assess the functionality of the system, changes in timeliness and quality of radiology consultations, and the impact on work efficiency and patient care. Additionally, the research will assess the extent to which the new Stentor system provided staff access to diagnostic quality images irrespective of location. The study has three parts: 1) pre/intermittent and post implementation surveys, 2) pre/post implementation interviews, and 3) site visits observations.

**Project Delays**

The implementation of the Stentor system at Wright Patterson suffered significant delays based on the scope of the security approval process (DISTCAP). The system was initially projected to be fully functional in early 2003. Mandatory security compliance requirements forced delays in system installation and full functioning at the medical center. Effective December 2003, the Stentor 3.01 System passed all requirements and an IATO was granted for operations. Project delays significantly impacted evaluation activities. (See Appendix A TR2\_Stentor Implementation Milestones and Appendix B TR3\_DISTCAP Timeline and Delays).

**Adjustments to Evaluation Timeline**

Evaluation activities were scheduled to occur in conjunction with Stentor applications training. As staff received system training in May 2003, they completed the pre-implementation survey. Based on extensive delay between initial training and clinical installation, staff received refresher training and, again completed a pre-implementation survey in early January 2004.

Pre-implementation interviews were conducted with radiologists and technologists based on a May installation schedule for Stentor. Pre-implementation interviews with clinicians will be conducted based on Stentor's implementation schedule across clinical departments at the medical center.

See Appendix xx: *TR4\_Evaluation Timeline*

## **Progress/Findings**

### **Surveys**

Pre-implementation surveys were conducted with a total of 70 staff members who will be interacting with the Stentor system. Survey data serves as a baseline measure of perceptions of the system's performance and potential impact on patient care.

- Time Point 1: 33 Surveys were obtained during May 2003 applications training
- Time Point 2: 37 surveys were obtained during January 2004 applications training

A summary of initial findings is included.

*See Appendix xx: TR5\_Report of Initial Survey Findings*

### **Interviews**

- 5 radiologists participated in the pre-implementation interview process conducted during a January 2003 site-visit
- 5 technologists participated in pre-implementation telephone interviews conducted in May 2003
- 1 clinician participated in a pre-implementation telephone interview conducted in May 2003
- 4 additional pre-implementation interviews will be conducted with clinicians

Interview data contributed to workflow analysis related to the old PACS system. Data from interviews, surveys and site visits has been reviewed for user comments on the advantages and disadvantages of the old PACs system and perceptions of Stentor.

*See appendix xx: TR6\_Advantages and Disadvantages of PACs Systems*

### **Workflow Analysis**

Site visits and interviews contributed to a workflow analysis of staff practices and interactions with the old PACS system. Staff roles and responsibilities in processing diagnostic images and patient reports are included as an attachment.

*See Appendix xx: TR7\_Pre-StentorWorkflow*

### **IRB Approval Process**

It is the intent of the IMITS Project to conduct evaluation studies measuring in the impact of telemedicine as it is applied across military settings. Findings from the teleradiology study will contribute to an understanding of the significance of an advanced PACS system to the critical demands for radiology services in the military. This project may be the first of similar applications to be installed across military settings in the future. Findings may contribute to a better understanding of the unique nature and needs of implementing information technology systems within military environments.

The research is being planned and conducted in a manner consistent with the goals of the project. Evaluation studies are being conducted with the full approval of investigation review boards (IRBs) at each institution and medical center involved in the conduct of the studies. The IRB review process has proven to be a time-consuming process. It is significant to note the work effort and time involved in securing full IRB approvals.

*See Appendix xx: TR8\_Stentor Study IRB Approval Process*

***Evaluate the consultative workflow process at UPMC with carefully selected users to determine if the proposed process meets acceptable standards for clinical radiology.***

The purpose of this research is to identify factors that may contribute to building and maintaining effective electronic consultations between radiologists and prescribing clinicians. The proposed study has three parts: 1) observations of consultative methods and behaviors, 2) surveys of

consultative interactions, and 3) interviews with staff who engage in Stentor consultations. This information may contribute to the identification of practices and behaviors that are supportive of remote professional consultations. Information may result in modifications to the Stentor system that may result in improved diagnoses and health outcomes for patients.

#### Progress

An observational checklist was developed and work practices and behaviors related to the consultative process are being tracked for a select group of radiologists at UPMC. A list of contributing factors was developed from the observation sessions and literature reviews and findings are summarized.

*See appendix xx: TR9\_Preliminary Consultation Findings*

## **Telepathology**

***Implement a prototype static telepathology system within the Air Force leveraging the system already in use at UPMC Health System.***

***Design, develop and implement a prototype telepathology workflow application.***

***Evaluate compliance of the prototype telepathology system with the Common Criteria for Information Technology Security Evaluation (C2) data security requirements and perform the needed remediation to submit system for C2 certification.***

The UPMC static Telepathology system that had been developed to support transplant pathology in Italy was modified based on requirements as outlined by the Air Force (See Appendix). Equipment was purchased by UPMC and the application loaded in Pittsburgh. Network security requirements for the DoD have been revised since the initial proposal was written. This project was subject to DITSCAP guidelines. Phase 1 and 2 DITSCAP documents were written for "UPMC Static Telepathology v.1" and submitted for review per guidelines in June 2003. The documents were revised in September 2003 and submitted as final. Initial CT&E was completed in November 2003. Final CT&E is scheduled for early January 2004. (See discussion regarding security processes in the section entitled Barriers.) Preparations are being made for a February installation at Keesler and Eglin AFB.

***Evaluate the utility of digital slide pathology in the Air Force environment.***

Based on requirements outlined by the vendor (See Appendix), a detailed evaluation of the two leading whole slide imaging vendors was conducted by UPMC team members (See Appendix). Aperio was chosen as the vendor for this project. A whole slide image was purchased for UPMC development purposes and installed in Pathology Informatics. Secure web-based access was provided to the AF allowing their participation and evaluation of the equipment. In addition the AF contributed slides to the imaging library. A formal review was conducted of the system (See Appendix). An Aperio whole slide imaging unit will be ordered and installed at Keesler AFB in the first quarter of 2004.

***Implement a prototype dynamic telepathology system at Keesler AFB, Eglin AFB and Travis AFB.***

Requirements for this project were obtained from the AF (See Appendix). UPMC had a prototype dynamic robotic telepathology system that it was developing in the pathology informatics lab. In June 2003 concerns developed regarding potential patent infringement with an existing commercial off the shelf (COTS) product. The AF and UPMC agreed to discontinue this development effort and find a suitable substitute.

UPMC conducted a review of the commercially available product for robotic telepathology. The Nikon CoolScope was chosen for use in static robotic telepathology because of the availability of the source code from the manufacturer. However, there are DITSCAP security issues regarding communication protocols between the client and the CoolScope. UPMC is developing and testing a design infrastructure that will meet DoD security requirements. Testing is expected to be completed in early January 2004.

### ***Design and develop trial software to identify image quality.***

A bright field image capture system has been developed to capture high-resolution digital RGB images of histopathological tissue samples. The software provides a histogram dialog box that provides a graphical representation of white balance and under/over exposure for a given image. The systems assists the user to capture an image of the highest quality color and focus. This software will be included in UPMC Static Telepathology v.2. (See Appendix for User Guide).

### ***Evaluate the impact of implementation and usage of Static Image Telepathology at Keesler, Eglin and Travis Medical Centers.***

A detailed evaluation study was developed and is currently being implemented to assess the impact of Static Image telepathology across participating medical centers. The purpose of this research is to evaluate usage and acceptance patterns for pathologists interfacing with static image telepathology systems in pathology departments at Keesler, Eglin and Travis AFBs. The study has three parts: 1) Surveys - conducted pre, intermittent and post implementation, 2) Interviews - conducted pre and post implementation, and 3) User Activity Reports of frequency and patterns of use across system components.

### **Progress**

Evaluation activities are scheduled to occur in conjunction with applications training at each site. Staff at Keesler Medical Center received system training in December 2003. Staff at Eglin and Travis Medical Centers will receive training following completion of the security approval process.

Pre-implementation interviews were conducted with pathologists at Keesler and Eglin Medical Centers. Pathologists at Travis will be interviewed following Travis IRB approval of the research study.

### **Progress/Findings:**

#### **Surveys**

Pre-implementation surveys were conducted with a total of 9 Keesler staff members who will have to option of interacting with the Static Image system. Survey data serves as a baseline measure of perceptions of the system's performance and potential impact on patient care.

A summary of initial findings is included.

See Appendix xx: *TP2\_Pre-Implementation Survey Results*

#### **Interviews**

Five pathologists, 3 from Keesler and 2 from Eglin, participated in the pre-implementation interview process conducted during an October 2003 site-visit. Interview data is currently being analyzed and will contribute to baseline workflow analysis and user functionality and satisfaction information.

### **IRB Approval Process**

Findings from the telepathology study will contribute to an understanding of the significance of an interactive telepathology system to the critical demands for pathology services in the military. This project may be the first of similar applications to be installed across military settings in the future.

The research is being planned and conducted in a manner consistent with the goals of the project. Evaluation studies are conducted with the full approval of investigation review boards (IRBs) at each institution and includes medical center involved in the conduct of the studies. The IRB review process has proven to be a time-consuming process. It is significant to note the work effort and time involved in securing full IRB approvals.

*See Appendix xx: TP3\_ Static Image Study IRB Approval Process.*

### **Pediatric Tele-echocardiography**

***Design, develop, implement and evaluate a prototype pediatric tele-echocardiography system for use in the Air Force.***

Children's Hospital of Pittsburgh (CHP) and UPMC conducted an evaluation of the COTS videoconferencing products for potential use in this project. In consultation with the DoD Video Network Center in San Antonio, Texas a decision was made to use PolyCom equipment for this project. It was also determined that MEDNet was the appropriate communications link. Eglin AFB and the Naval Hospital Pensacola had a pre-existing node on MEDNet but Keesler AFB did not. It was decided that Keesler would use commercial ISDN for this project until such time as a MEDNet node becomes available. Equipment procurement was delayed due to overseas shipping and port disputes. Installation of equipment is scheduled for mid January 2004. Standard operating procedures were developed and approved by the pediatric cardiologist at Keesler (See Appendix). Clinical implementation is expected in early February 2004.

***Evaluate the regional impact of a prototype pediatric tele-echocardiography system in Tri-Care Region 4.***

A detailed evaluation study has been developed to gain information about perceptions of the use of the tele-echocardiography equipment. The study has three parts: (1) surveys following each tele-echocardiography session; (2) interviews - conducted pre and post; and (3) monthly patient care statistical reports from TRICARE Region 4.

The planned evaluation study has been approved by UPMC and Wilford Hall IRBs. Wilford Hall IRB is serving as the oversight IRB for this study. Concurrence agreements have been awarded by Eglin and Keesler IRBs. IRB concurrence is being sought from Pensacola Naval Hospital.

*See Appendix xx: TE2\_ Tele-Echocardiography Study IRB Approval Process*

## ***Emergency Medical Services***

### **Emergency Medicine Triage Database**

*Adapt existing UPMC medical facility database for pilot use in the Air Force.*

Air Force personnel evaluated the contents of the existing UPMC international medical facilities database in June 2003. Based on those recommendations, UPMC has restructured the database to include the new fields. UPMC and the AF identified a lack of information in the database for the Central and South American region. Collection of data for this region is ongoing. In early January 2004 development efforts will focus on web enabling the application to improve accessibility and allow the AF to evaluate the final product.

### **EMEDS Wireless Demonstration**

*Establish and field-test a prototype wireless broadband telecommunication link in the Air Force.*

MountainTop Technology (MTT) will be conducting a feasibility study for this project with the potential for a follow on demonstration project at Fort Detrick, Maryland. The subcontract for MTT is currently under negotiation and is expected to be signed in early January. Completion of the feasibility study is scheduled for May 2004.

### **Telemental Health**

*Design, implement and evaluate a telemental health pilot project in the Air Force.*

This project was discontinued due to multiple reasons including:

- Administrative changes in the flight command for psychiatry at Wilford Hall Medical Center (WHMC), Lackland AFB, San Antonio, Texas
- Command changes at WHMC
- Level of support TRICARE Region 6 lead agent.

### **Teleradiation Oncology**

*Develop and implement a model for delivery of IMRT treatment planning in an MTF.*

This project was discontinued because a suitable IMRT site could not be found within the Air Force.

## **Major Barriers**

### **DITSCAP Certification**

From the time the IMITS proposal was written to the time of final award, the DoD security certification process was revised. The DoD Information Technology Security Certification and Accreditation Process (DITSCAP) is an extremely rigorous program. The teleradiology and telepathology projects had significant delays in timelines due to this process.

While there were technical issues that needed to be addressed, the most significant reason for the delay appeared to be related to the process. These are outlined below:

- Extended period of time for AF security personnel to review and provide feedback on required security documents.
- Shortage of AF security personnel causing significant delays in scheduling testing dates.
- Change in priorities for AF security personnel caused planned security testing to be rescheduled or delayed.

UPMC is addressing this issue with the AF Surgeon General's Office. In order for future efforts to be successful, the appropriate staffing must be put into place to handle the current demand.

## **IRB Approval Process**

The United States Army Medical Research Acquisition Activity is the contracting office for this award. The award agreement specifically prohibits human subject research without approval from the Army. Due to the nature of our telemedicine initiatives, our projects involve numerous sites in the Air Force and one site in the Navy. Each of the IRBs at these sites had the right to review human subject research that will occur at their base. And finally, the evaluation studies conducted by UPMC personnel must be reviewed by the University of Pittsburgh IRB. This sets up a very complex situation of application and approvals that proved to be a major barrier. As an example, the Pediatric Tele-echocardiography project requires approval by 5 IRBs, Pitt, Keesler, Eglin, Pensacola Naval and the Army. The approvals cannot be done at the same time as each entity wants to see the approval of the others and the Army will not approve without seeing all of the local approvals. This creates significant delays in the process creating disruption to the implementation timelines for evaluation.

At the suggestion of the Keesler IRB, UPMC approached the IRB at Wilford Hall Medical Center and asked them to act as a regional IRB for the Air Force. WHMC agreed to participate. The IRB at WHMC now reviews the protocols for the Air Force and each base provide a concurrence letter. This has streamlined the process within the Air Force when there are multiple AF bases. However, the process is unchanged for the external IRBs.

UPMC is working with the Surgeon General's office to find a suitable solution to this issue. Until such time as all branches of the service can agree on a process, there will continue to be extended delays for IRB approvals.

## **Key Research Accomplishments**

### **Teleradiology**

- Implementation of a state-of-the-art PACS/Teleradiology system (Stentor) at Wright Patterson AFB.
- Stentor is the first and only vendor to complete the DITSCAP process.
- Developed beta version of DICOM wrapper for visible light images.

## **Telepathology**

- Development of UPMC Static Telepathology v.1 for use at Keesler AFB.
- Successful completion of initial DITSCAP security testing process.
- Evaluation and testing of whole slide imaging system.
- Development of enhanced image capture software for UPMC Static Telepathology v.2.

## **Pediatric Tele-echocardiography**

- Equipment evaluation and selection
- Network infrastructure design and development
- Creation and approval of Standard Operating Procedure for pediatric tele-echocardiography.

## **Emergency Medical Services**

- Revision of existing UPMC database with DoD specific information
- Addition of medical facility information for Central/South America Region.

## **Reportable Outcomes**

Please see Appendix for work product documentation.

## **Conclusions**

The Air Force has and will continue to benefit greatly from the work done on the IMITS Program. A state-of-the-art PACs/teleradiology system has been installed at Wright Patterson AFB. Based on the specifications provided by the AF, work on customization of the COTS project is ongoing. This system provides the footprint for a worldwide teleradiology infrastructure. Keesler AFB has now been established as the hub for a static telepathology network. In addition, collaborative research and development work between UPMC and the AF continues on new state-of-the-art devices for image acquisition.

All of the applications implemented and discussed above are the first of their kind in the Air Force. They are the proof of concept for further deployment of the technology to locations worldwide. The applications are scalable and replicable and can be deployed throughout the DoD.

As we move into the second year of the project, UPMC will complete the formal evaluation process that should provide valuable data for the Air Force regarding future deployment of the technology. The feedback given by current users will provide a guide for future modifications of the technology to meet the needs of the military population.

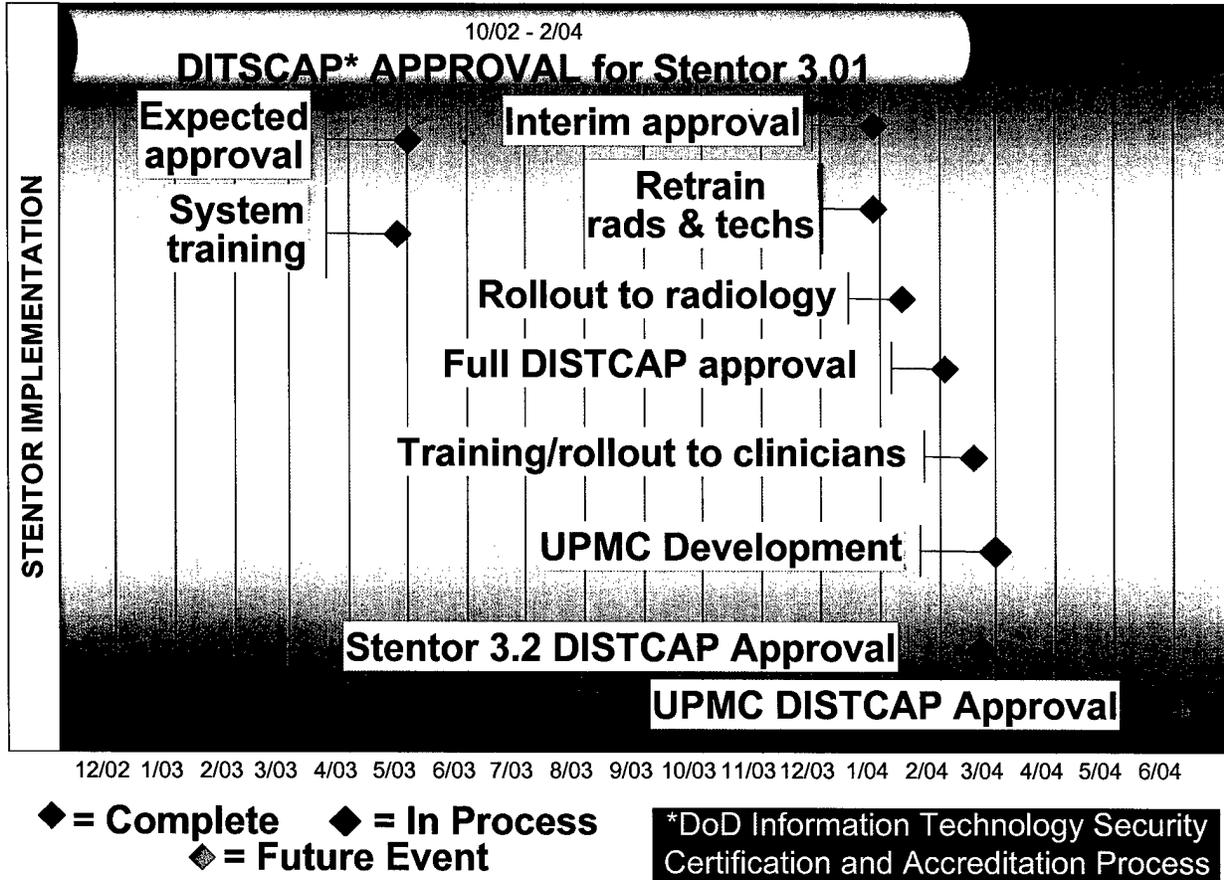
## **References**

None

# Appendices

**A. TR\_2 Stentor Implementation Milestones**

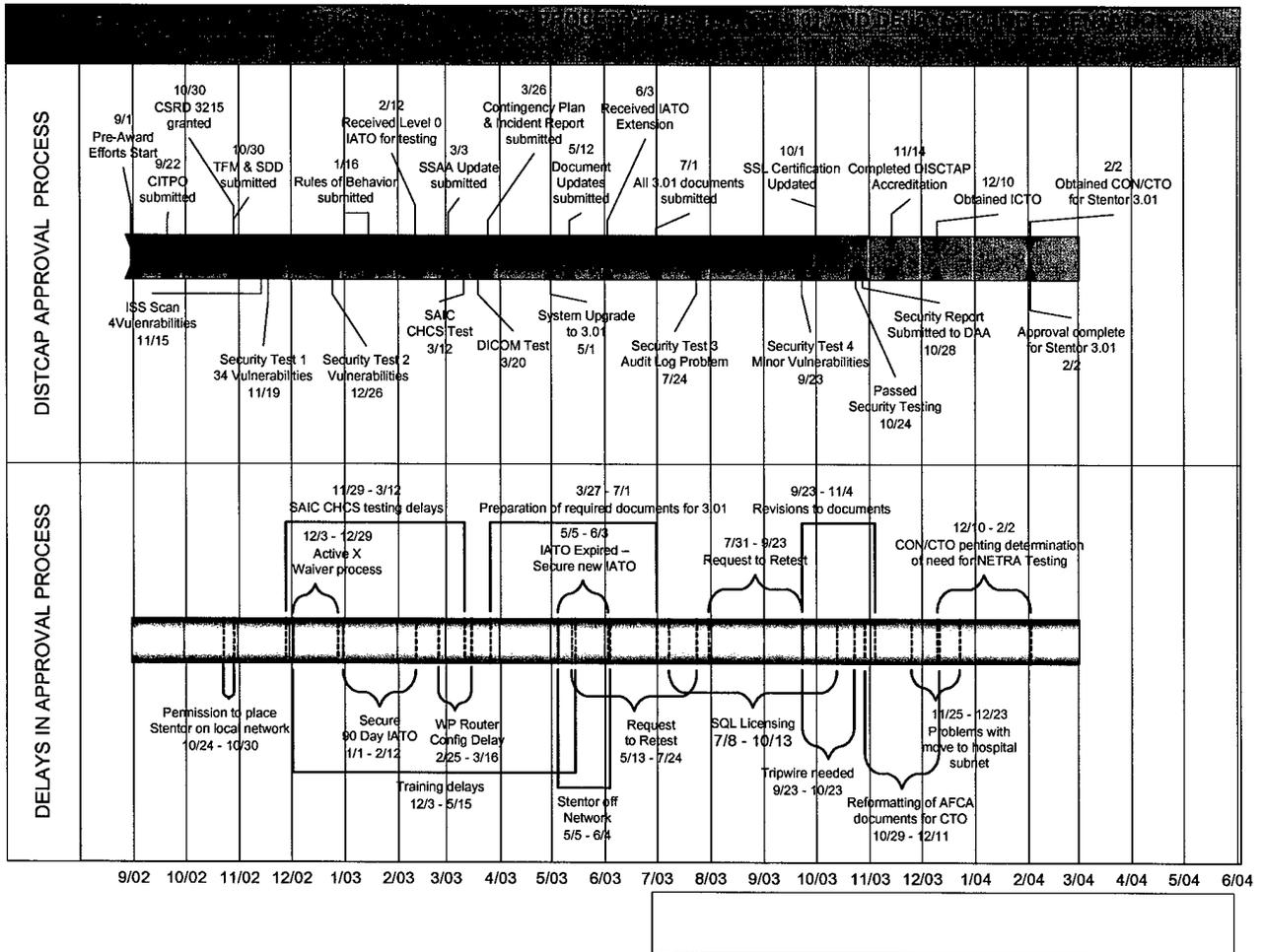
**TELERADIOLOGY: STENTOR MILESTONES**



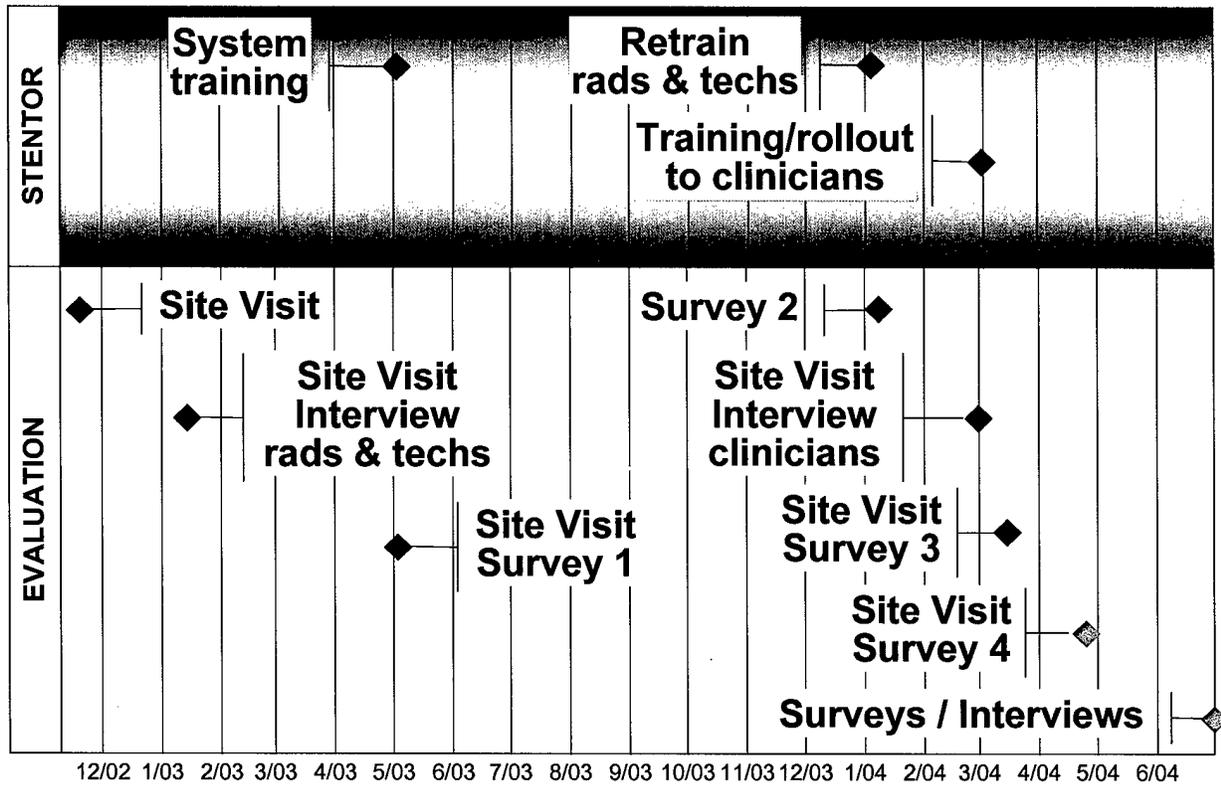
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# B. TR\_3DITSCAP Timeline and Delays



### TELERADIOLOGY: EVALUATION ACTIVITIES



◆ = Complete    ◆ = In Process  
 ◆ = Future Event

**\*DoD Information Technology Security Certification and Accreditation Process**

## D. TR\_5 Report of Initial Survey Findings

### IMITS Teleradiology Project Pre-Implementation Survey Preliminary Findings – Time Points 1 & 2

Time Point 1: n = 33

Time Point 2: n = 37

Position	Time Point 1	Time Point 2
Radiologist	4	4
Clinician	2	4
Technologist	25	26
Technical Development	0	0
System Administration	2	0
Other		
Resident	1	--
Medical Physicist	--	1
Neurosurgeon	--	1
PA	--	1
Student	0	0
Civilian	1	0
<b>Total</b>	<b>33</b>	<b>37</b>

#### Hours/week using a computer for work-related tasks (range 2 – 60, mean 23.81)

Position	Hrs/Wk Time Point 1	Hrs/Wk Time Point 2
Radiologist	46.25	40.00
Clinician	15	4.25
Technologist	27.91	17.20
Technical Development	---	---
System Administration	40	---
Other	NR	10.70
Student	---	---
Civilian	30	---
<b>Total</b>	<b>29.57</b>	<b>18.04</b>

#### Participants who currently access a computer from outside the medical center for work-related tasks

Position	Time Point 1	Time Point 2
Radiologist	3	3
Clinician	0	2
Technologist	3	7
Technical Development	---	---
System Administration	0	---
Other	0	2
Student	---	---
Civilian	1	---
<b>Total</b>	<b>7</b>	<b>14</b>

**Self-report on level of computer sophistication:**

Position	Time Point 1					Time Point 2				
	Very sophisticated	Sophisticated	Neither sophisticated/unsophisticated	Unsophisticated	Very unsophisticated	Very sophisticated	Sophisticated	Neither sophisticated/unsophisticated	Unsophisticated	Very unsophisticated
Radiologist	0	2	2	0	0	0	2	2	0	0
Clinician	0	1	1	0	0	0	2	2	0	0
Technologist	2	4	16	2	0	0	11	15	0	0
Technical Development	---	---	---	---	---	---	---	---	---	---
System Administration	1	0	1	0	0	---	---	---	---	---
Other	0	1	0	0	0	0	0	2	1	0
Student	---	---	---	---	---	---	---	---	---	---
Civilian	0	1	0	0	0	---	---	---	---	---
Total	3	9	20	2	0	0	15	21	1	0

	Time Point 1							Time Point 2						
	Radiologist	Clinician	Technologist	Systems Administrator	Other	Civilian	MEDIUM	RANGE	Radiologist	Clinician	Technologist	Other	MEDIUM	RANGE
<b>Participant responses:</b>														
<b>5 Point Scale:</b>														
<b>5 = Strongly Agree</b>														
<b>1 = Strongly disagree</b>														
Image quality will be comparable to or better than the current PACS system?	3.75	4.00	4.24	5.00	4.00	5.00	4.18	3-5	4.75	4.25	4.15	5.00	4.54	3-5
There will be wide-scale availability to the Stentor system in the Medical Center?	4.00	3.50	4.12	5.00	5.00	5.00	3.61	3-5	4.67	4.50	4.08	4.33	4.40	3-5
You will be able to access the Stentor system outside of the Medical Center (e.g., your home or another Air Force base)?	4.25	2.50	3.68	5.00	3.00	5.00	3.70	1-5	4.00	3.00	3.38	2.33	3.18	1-5
You will be able to query the Stentor system to locate patient information and bring up images?	4.00	4.00	4.48	5.00	5.00	5.00	4.42	3-5	4.75	4.25	4.27	5.00	4.57	2-5
The system will display current Stentor images in less than 5 seconds?	3.50	4.00	4.08	5.00	5.00	5.00	4.06	3-5	4.00	4.00	4.23	5.00	4.31	2-5
The system will display prior/archived Stentor images in less than 20 seconds?	3.00	4.50	4.04	5.00	5.00	5.00	4.00	2-5	4.67	3.00	4.19	4.00	4.97	1-5
Stentor will generally make it easier for you to accomplish your work?	3.75	4.00	4.28	5.00	5.00	5.00	4.24	3-5	4.33	4.25	4.12	4.33	4.26	3-5
Stentor will increase your productivity?	3.75	3.00	4.24	5.00	5.00	5.00	4.15	3-5	4.00	4.25	4.08	4.33	4.17	3-5
Stentor will make results available to clinicians faster than with the current PACS system?	3.25	3.50	4.24	5.00	5.00	5.00	3.85	3-5	3.50	4.00	4.08	4.33	3.96	2-5
Stentor will improve provider to provider communications?	3.25	3.50	4.04	5.00	5.00	5.00	3.97	3-5	3.50	3.50	4.00	4.00	3.75	2-5
Stentor would improve provider to patient communications?	3.00	3.50	4.00	5.00	4.00	5.00	3.88	3-5	3.25	3.50	3.88	3.66	3.58	2-5
Stentor will improve patient care?	3.50	3.50	4.52	5.00	5.00	5.00	4.18	3-5	4.00	3.50	4.12	4.33	3.99	3-5
RANGE	3-5	2-5	1-5	5	3-5	5	1-5		1-5	1-4	2-5	1-5	1-5	

**Written Responses**  
**58 individual comments**

**Perceived benefits (n = 58 comments)**

**Speed**

- 13 brief responses related to speed (e.g., speed, fast, rapid, quicker, etc.)
- Rapid accessibility to specific modality images
- Quick screen pull up
- Faster applications
- Quicker access to patient images

**Features**

- All the options
- Variable operator options
- More options to work with makes things easier
- "Syne" mode.
- Ability to make duo-study comparisons/Able to compare 2 images side by side/Use for comparison studies
- Ability to take the same study and use different contrast modes
- Linking different image windows and modalities
- Manipulation of images
- Much better lay out capabilities
- Formats excepted/Correcting exceptions/ Exception process

**Image Quality**

- Better images
- High quality
- Image quality
- Detailing of imaging
- Color images

**Ease of use / Accessibility**

- 5 related simply to ease of use
- Two "User friendly"
- Easier to look up patients
- More options to work with makes things easier
- There will be one available in each room providing them to be queued quicker
- Availability to regular pc
- Can be accessed easily
- Rapid accessibility to specific modality images
- Online all the time images

**Cost effectiveness/time savings**

- The time it will save
- Efficient

**Capacity**

- Able to review large exam files without crashing the system
- Able to handle larger files better

**Equipment**

- Better monitor
- Flat panel work stations
- The monitors

**Other**

- Availability at various section

- Hope it will perform as advertised
- Right now it show total work load (ie showing reports)
- Learning new technology
- Accuracy

**Concerns** (n = 35 comments)

Features

- Using military dates and social security prefixes
- Not being able to develop certain exams.
- Deleting images.
- Merging patients.
- Being able to merge 2 parts of the same examination.
- Color presentation.
- Unable to delete repeated films.
- Need to improve font size
- Need to improve contrast on menu screen
- Total image manipulation, cleaning up exams

Complexity

- Too much to remember
- Complicated at first
- Too many options may get confusing or to complicated
- Pressing the wrong buttons and messing something up

Accessibility / Availability

- What if there is a connection problem with the server? / Up time? What if the Internet connection goes down, no patient care?
- Is there an alternate system or way of connecting with limited use?
- Effects of sudden power fluctuation/power outage.
- Hopefully, it will be available on all desktops in the hospital soon.
- Have yet to implement it! /Not installed and ready for use
- Availability of monitors

Support

- Being able to ask someone who is very knowledgeable of the system
- Training for the new system / Training
- Learning new system
- Problem solving
- Getting to know it as problems arise

Other

- That the AF will screw it up even more so than currently
- More friendly user / Being user friendly
- Stability
- Initial problem with any new system; acceptance by clinicians outside radiology (old dog new tricks)
- More work

**Suggestions** ( n = 14 comments)

Training

- Hands on / Allowing hands on training
- Cine presentation

Support

- Have someone here the first couple of days when we actually have the system
  - Have an on-site trainer once we start using the system
  - Lots of help readily available when system goes live
- On-site PACS person

- On site personnel
- Hire SSgt Gibson to work for Stentor

Options

- Have Window/level/origination \_\_\_\_\_ on screen continuously
- Have default parameters for the various MR sequences like they currently have for the Cat Scan
- Bigger fonts and more contrast
- You should make it possible to delete images
- Make Patient HX more visible/quicker (ie on screen)

## **E. TR\_6 Advantages and Disadvantages of PACs Systems**

### **IMITS Teleradiology: Stentor Implementation Evaluation Study**

#### **Summary of Initial Findings from Surveys, Interviews and Site Visits**

##### **Baseline Findings – Old PACS**

###### **Radiologist Likes**

- Ability to do 3-D acquisition
- Page format:
- Overall page setup
- Tabs/index across the top
- Prior images listed
- Patient information listed
- One main list of all exams
- Work distribution flowing from the main work lists
- Current system for cross-referencing area of one image to same area of another image

###### **Technologist Likes**

- Good image quality
- Ability to manipulate images so that they are readable

###### **Clinician Likes**

- Ability to access radiology reports as needed
- Ability to save patient images to a folder for access at a later time

##### **Baseline Findings – Old PACS**

###### **Radiologist Dislikes**

- Heat generated from equipment- gets hot/fast – office areas are small - must leave door open and that invites interruptions
- Equipment occupies a lot of space
- Need to go to other area/room to read mammogram/ultrasound images and this system is not set-up the same
- Too many codes in system that radiologists need to know
- Issue with delete button – “can’t hit the delete button”
- Can’t always rely on ordering of films on worklist
- Does not provide accession numbers for radiologists - radiologists forced to toggle back and forth to get this information (“pain”)
- Cross-referencing function is cumbersome to use
- Cursors do not always respond as they should
- Tool boxes are hard to use
- Tools are a pain
- Hard to click on desired icon and have it respond as it should
- System hard to understand / hard to work with
- Not pleased with screen preset views

###### **Technologist Dislikes**

- Images frequently get backed up

- Slow when images are backed up
- Slow when sending images
- System periodically freezes up
- System goes down quite a bit
- Low productivity
- Repeatedly buying licenses

#### **Clinician Dislikes**

- Accessing patient images from office area is cumbersome
- Logging onto the computer and adjusting the settings
- Opening the PACS system and loading the images
- Issues with larger cases (e.g. CTs with 150+ images)
- Can only 'call up' a limited number of images
- System times out and connection gets dropped before all images have been viewed
- Causes the machine to crash / need to reboot
- Unable to bring up larger studies in clinical areas – would have to view in radiology department
- Impedes performance in OR
- Periodic trouble getting images
- Network down
- Image clarity isn't always good – not sure if it is a system or monitor issue

#### **Baseline Findings - Perceptions of Stentor**

##### **Radiologist Perceptions**

- Anticipated to be ten times faster than PACS
- Will take much less equipment/physical space to operate
- Will have two flat panels generating less heat – environmentally will be a big improvement
- More scans located in point of service areas in WP
- Increased ability to run quality assurance checks on the images
- Images can be viewed by several people simultaneously

##### **Technologist Perceptions**

- Ease of use and friendliness
- Quicker than what we use now
- Seems like it will be a lot smoother
- Better quality monitors
- Time it will save
- Will result in better patient care

##### **Clinician Perceptions**

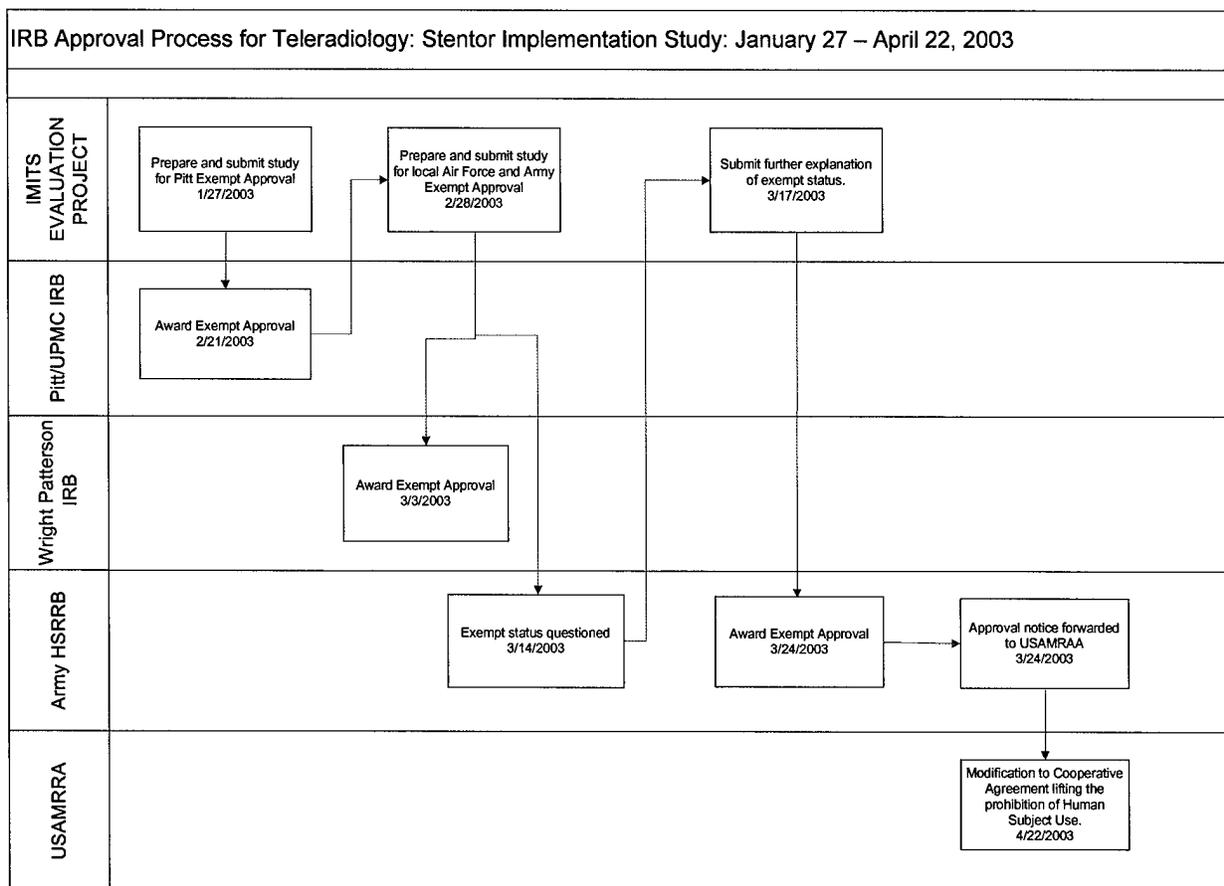
- Apparently will speed things up
- User-friendly features
- Easier to use
- Ability to compare 2 images side by side
- Clean images
- New monitors

## F. Pre-Stentor Workflow

	Ordered	Received	Examined	Dictated	Transcribed	Verified	Follow-up
<b>Clinician</b>	<ul style="list-style-type: none"> <li>Exam ordered electronically on CHCS</li> <li>Day-of exams (add-ons) ordered via contact/approval by radiologist</li> <li>Reason for study/Impressions noted on CHCS order</li> </ul>		<ul style="list-style-type: none"> <li>ER docs provide initial assessment of findings</li> </ul>	<ul style="list-style-type: none"> <li>Clinicians may contact rads for early results.</li> <li>Once dictated, a preliminary report can be accessed on the Dictaphone Enterprise Server or CHCS via the Internet.</li> </ul>			<ul style="list-style-type: none"> <li>Official report received by clinician.</li> <li>FU consults with rad as needed</li> </ul>
<b>Patient</b>	<ul style="list-style-type: none"> <li>Patient contacts Diagnostic Imaging (DI) to schedule exam</li> <li>Exceptions: Inpatient add-ons Faxed orders (usually from outside physicians)</li> </ul>						
<b>Technologist</b>	<ul style="list-style-type: none"> <li>DI front desk tech brings up pt information that includes physician order info</li> <li>Pt demo and case specific info entered/confirmed in CHCS (i.e., hospital's electronic record - HIS &amp; RIS combined)</li> <li>Pt receives standard prep orders by exam type (paper copy)</li> <li>"519" paper requisition is generated and placed in department folder - organized by exam date</li> <li>Med orders, as required for exam, are entered into CHCS under a rad's name. Rad must sign/approve later. These pre-approved orders are listed when rad logs onto CHCS.</li> <li>Daily schedules generated for each department</li> <li>Dept tech picks up orders and reviews</li> <li>Daily add-ons go through front desk or exam modality area following exam approval by radiologist</li> <li>Accession number(s) assigned - linked studies are assigned different accession numbers</li> </ul>	<ul style="list-style-type: none"> <li>Pt arrives and front desk tech looks up "arrivals" (list of scheduled exams/patients)</li> <li>Pt located and 'retrieve info' is selected</li> <li>List of ordered exams is presented</li> <li>All ordered exams for the pt are highlighted and marked as "arrived" - termed "arrived in"</li> <li>Another 519 is printed with pt labels as needed.- this 519 is printed out in the Core area (or in exam dept, depending on modality).</li> <li>Pt sent to waiting area</li> <li>Floor manager/tech retrieves 519 and assigns the order to a tech ("permanent party" for exam). Frequently a tech student will be assigned to shadow the tech</li> <li>Tech preps room for study and gets pt</li> <li>The 519 order is placed in slot on assigned exam room door</li> <li>There are 3 exam rooms in the core area for CR imaging</li> </ul>	<ul style="list-style-type: none"> <li>Tech captures images</li> <li>Plates are taken to a processor in the core area</li> <li>Tech enters accession number into processor and pt info is brought up</li> <li>Exam type is entered and exam type is brought up</li> <li>Plate is loaded into processor and image is loaded into PACS - tech can watch image come up as it is being loaded</li> <li>Tech checks quality of the image - poor quality images are retaken</li> <li>All associated images for exam are loaded into processor</li> <li>Tech pushes button to send images to PACS</li> <li>QC Tech (quality control) brings up image from worklist and does the following: <ul style="list-style-type: none"> <li>Scans image quality - deletes poor images (may order retakes)</li> <li>Superfluous images removed from PACS</li> <li>Adjusts window levels</li> </ul> </li> <li>Set hanging protocols (puts in right order)</li> <li>Merges/splits studies as required</li> <li>Monitors pt info for detection of internal administrative errors - changes made via Amber unit</li> <li>Marks study as complete in CHCS</li> <li>Study locked into PACS and it appears on rad worklist.</li> <li>QC run on tacite site images and sent directly to PACS.</li> </ul>				<ul style="list-style-type: none"> <li>Techs run weekly CHCS queries to uncover errors in processing: <ul style="list-style-type: none"> <li>Accession numbers are entered for linked studies</li> </ul> </li> </ul>

	Ordered	Received	Examined	Dictated	Transcribed	Verified	Follow-up
<b>Clinician</b>	<ul style="list-style-type: none"> <li>Exam ordered electronically on CHCS</li> <li>Day-of exams (add-ons) ordered via contact/approval by radiologist</li> <li>Reason for study/Impressions noted on CHCS order</li> </ul>	<ul style="list-style-type: none"> <li>Pt arrives and front desk tech looks up "arrivals" (list of scheduled exams/patients)</li> <li>Pt located and 'retrieve info' is selected</li> <li>List of ordered exams is presented</li> <li>All ordered exams for the pt are highlighted and marked as "arrived" - termed 'arrived it'</li> <li>Another 519 is printed with pt labels as needed - this 519 is printed out in the Core area (or in exam dept, depending on modality).</li> <li>Pt sent to waiting area</li> <li>Floor manager/tech retrieves 519 and assigns the order to a tech ("permanent party" for exam).</li> <li>Frequently a tech student will be assigned to shadow the tech</li> <li>Tech preps room for study and gets pt</li> <li>The 519 order is placed in slot on assigned exam room door</li> <li>There are 3 exam rooms in the core area for CR imaging</li> </ul>	<ul style="list-style-type: none"> <li>ER docs provide initial assessment of findings</li> </ul>	<ul style="list-style-type: none"> <li>Clinicians may contact rads for early results.</li> <li>Once dictated, a preliminary report can be accessed on the Dictaphone Enterprise Server or CHCS via the Internet.</li> </ul>			<ul style="list-style-type: none"> <li>Official report received by clinician.</li> <li>FU consults with rad as needed</li> </ul>
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## G. TR\_8 Stentor Study IRB Approval Process



## H. TR\_9 Preliminary Consultation Findings

**IMITS PROJECT  
TELERADIOLOGY: CONSULTATIVE STUDY**  
Initial Findings from General Observations Conducted Across the Following UPMC Divisions of  
Radiology: Abdominal, Neuro, Muscular/Skeletal And Angio/Interventional

<b>I. FACTORS THAT MAY CONTRIBUTE TO EFFECTIVE CONSULTATIONS</b>		
<b>Physician's Choice of Radiologist</b>	<ul style="list-style-type: none"> <li>▪ Proximity</li> <li>▪ Specialty</li> <li>▪ Knowledge of case domain</li> <li>▪ Acquaintance/familiarity</li> <li>▪ Professional relationship</li> <li>▪ Available</li> <li>▪ pre/post</li> <li>▪ per referral/request</li> <li>▪ Accommodating</li> <li>▪ Defined methods of contact</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ease of contact</li> <li>▪ Rapid response time/prompt</li> <li>▪ Years of experience</li> <li>▪ Years in current practice</li> <li>▪ Formal training</li> <li>▪ Professional involvement/associations</li> <li>▪ Trustworthy</li> <li>▪ Adds value to case</li> <li>▪ ROC – propensity to overcall/undercall cases</li> </ul>
<b>Information Transfer (Quality of information received for consult)</b>	<ul style="list-style-type: none"> <li>▪ There is a clear reason for ordering the consult</li> <li>▪ Initial findings adequate for proceeding with interpretation</li> <li>▪ Patient history is relevant to current reason for consult</li> <li>▪ Patient history contains essential elements for consult</li> <li>▪ Patient history is concise/</li> </ul>	<ul style="list-style-type: none"> <li>▪ comprehensive</li> <li>▪ Image quality is suitable for interpretation</li> <li>▪ Prescribing physician information is included</li> <li>▪ Trust in physician ordering tests – validity of case</li> <li>▪ Trust in physician's interpretation of signs/symptoms</li> </ul>
<b>Consult behavior</b>	<ul style="list-style-type: none"> <li>▪ Review of med history</li> <li>▪ Review of Stentor preliminary report</li> <li>▪ Review of current images – generally includes image manipulation (contrasting, scrolling, measuring)</li> <li>▪ Comparison of current case images</li> <li>▪ Review of archived images</li> </ul>	<ul style="list-style-type: none"> <li>▪ Review of archived reports</li> <li>▪ Comparison of current and archived images</li> <li>▪ Consult/FU with Rx physician</li> <li>▪ Consult/FU/second opinion with another radiologist (generally based on area of specialization)</li> <li>▪ More information requested/needed</li> </ul>
<b>Elements of Advice Given</b>	<ul style="list-style-type: none"> <li>▪ Logistical</li> <li>▪ Clinical</li> <li>▪ Organizational</li> <li>▪ Hierarchical – ordering/prioritizing treatment/procedures /multiple issues for patient care</li> <li>▪ Acknowledgement/agreement with initial findings</li> <li>▪ Approval to proceed with pending treatment/procedures</li> <li>▪ Confirmation of pending treatment/procedures</li> <li>▪ Recommendations/options for treatment/referral</li> </ul>	<ul style="list-style-type: none"> <li>▪ Recommendations/options for FU testing</li> <li>▪ Diagnosis offered</li> <li>▪ Immediate contact with physician if urgent care is required</li> <li>▪ Immediate contact w/ physician if significant disagreement is found</li> <li>▪ Adequate consideration of next level of testing/treatment</li> <li>▪ Recommendations regarding upcoming procedure (e.g., needle biopsy – area of entry)</li> <li>▪ Review of abnormalities (known and unknown)</li> </ul>

<b>II. ISSUES THAT RADIOLOGISTS NOTED DURING THE OBSERVATIONS</b>	
<b>Physician's Choice of Radiologist</b>	<ul style="list-style-type: none"> <li>▪</li> </ul>
<b>Information Transfer (quality of information received for consult)</b>	<ul style="list-style-type: none"> <li>▪ Standardization of data entry process for patient history</li> <li>▪ Current system is haphazard no uniform reporting practices</li> <li>▪ Anyway to automatically populate some data fields?</li> <li>▪ Anyway to have font distinction between new information and information retrieved (cut and pasted) from patient med record?</li> <li>▪ Consideration of re-formatting presentation for optimal use. Rads need to scroll up and down to capture desired history/information for consult.</li> <li>▪ Features: <ul style="list-style-type: none"> <li>▪ Save features not easy to use.</li> <li>▪ Some measurement tools not easy (rad admitted – may be based on frequency of use/experience)</li> </ul> </li> <li>▪ Not always aware of physician/specialization</li> <li>▪ Level of trust in physician impacts validity of information transfer</li> </ul>
<b>Consult behavior</b>	<ul style="list-style-type: none"> <li>▪ Retrieving archived PACS images/reports</li> <li>▪ Unable to transmit partial study.</li> <li>▪ Unable to consult with physician or other specialist while current case is open/active. In angio, this could be a benefit on at least 10% of their cases (synchronous consultation?)</li> <li>▪ Unable to look at other patient's images while in middle of dictating current case</li> <li>▪ Dictation – Not happy with the order of reporting findings</li> <li>▪ No ICD-9 dropdown list – Could improve dictation process – especially a problem when findings occur that are not part of the rads division of radiology</li> </ul>
<b>Elements of Advice Given</b>	<ul style="list-style-type: none"> <li>▪ Physicians becoming more self-reliant (may not really be an issue – most rads wish they would be more self-reliant)</li> </ul>

## ***I. Telepathology Requirements***

### **Telepathology Static Version 1 Requirements**

#### Technical Requirements

1. Base architecture and system requirements:
  - The System shall be implemented as a three-tier client/server/database architecture. Java shall be used for the first two tiers and Oracle for the third tier.
  - The System requires a PC running the Windows 2000 OS, with at least 512 Meg of memory and a minimum of 1024X768 screen resolution.
  - The System shall meet the certification and accreditation requirements of DoD IT Security Certification and Accreditation Process (DITSCAP). The system shall conform to security guidelines for Mission Assurance Category (MACIII)/sensitive systems.
2. The System shall support a single central database.
3. The System shall support three classes of users:
  - Those who can enter/view only those cases that originate from their home site.
  - Those who can enter cases from their home site but view cases from all sites.
  - The DBA, who is responsible for maintenance activities such as adding/deleting users using SQL commands.
4. The System shall utilize separate client processes for case-entry and case-viewing.

#### Functional Requirements

5. The Case Entry client shall support the following functions:
  - Creating a new case.
  - Adding images to the case.
  - Entering patient demographic information.
  - Entering patient history, preliminary diagnosis, and general messages.
  - Saving the case to the central database.
  - Saving the case to a local file and restoring it from that file. Once the case has been saved, only a DBA can perform administrative database edits.
6. The Case Viewer client shall support the following functions:
  - Bringing up a list of all cases that the user is permitted to view and selecting a case from that list.
  - Adding images to the case.
  - Adding additional comments to the patient history, preliminary diagnosis, and general message fields.
  - Saving the additional information to the central database.

7. The System shall support a Notification function, such that when a user enters a new case or adds images to an existing case, a select list of users may be notified via email or email pager. This select list of users is maintained by the DBA.

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Signature below indicates review and agreement to the Telepathology Static Version 1 requirements.

**Date:** 6/11/2003

**Authorized Signature:**

---

**Printed Name/Title:**

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**Organization:**

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**Authorized Signature:**

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**Printed Name/Title:**

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**Organization:**

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## Static Telepathology Version 2 Requirements

### Technical Requirements

1. Base architecture and system requirements:
  - The System shall be implemented as a three-tier client/server/database architecture. Java shall be used for the first two tiers and Oracle for the third tier.
  - The System requires a PC running the Windows 2000 OS, with at least 512 Meg of memory and a minimum of 1024X768 screen resolution.
  - The System shall meet the certification and accreditation requirements of DoD IT Security Certification and Accreditation Process (DITSCAP). The system shall conform to security guidelines for Mission Assurance Category (MACIII)/sensitive systems.
2. The System shall support multiple databases. (The user chooses which database to access at startup time).
3. The System shall support three classes of users:
  - *Standard users*, who can enter new cases and view/add-to existing cases. Each user has a home site through which he can enter new cases. Each user can also be granted view access to one or more additional sites.
  - *Admin users*, who are permitted to edit the user table and other system maintenance tables via the Admin GUI.
  - *The DBA*, who can directly manipulate the database via SQL.
4. The System shall utilize a single application GUI with separate modules for each of four primary functions:
  - Case entry
  - Case viewing/editing
  - Table maintenance
  - Case transfer (from one DB to another DB).

### Functional Requirements

5. The Case Entry module shall support the following functions:
  - Creating a new case.
  - Adding images to the case, including image annotation (ellipses, arrows, text).
  - Entering simple patient demographic information, either directly or by pulling the information from Copath.
  - Entering patient history, preliminary diagnosis, and general messages, either directly or by pulling the information from Copath.
  - Saving the case to the central database.
  - Saving the case to a local file and restoring it from that file. Once the case has been saved, only a DBA can perform administrative database edits.
6. The Case Viewer module shall support the following functions:

- Bringing up a list of all cases that the user is permitted to view and selecting a case from that list.
  - Adding images to the case, including image annotation (ellipses, arrows, text).
  - Adding annotation to existing images.
  - Adding additional comments to the patient history, preliminary diagnosis, and general message fields.
  - Saving the additional information to the central database.
7. The Maintenance module shall support the following functions:
    - Adding and deactivating users
    - Modifying user privileges
    - Modifying system menus such as the stain-type menu.
  8. The system shall support an Image Export function that writes all images for a case to a directory on the local machine. This function will be useful for sending the case to AFIP.
  9. The System shall support a Notification function on various system events where a select list of users may be notified via email or email pager. System events include, but are not limited to the following: a user enters a new case, receives a consult request, has a requested consult completed or adds images to an existing case. This select list of users is maintained through the Maintenance GUI.

---

Signature below indicates review and agreement to the Telepathology Static Version 2 requirements.

**Date:** 6/11/2003

**Authorized Signature:** \_\_\_\_\_

**Printed Name/Title:** \_\_\_\_\_

**Organization:** \_\_\_\_\_

**Authorized Signature:** \_\_\_\_\_

**Printed Name/Title:** \_\_\_\_\_

**Organization:** \_\_\_\_\_

## **Telepathology Research And Development Requirements**

### Technical Requirements

#### 10. Base architecture and system requirements:

- The System shall meet the certification and accreditation requirements of DoD IT Security Certification and Accreditation Process (DITSCAP). The system shall conform to security guidelines for Mission Assurance Category (MACIII)/sensitive systems.

### Functional Requirements

#### **Dynamic Robotic Telepathology**

#### 11. Hardware Installation:

- Equipment such as Microscope, camera, etc. (Image Capture Station) shall be ordered by UPMC and shall be installed at Keesler and Eglin.
- Image Capture Station shall be implemented into the existing teleconferencing.
- Communications between teleconferencing systems shall be established between Eglin, Keesler, UPMC.

#### 12. The System shall support Robotic microscope

- The microscope of Image Capture Station shall be controlled by the software UPMC will provide
- The functions can be controlled by the software are a stage coordinates, focus, objective lens, brightness.
- The software can control the microscope locally and remotely.
- The software shall be implemented as client/server/database architecture.
- The system shall utilize separate client for remote control and accessibility to the remote microscope.

#### 13. System Evaluation report shall be provided by Keesler

#### 14. System integration report shall be provided by UPMC.

#### **Research Telepathology**

#### 15. Image analysis of static images (for problems) shall be available by UPMC

#### 16. Classification and image correction algorithm shall be available by UPMC

#### 17. Prototype software for image evaluation module and Image enhancement shall be available with minimum user interface

#### 18. Demonstration of beta version of software shall be available

19. Integration plan into existing telepathology systems and next available technologies shall be presented by UPMC.

### **Whole Slide Imaging**

20. Imaging Devices will be installed at UPMC and Keesler. UPMC and Keesler will evaluate this product and form a strong user group (with the AFIP) to put pressure on the vendor to make product changes (if necessary)

- First Version of Whole Slide Scanner shall be delivered, running and imaging slides at UPMC
- Preliminary Evaluation of Vendor Scanner at UPMC
- Latest version of Whole Slide Scanner shall be delivered by the Vendor at Keesler
- Evaluation Report (Image quality, functionality, System stability) shall be provided by Keesler/UPMC

21. UPMC and Keesler will develop an education module based on UPMC Software and Keesler/UPMC/AFIP slides and expertise based on whole slide imaging.

- First group of Educational cases (slides and case information) shall be selected by UPMC/Keesler/AFIP and made available to UPMC for image capture
- First Version of the Educational GUI and Web Site shall be available at Keesler/UPMC. This version requires data entry at UPMC
- Second Version of the Educational GUI and Web Site shall be available at Keesler/UPMC. It allows data entry to Keesler.
- Education Evaluation Report (Image quality, functionality, System stability) shall be provided by Keesler/UPMC

22. UPMC and Keesler will evaluate the use of whole slide imaging in clinical practice. In particular, we will evaluate image quality; capture speed and features necessary for a clinical GUI. This will be done using UPMC GUI software.

- Evaluation of USAF LIS system for possible development of integration of telepathology services in year 2
- Plan of Clinical workflow and installation in clinical environment shall be proposed by UPMC

23. UPMC and Keesler will develop three reports:

- One on the functionality of the Vendor supplied imager.
- One the utility of whole slide images in education.
- The best way to implement WSI in the Static/Dynamic environment developed in year 1.

These reports, especially report 3, will guide development of the UPMC/USAF system in year 2.

24. Final reports of Year1 shall be provided by Keesler

**Education**

25. Selected UPMC Web Cast Conferences will be available to the Air Force through the UPMC Server.

26. UPMC will develop a system for archiving conferences and providing CME for on-line conference participants. This will involve password authentication, a database of users and database of archived conferences available through the UPMC and Air Force firewalls.

27. UPMC will deliver the Web Cast Conferencing System to Keesler Air Force Base so that Keesler will be able to provide Web Cast Conferences to the Air Force.

---

Signature below indicates review and agreement to the Telepathology R&D requirements for:

- Dynamic Robotic telepathology;
- Research telepathology;
- Whole Slide Imaging;
- Education

**Date:** 6/11/2003

**Authorized Signature:**

\_\_\_\_\_

**Printed Name/Title:**

\_\_\_\_\_

**Organization:**

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**Authorized Signature:**

\_\_\_\_\_

**Printed Name/Title:**

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**Organization:**

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## K. Whole Slide Imaging Vendor Review

### Aperio vs Interscope

#### Interface

The Aperio interface is very user friendly and has great ease of use. Selecting the tissue to scan is as easy as just sizing a text box like in any Microsoft application. It has features to find the tissue and focus points automatically. Also focus points may be added manually where the user feels necessary.

Scanning an image on the Aperio takes only a few steps, select the tissue then select focus points and click Autoscan.

The Interscope interface is not as user friendly as the Aperio. To select the tissue to be scanned the slide has to be placed on a piece of paper with a measurement grid. The measurements are then taken from the area of the tissue and has to be manually entered into the Interscope application. The user also has no control over where and how many focus points selected.

#### Performance

On the chart below shows the time it takes to scan a slide when both the exact same slides and the same areas of the slide are scanned by each machine. As you can see the time difference between the two is not to different. This was also done using the research Aperio system. The new Aperio system is faster now and takes full advantage of Hyperthreading. The times may show to be the same on the chart but if taken into consideration on the time it takes to manually measure out the area and enter into the Interscope vs the speed of selecting the tissue and focus points on the Aperio. The Aperio is much faster. The other factor is that the Interscope does not compress its files and uses TIFF format and the Aperio compresses with JPEG200. Notice the difference in file sizes on the Aperio vs Interscope system

Section Number	Box	Section	Slide number	Diagnosis	Aperio Scan	Aperio Scan Time	Aperio File Size	Interscope Scan	Interscope Scan Time	Interscope File Size	Comments
17	A	Muscle & Nerve	97-727	Nerve: Vasculitic Neuropathy	Yes	4min 30sec	53MB	Yes	5min 45sec	239MB	Scanned on Aperio Research scanner
18	A	Muscle & Nerve	99-3616	Muscle: Neurogenic Atrophy	Yes	4min 15sec	52MB	Yes	4min 00sec	193MB	Scanned on Aperio Research scanner
19	A	Muscle & Nerve	99-17105	Muscle: Inflammatory Myopathy	Yes	3min 30sec	46MB	Yes	4min 00sec	197MB	Scanned on Aperio Research scanner
2	A	Bladder	98-	Carcinoma in	Yes	2min	23MB	Yes	2min 45sec	85MB	2 Attempts

Section Number	Box	Section	Slide number	Diagnosis	Aperio Scan	Aperio Scan Time	Aperio File Size	Interscope Scan	Interscope Scan Time	Interscope File Size	Comments
			25686	SITU		30sec					on Interscope, Scanned on Aperio Research scanner
20	A	Muscle & Nerve	98-20984	Nerve: Sarcoidosis	Yes	1min 30sec	3MB	Yes	3min 45sec	163MB	Scanned on Aperio Research scanner

## Features

The Aperio offers many nice other features, such as a 40x Objective lens to scan with. Image viewer That has many feature to compare images side by side and annotations. Everything is also intergrated together on the Aperio. Once the file is scanned a button appears to click and brings up the image in the Aperio image viewer. There is much more user control on the entire scanning of an image then on the Interscope system.

Aperio Viewer has the ability to open images remotely to be viewed

## Resolution

The Aperio uses 47 micron per Pixel

The Interscope system is 33 micron per Pixel

## Color

Both systems have good color to match a slide on a microscope

## Aperio

Pros – Ease of use, fast, user friendly, excellent images captured, smaller file size, complete system with viewer that is all integrated, use of annotations, support

Cons – Large in size

## Interscope

Pros – Small in size, good images

Cons – Interface is not user friendly, image area must be selected by measuring on a piece of paper, limited support, large image sizes

## **L. Whole Slide Imaging Evaluation**

### Whole Slide Imaging Evaluation

Yukako Yagi  
March 17, 2004

#### **Summary**

We have evaluated whole slide imaging for last one year. We have over 1000 whole slide images on our server, 350 are for the US Air Force. The Air Force slides are in several categories such as system evaluation, education, etc. During this term, the system, (both software and hardware) was upgraded several times and improvements were made in image quality, speed and system reliability. As of October 2003, we believe the system is operating at an acceptable level for Air Force facilities installation with UPMC support. The system continues to improve adding initial version of the Auto Loader (even though it needs further development and testing). The Auto Loader requires improvements such as implementation of bar code leader and its database.

We have developed a variety of GUI for each application (such as standalone viewer and web application) and have used these to understand the limitation of the software. Functionality of the API also improved. Although it has still limitations, it has become more flexible with the addition of annotation commands.

Details about the whole slide imaging evaluation are described below.

**Next coming year, we will focus on following items.**

- 1. Development GUI and database with consideration of Auto-loader system**
- 2. Installation and operation at Air Force Medical Treatment Facility.**
- 3. From the experiences of (2), design the Clinical System for Air Force MTF.**

#### **Purposes:**

We have evaluated whole slide imaging using ScanScope, Aperio to determine the value of whole slide imaging itself and to design and develop the best system for USAir Force. In this year, we focused on

1. Image Quality: improve image quality to use for clinical diagnosis
2. File Format
3. GUI for Pathology
4. System stability
5. System operability (Software, Hardware and speed)
6. API
7. Network

#### **Methods**

1. Imaging

- a. Whole slide images were compared by software version, hardware version, other system, file format (JPEG, JPEG2000, Tiff)
  - b. Relationship between focus points, number of focus points and image quality
  - c. Evaluation for diagnostic purposes
  - d. Evaluation for image analysis
  - e. Evaluation of 40x objective lens option
- 2. Hardware
    - a. Compare the process from setting the slide on ScanScope until image shows up on the screen
    - b. Scanning same slide multiple times to see the stability of the system
  - 3. Software
  - 4. API
  - 5. Network

**Results:**

**Image collection (Total 350\*)**

\*This number does not include the slides Ellen Roh scanned for Drazen and Rebecca

- 1. Test image library: 48
- 2. Organ System
  - 2.1. Bladder: 12
  - 2.2. GI tract: 21
  - 2.3. Muscle & Nerve: 4
  - 2.4. Bladder: 12
- 3. Neuropathology lecture AP Conference:12
- 4. Neuropathology Quiz (Distance Education)
  - Neuro muscular 32
  - Hypoxia 4
  - Glial Tumors 15
  - NonGlialTumors 10
  - Pediatric tumors 8
  - Hydrocephalus 8
  - Malformations: 5
  - Vascular: 12
  - AP conference: 12
- 5. Pathologists
  - Dr. Zalme: 32
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- 6. System Evaluation
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6.3: TIFF vs JPEG2000: 6

6.4: system upgrade: 5

### **Scanning Process Improvement:**

The scanning process in 1<sup>st</sup> version of the system was:

1. Load slide
2. Find Tissue
3. Find Focal Point
4. Auto Focus
5. Pre-scan White Balance
6. Scan
7. Strip Alignment
8. Compression

The latest version with Autocoder is

1. Set slides in Auto loader cassettes. (Max. 160)
2. Push "Start" bottom of the ScanScope
3. Check images

The manual version of this version is

1. Load slide
2. Auto Scan
3. Macro Adjustment
4. Compression

### **Speed from Loading until accessible from remote site**

The scanning speed was improved dramatically during the past year.

Sample size 15mm x 15mm can be scanned within 5 min with current system.

It had taken more than 30min with initial version of the system.

It takes 2 hours in average to scan 30 slides using Auto loader.

### **Image Quality**

Version 1:

Slide orientation was not normal

Slow

The line of the connection of each strip was clearer

Focus problem

Alignment problem

Color was OK

Version 2 (software version upgrade up)

Alignment, Focus, line connection, slide orientation and speed were improved

**Version 3 (software & hardware version upgrade) optional 40x**

GUI became very user friendly, the system became more stable and ready to install to Air Force with semi-manual scanning

Color was brownish

Version 4 (version 3 with Gamma Correction)

After the Gamma correction, the tissue area of color was improved.

Instead, the white area became reddish. (Still)

Version 5 (version 4 with Autoloader)

- Whole Slide Imaging
  - Gamma Correction (color improved)
  - Version 4.0 Beta Test
  - Auto-Loader Beta test

### **20x vs. 40x Objective Lens**

- **Process of switching:** Currently, when we need to change the objective lens, we need to:
  1. Replacing an objective lens.
  2. Select the objective lens from ScanScope console. It is very easy process. Initially, we had to re-align the system every time when we switch the objective lens. It was very painful process.
- **Image quality and its value:** 40x image shows excellent image quality. Every user likes 40x image more than 20x. However, the file size is 4 times bigger and scanning time also 3-4 time longer than 20x. With consideration of those facts, pathologists decided not to have 40x images as default since 20x image does not show any problem for diagnostic purposes. It helps pathologists emotionally because they know they can use 40x when they need it. Air Force is going to have this capability.

### **TIFF vs JPEG2000**

Most Tiff files are bigger than 4GB without compression. It is difficult to have Tiff format image because of maximum size limitation of Tiff. When we have Tiff image, the tiff format shows better quality of image than Aperio's recent version of JPEG2000. Actually recent version (newer than version 2.x) shows the artifacts by JPEG, not JPEG2000. It means that they are using JPEG format with Jpeg2000 extension.

Version 1 did not show clearly the artifacts by JPEG.

We have discussed with Aperio about JPEG/JPEG2000 issue. They are working on JPEG 2000 compression board. Until then they want us to use lower compression ratio such as 1/10-1/20 with JPEG compression.

File extension has JP2.

### **Manual vs Auto**

3 out of 9 slides shows focus problem with Auto loader scanning.

1 out of 3 was completely out of focus.

When the focus by Auto scanning does not have any problem, Auto version has good focus consistently compared with manual scanning. Most slides had slightly better quality of images by manual scanning. Here, Manual Scanning means scanned by Jon Duboy.

Until we have consistent good quality of images through out the slide and any slide, we decided to use semi-manual scanned.

## **By Material and Color**

### **1. Neuropathology experience**

Some slides, especially from Neuropathology, were difficult to image because of thickness and type of stain (images were of lower quality).

Thickness problem was acceptable for pathologists. Every time, we have thick slides, we announce pathologists that image quality might have some problems.

When we have special stain, especially Congo Red and Gomiriri, pathologists complained about the color. However, we need some guidance by pathologists on the exact nature of the problem to correct it.

Current Aperio system can not have multiple Gamma files.

Every time when we need to change the gamma, we have to switch text file. Application should support multiple files so that we can select the stain name when we scan (we want to be able to match gamma values to histologic stain).

### **2. Needle biopsy samples (when we use Auto Loader)**

Some needle biopsy slides (very small multiple tissues fragments, especially when that are far apart on the slide) present problems for the tissue finding process. A tiny part of tissue is missing in the image. It is not necessarily critical but not comfortable to use. All slides we had imaging problems in Aperio could not be scanned at all by InterScope system.

We are working with Aperio to solve this problem.

## **Viewer Evaluation**

Image Scope

UPMC viewer

UPMC Web

Aperio Web 1

Aperio Web 2 (zoomify)

Many users like the Aperio web viewer (Zoomify version). However, it can not use from outside UPMC network.

UPMC Web Viewer (Active X control) is accessible from anywhere.

Image Scope is unstable with my PC.

DSI Server: Need to up and running 24hours 7days/week

## **API**

Latest version of API has annotation. Aperio does not know how they should implement. It is not completed. However we have started using it.

## **Conclusions**

**The Whole slide imaging is very useful tool in pathology for many purposes.**

For Air Force, we have a plan to implement the same function with UPMC. However, initial version will not have Autoloader. The Autoloader will be installed later when it is stable and reliable enough.

Air Force Personnel has trained the scanning and they can scan the image comfortably. They will be able to provide educational cases by themselves when the ScanScope will be available at Air Force (This month).

They need to be trained on how to use the viewer.

## **Discussion**

The Aperio system is showing improvement every time when we have new version of software or hardware. To implement it into clinical environment, the focus and tissue finding of Autoloader has to be improved. Real Jpeg2000 needs to be implemented into the system as soon as possible.

Auto loader will be upgraded in early April.

We need to prepare the system to support Auto Loader at UPMC.

***M. Image Capture User Guide***

# **Image Capture User Guide**

**Version 1.0**

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## Introduction

The Image Capture system is a bright field microscope image capture system designed to capture high-resolution digital RGB color images of histopathological tissue samples. The digital images can be captured, viewed and saved to disk by a pathologist or a user.

This document addresses only basic system functionality of the image capture station. It does not address setting all hardware components used in the system. For help in setting the microscope and optics please refer to the microscope user guide.

### **System Components**

Microscope: Olympus BX61 Microscope with 4X, 10X, 20X, 40X and 60X UPlanFL objectives.

Stage: Prior OptiScan motorized stage.

Camera: CC12 Olympus 1 CCD camera (1376 X 1032).

Computer: Dell OptiPlex GX260, Pentium 4, 2.8 GHz, 1G RAM, 74.4 G hard drive, Window 2000 and Dell 18 inch LCD monitor.

### **Startup Screen**

First be sure to turn **ON** the computer, monitor, stage and the microscope. To start image capture application software double click on the "ImageCapture.exe" shortcut on the screen or double click on the "ImageCapture.exe" file located in the "C:\ImageCapture" directory, the screen shown in Figure 1 will appear. The user will have the option as shown in the message box in the center of the application window in Figure 1 to either initialize the camera or load an image file from disk, both functions will be discussed latter in this document.

Press the **OK** button in the message box and the main Image Capture application window will appear as in Figure 2.

### **System Functions**

The Image Capture Tool Bar shown in Figure 3 contains the functions that can be performed using the Image Capture system.

**Open:** Load and display image file from disk. Refer to **Load Image File** section in this document.

**Save As:** Save an image file to disk using JPEG 2000, JPEG compressed or lossless and TIF uncompressed format. Refer to **Save Image File** section in this document.

**Initialize Camera:** Initialize the camera, camera must be initialized before using it in single or live image mode.

**Grab Image:** Grab a single camera image. Refer to **Single Grab** section in this document.

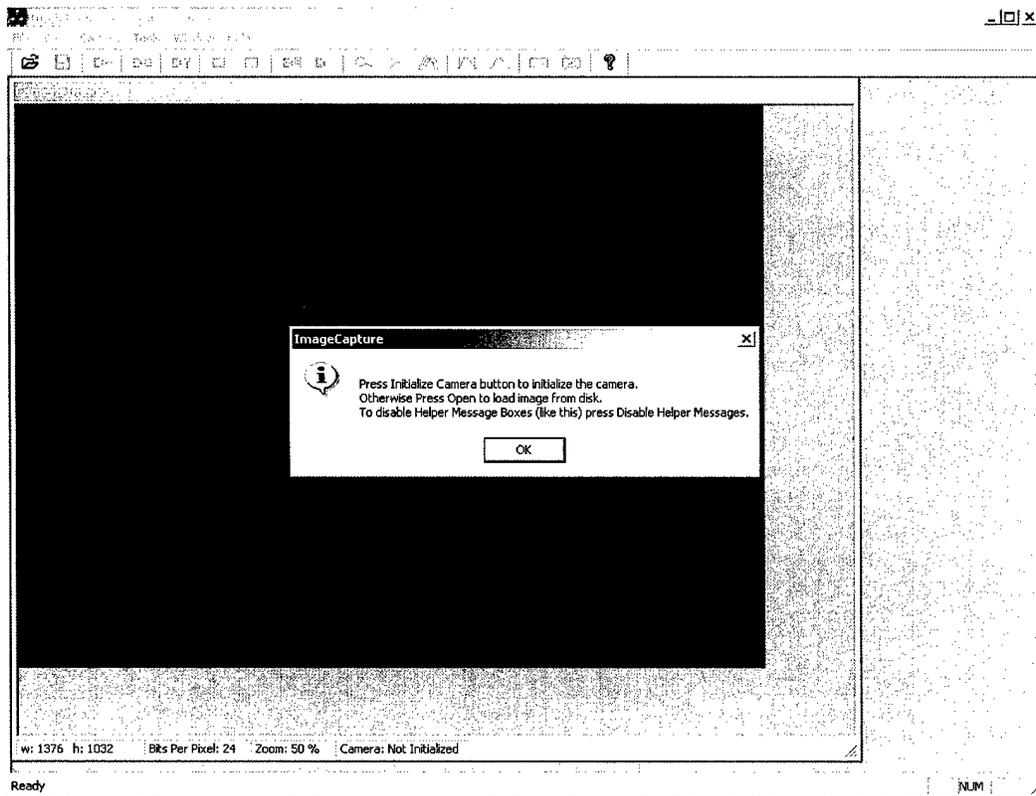


Figure 1: Image Capture Startup Screen.

**Camera Control Dialog:** Display camera control dialog, used to set camera exposure time. Refer to **Camera Control Dialog** section in this document.

**Select White Balance Region:** Select rectangle region in the background area of the image (no tissue or dirt should exist in this region), this region will be used for camera white balance. Refer to **White Balance Setup** section in this document.

**White Balance:** Apply white balance. Refer to **White Balance Setup** section in this document.

**Start Live:** Set the camera to live mode. Refer to **Live mode** section in this document.

**Stop Live:** Stop camera live mode. Refer to **Live mode** section in this document.

**Zoom Dialog:** Display zoom dialog, used to change the zoom factor for the active image. Refer to **Zoom Dialog** section in this document.

**Focus Measure Dialog:** Display focus measure dialog, used to display captured image focus measure or how well focused the captured image is. Refer to **Focus Measure Dialog** section in this document.

**Histogram Dialog:** Display image histogram. Refer to **Histogram Dialog** section in this document.

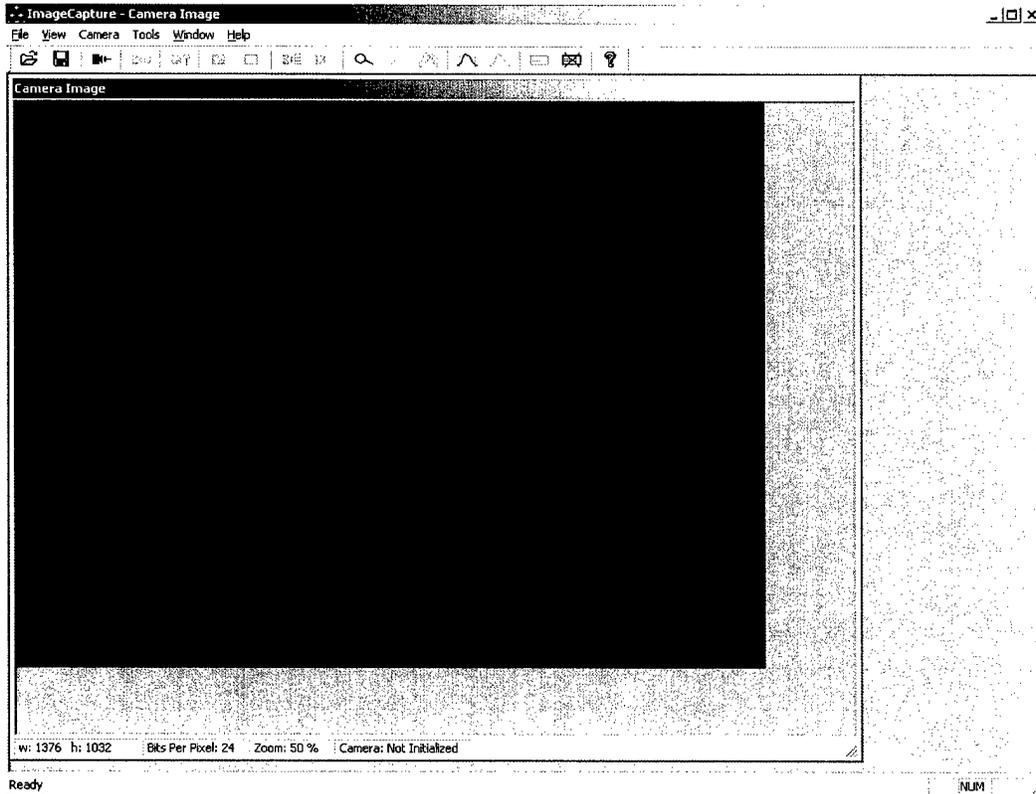


Figure 2: Image Capture application window after pressing the OK button.

**Enable Auto Gain:** Enable auto gain. Refer to **Auto Gain** section in this document.

**Disable Auto Gain:** Disable auto gain. Refer to **Auto Gain** section in this document.

**Enable Helper Messages:** Enable helper messages dialogs displayed after pressing some of the tool bar buttons, these messages are used to guide the user.

**Disable Helper Messages:** Disable displaying helper messages.

**About:** Display About dialog showing application version number and other Image Capture application information.

All functions discussed above can also be accessed through the menu.

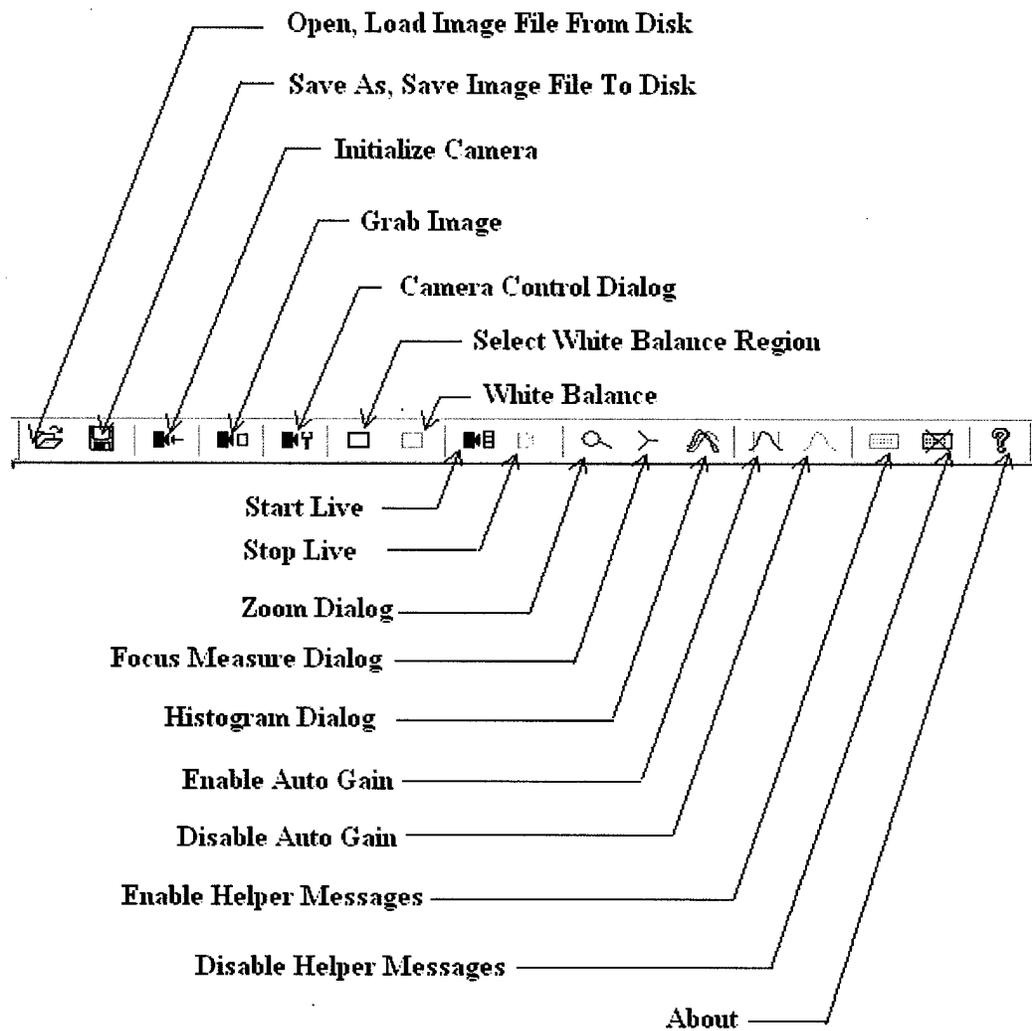


Figure 3: Image Capture Tool Bar.

### **Camera Control Dialog**

To display camera control dialog press **Camera Control Dialog** button and the dialog will be displayed as in Figure 4. To change the exposure time for a given microscope objective, first select the radio button for that objective, the exposure time for the selected objective will be displayed in micro second. To increase/decrease the exposure time for the selected objective in 500 micro second interval, press +/- buttons, the updated exposure time will be displayed in the text box. To increase/decrease the exposure time for the selected objective in 10 micro second interval, use the up/down small arrow buttons located beside the text box.

To set to default exposure values for all objectives, press **Default** button, and the exposure value for each objective will be set to the default value.

At dialog start up, the dialog will display the same settings for objectives and exposure times from the last time the dialog was used to change any setting.

To exit the dialog press the **Exit** button, at dialog exit all dialog settings such as selected objective and exposure value for each objective will be saved.

The dialog can only be used in camera single grab and live mode.

When exiting the Image Capture application all settings for the Camera Control Dialog will be saved.

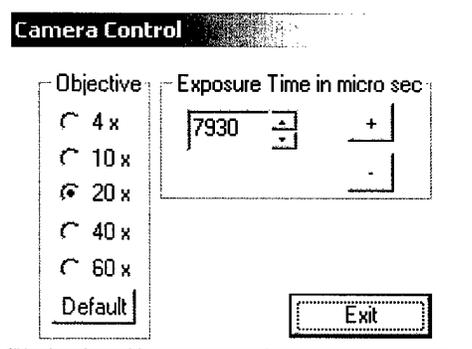


Figure 4: Camera Control Dialog.

### ***Focus Measure Dialog***

To display focus measure dialog press **Focus Measure Dialog** button and the dialog will be displayed as shown in Figure 5. This dialog displays the focus measure as a number and a progress bar, the focus measure number shows how well focused the image is. Best focus for captured image is obtained when the focus measure reaches a maximum value (does not have to be 100). If the content of the captured image changed due to slide movement or change in camera exposure press the **Reset** button to display the updated focus measure. Also there should be some tissue in the captured image.

The focus measure dialog can be used in single camera mode and also during live mode.

To get the best focused image, in live mode adjust focus until reaching maximum focus measure value ***WARNING: BE CAREFULL WHILE FOCUSING, DO NOT LET THE OBJECTIVE TOUCH THE SLIDE.***

The focus measure dialog can only be used with camera image and not with images loaded from disk. To be sure the active image is the camera image, click on the window with the title Camera Image.

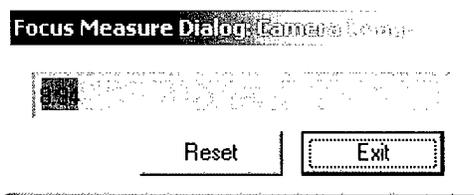


Figure 5: Focus Measure Dialog.

### ***Histogram Dialog***

To display histogram dialog press **Histogram Dialog** button and the image histogram of the selected image window will be displayed as shown in Figure 6. The histogram dialog displays the image histogram for the selected image window. For a given RGB image, the red curve represent the histogram of the red image plane, where the x-axis represent the red image plane gray scale pixel value and the y-axis represent the number of pixels, the green and the blue histogram curves are defined similarly.

The histogram dialog can be used to test if the image is under/over exposed and if a given background image is correctly white balanced.

The dialog can be used in single and live camera mode, when in live mode the histogram will be updated continuously.

The histogram dialog can also be used for image file loaded from disk. The histogram dialog title will display the corresponding image file name, for example in the dialog in Figure 6 displays the histogram of the Camera Image.

To exit the histogram dialog press **Exit** button.

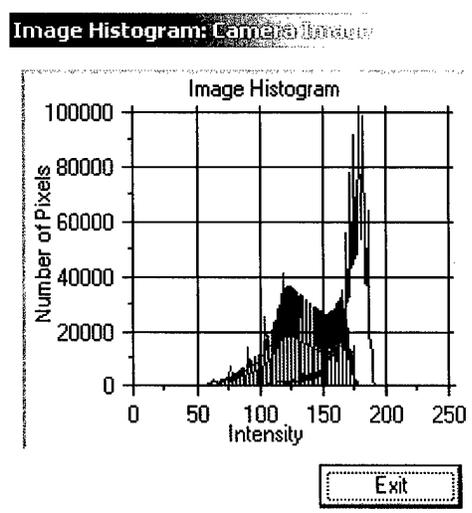


Figure 6: Histogram Dialog.

### ***Zoom Dialog***

To display zoom dialog press **Zoom Dialog** button and the zoom dialog for the selected image window will be displayed as shown in Figure 7. The zoom dialog is used to change the zoom factor for the selected image. To change the zoom factor for the selected image move the slider to the left/right to decrease/increase zoom factor. To set zoom factor to 100 press **Zoom 100** button.

The zoom dialog can be used in single mode, live mode and for image file loaded from disk.

To exit zoom dialog press **Exit** button.

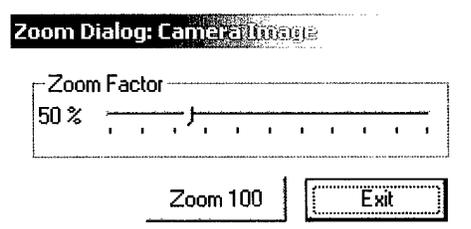


Figure 7: Zoom Dialog.

## Setup

To use the Image Capture system for the first time, some initial setup steps must be performed:

1. All hardware components such as computer, microscope, camera and stage must be properly connected, please refer to the hardware component user manual.
2. Microscope and optics must be setup correctly, please refer to the microscope user manual for proper setup documentation.
3. Stage must be setup correctly, please refer to the stage user manual for proper setup documentation.
4. Perform camera exposure setup for each objective, please refer to **Camera Exposure Setup** section below.
5. Perform white balance setup, please refer to **White Balance Setup** section below.

Steps 4 and 5 above must be performed after:

- a- Camera replacement or movement.
- b- Microscope replacement.
- c- Changing Filters.
- d- Changing microscope lamp.
- e- Changing microscope brightness level.
- f- Changing microscope Optical Path Selection position.
- g- Changing microscope lamp.

## Camera Exposure Setup

To select proper exposure time for each microscope objective, after start up screen the Image Capture application window will look as in Figure 2.

1. Set the Optical Path Selection lever of the microscope to **Eyepiece and Camera**.
2. Put a standard slide with a stained tissue sample in the stage slide holder. The slide cover slip should be on the upper side of the slide facing the microscope objective.
3. Check to be sure that one objective is properly selected and located above the slide.
4. Look through the microscope binocular eyepiece and move the slide along the x and y-axis using stage joystick until you see a tissue area, adjust the stage z-focus to get best focus view **WARNING: BE CAREFULL WHILE FOCUSING, DO NOT LET THE OBJECTIVE TOUCH THE SLIDE.**
5. Press **Initialize Camera** button to initialize the camera.
6. Press **OK** button in the displayed message box.
7. Press **Grab Image** button.
8. Press **OK** button in the message box, the camera should grab one image and the Image Capture main window will look as shown in Figure 8. The captured camera image could be brighter, darker or out of focus that what is shown in Figure 8.
9. Set the objective setting in the camera dialog to the same microscope objective being used.
10. Press **Start Live** button.
11. Press **OK** button in the displayed message box.
12. Look at the image histogram in the histogram dialog. Check if the image is over exposed, this happen if one or more of the three histogram curves (red, green and blue) will be touching (ignore points located on the x-axis, since it represent zero number of pixels) the vertical line located at intensity value equal to 255, this line is the right vertical edge of the histogram plot area. Example of an over exposed image histogram is shown in Figure 9, blue curve is touching the right vertical line.

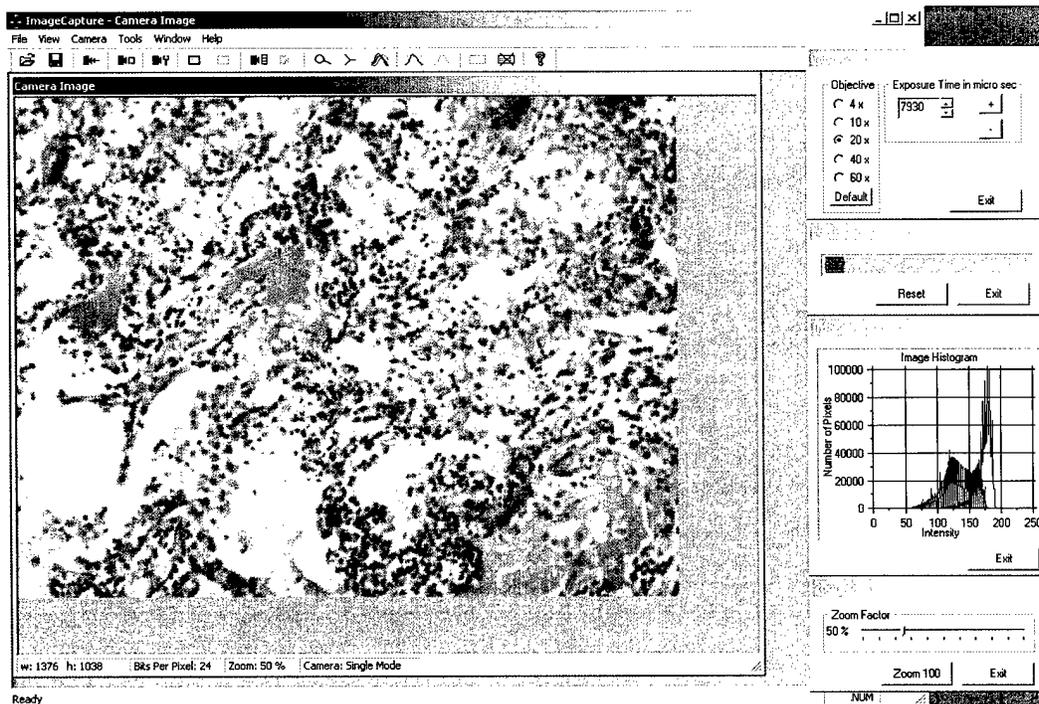


Figure 8: Camera single image grab.

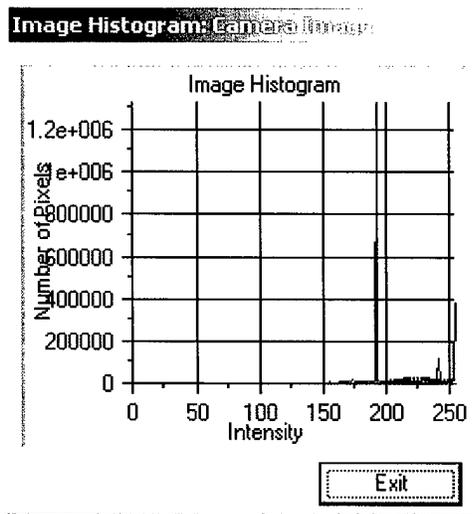


Figure 9: Histogram of an over exposed image.

To check if the image is under exposed, look at the image histogram in the histogram dialog and if all or the majority of the three curves are located in the low intensity values as shown in Figure 10 then the image is under exposed. Also by looking at the image the background regions in the image will look dark. If the image is under exposed, increase camera exposure time until the three histogram curves move closer but not touching the vertical right edge of the plot area (intensity value equal to 255).

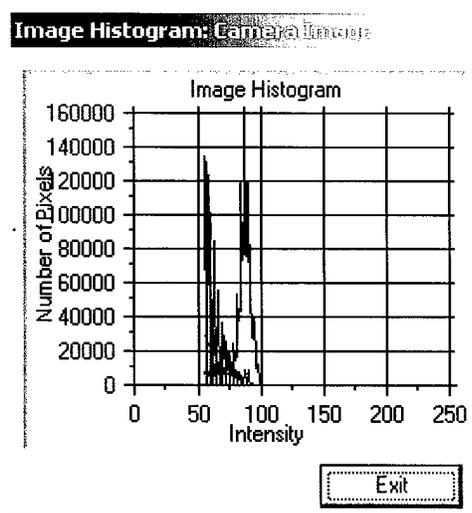


Figure 10: Histogram of an under exposed image.

13. Move the slide along the x and y-axis using stage joystick until you see in the camera image only background region as shown in Figure 11. Check as in step 12 above to be sure that the background image is not over exposed. Decrease the exposure time if the

- background is over exposed using the camera control dialog.
14. Move the slide along the x and y-axis using stage joystick until you see in the camera image a tissue region as shown in Figure 12.
  15. Repeat steps 1 to 14 above for each microscope objective.

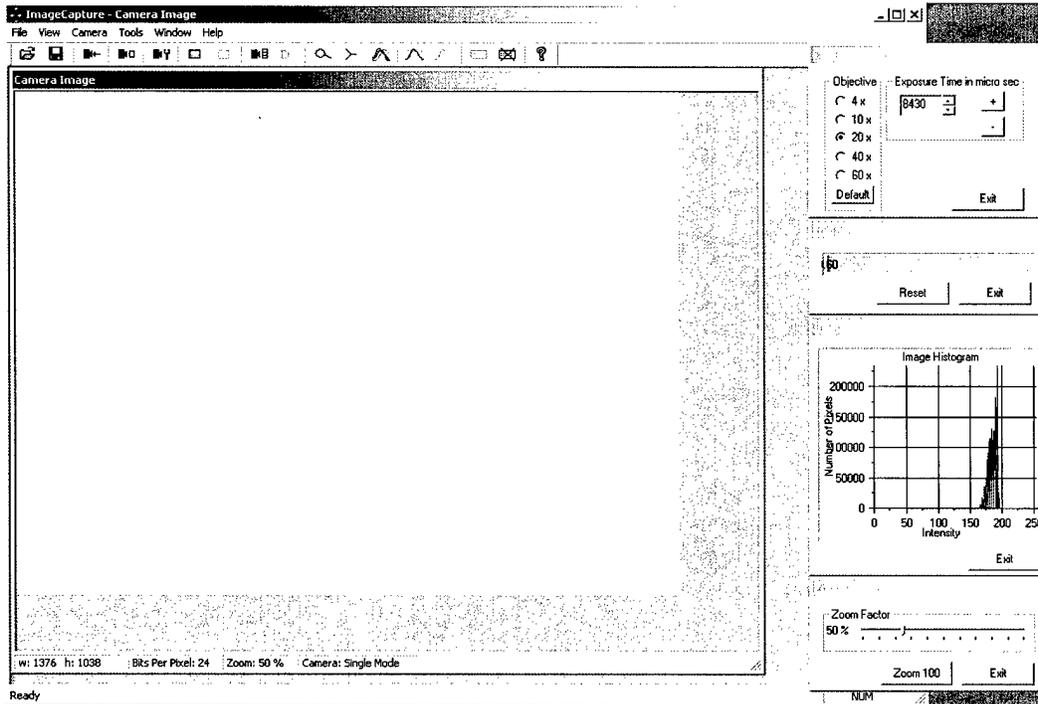


Figure 11: Background Image.

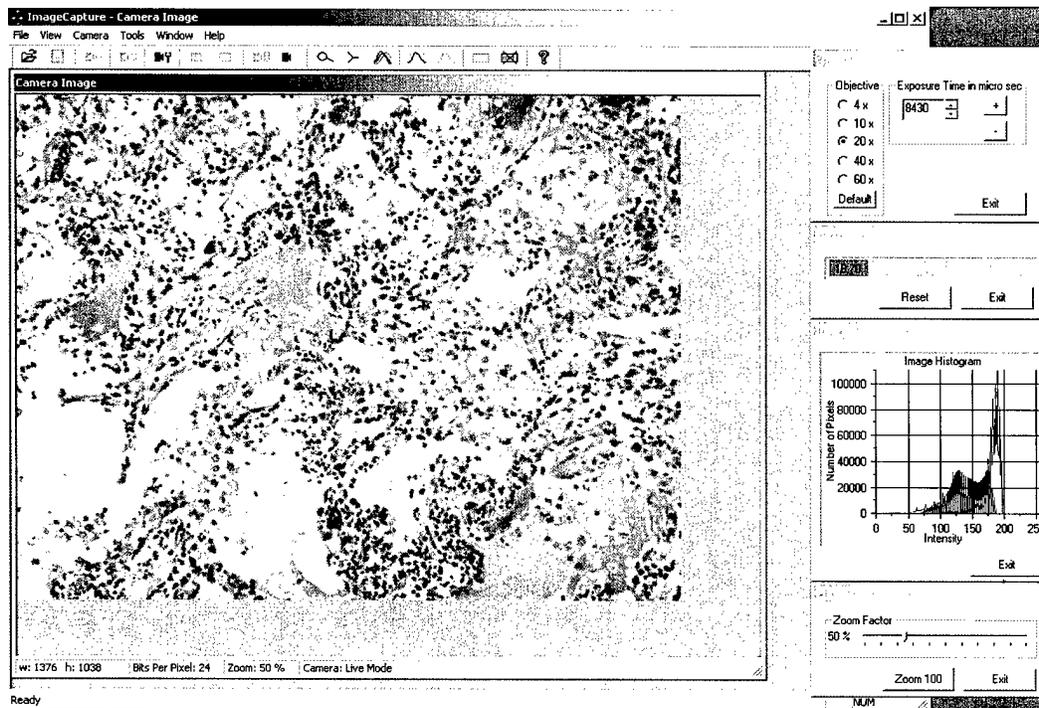


Figure 12: Well exposed camera image.

### White Balance Setup

It is assumed that camera exposure setup had already been done as shown above. To perform white balance:

1. Check that camera image window is in single grab mode, if the camera is in live mode press **Stop Live** button.
2. Press **Select White Balance Region** button.
3. Press **OK** button in the message box, and the camera image will look as shown in Figure 13. The black rectangle can be used to select rectangular region in the image that contains only background. The black rectangle can be resized and moved using the mouse.

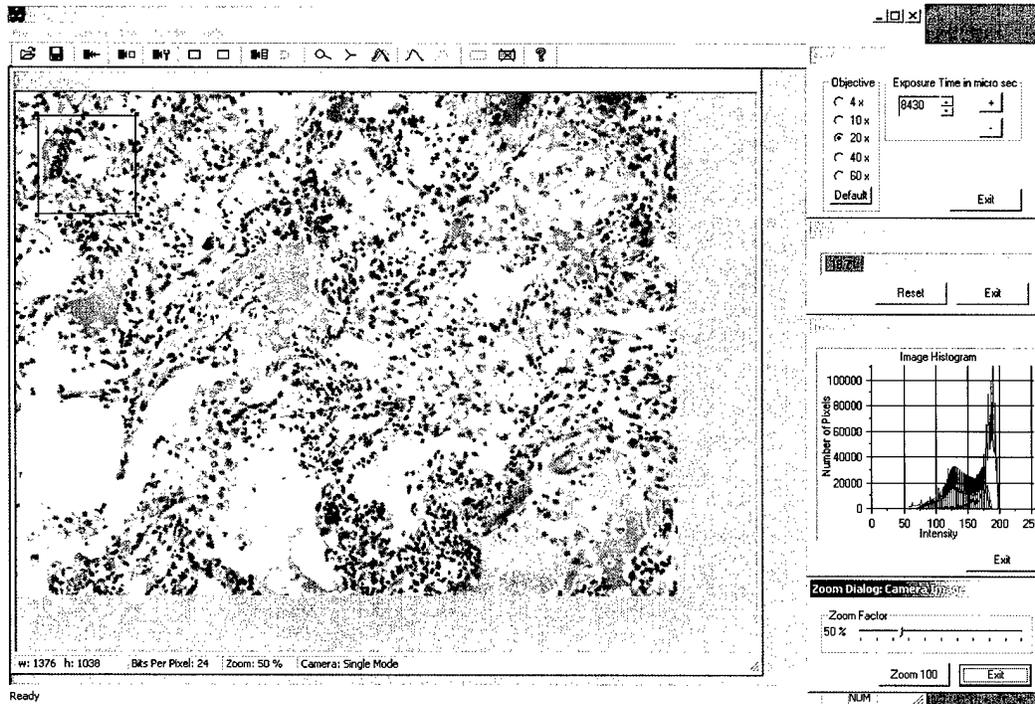


Figure 13: Selecting background region for white balance.

4. Press **Start Live** button.
5. Move the slide along the x and-y axis using stage joystick until you see in the camera image a background region.
6. Press **Stop Live** button.
7. Move/resize the black rectangle using the mouse so it cover only background region as shown in Figure 14.
8. Press **White Balance** button.
9. To apply white balance press **OK** in the displayed message box, to cancel press **Cancel**.
10. After pressing **OK** button in the message box, white balance will be applied and the camera image will look as shown in Figure 15. For a correctly white balanced background image, the three histogram curves should be aligned with each other as

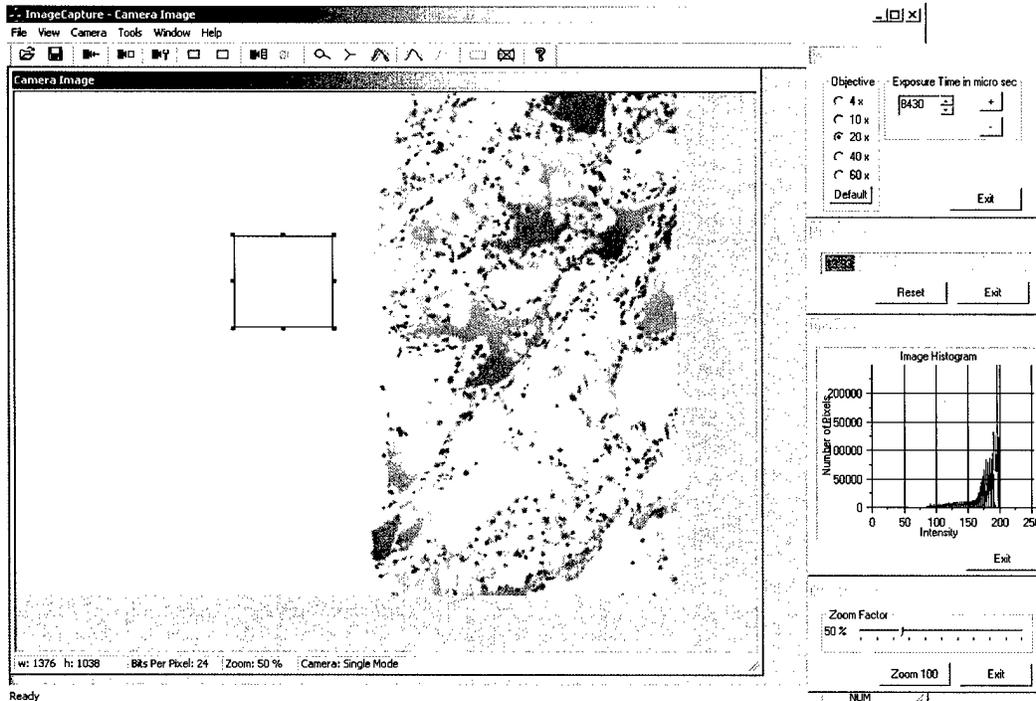


Figure 14: After Moving/Resizing black rectangle to background region.

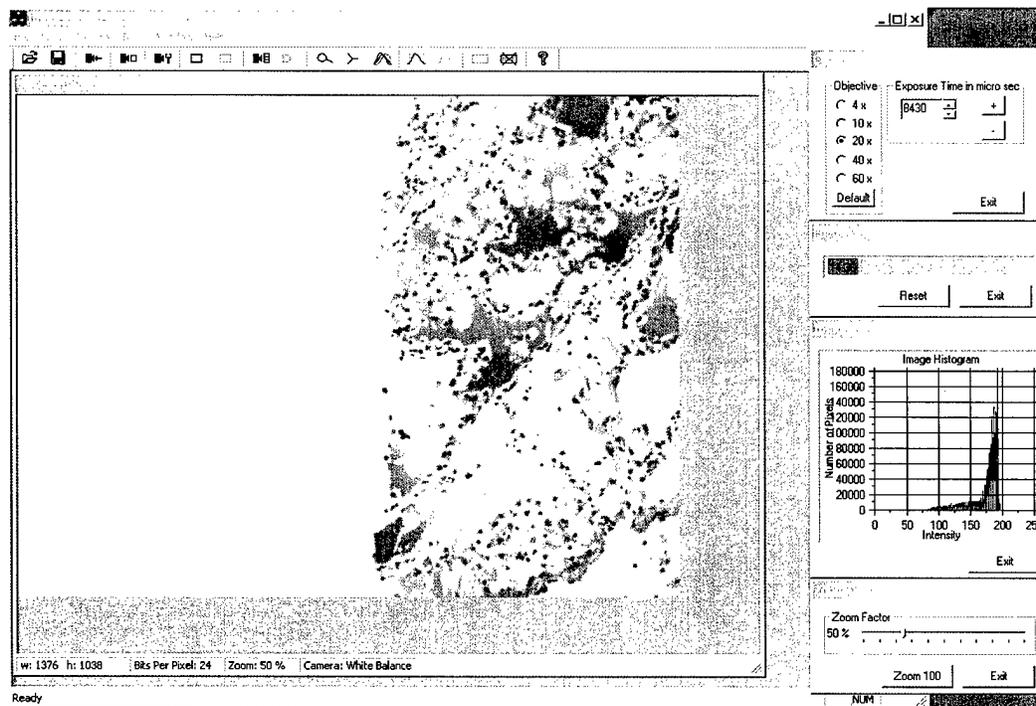


Figure 15: Applying white balance.

shown in Figure 16. Figure 17 show the histogram of a background image before applying white balance.

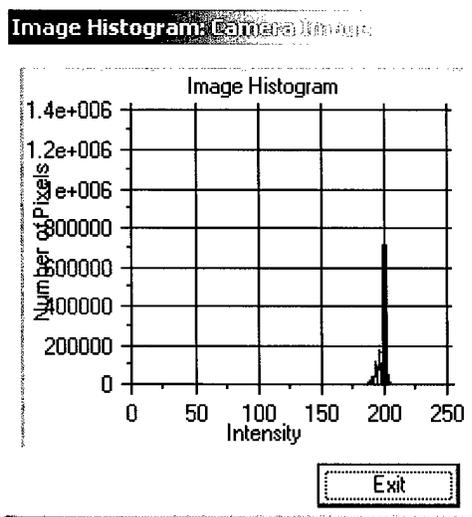


Figure 16: Histogram of a background image after white balance.

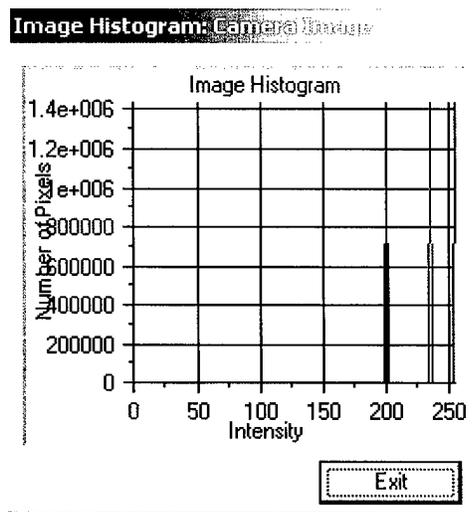


Figure 17: Histogram of a background image without white balance.

### **Single Grab**

To grab single image from the camera, press **Grab Single** button.

### **Live mode**

To start live camera mode, press **Start Live** button. To stop live camera mode, press **Stop Live** button.

### **Load Image File**

To load image file from disk, press **Open** button and select image file from disk using **Load image file from disk** dialog as shown in Figure 18. Selected image file can be previewed in the dialog before loading and displaying the whole image.

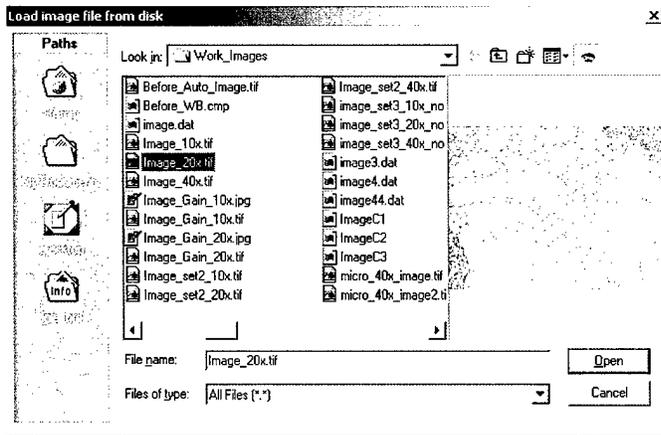


Figure 18: Load image file from disk dialog

More than one image can be loaded and displayed at the same time with the camera image (assuming available computer memory) as shown in Figure 19. To view a given image, click on that image.

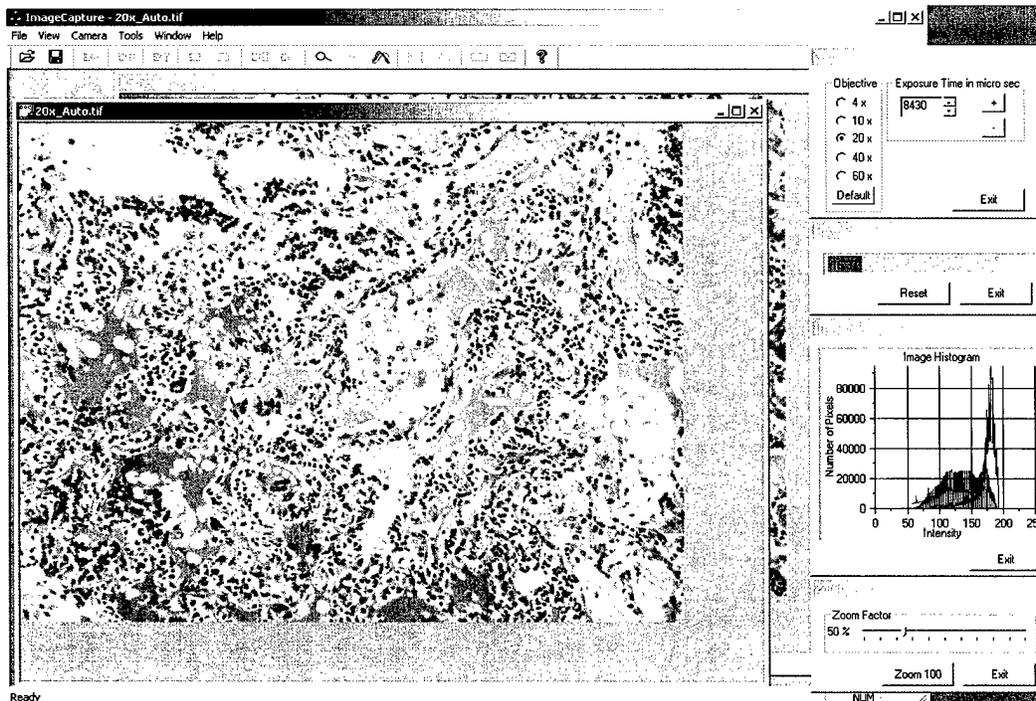


Figure 19: Image file and camera image.

### Save Image File

To save an image to disk, press **Save As** button. The save a file dialog will be displayed as shown in Figure 20. Select image file format JPEG 2000, JPEG or TIFF. Type an image file name in the file name box and press **Save** button in the dialog. TIFF format can be saved as uncompressed, JPEG 2000 and JPEG can be saved as lossless or lossy compressed.

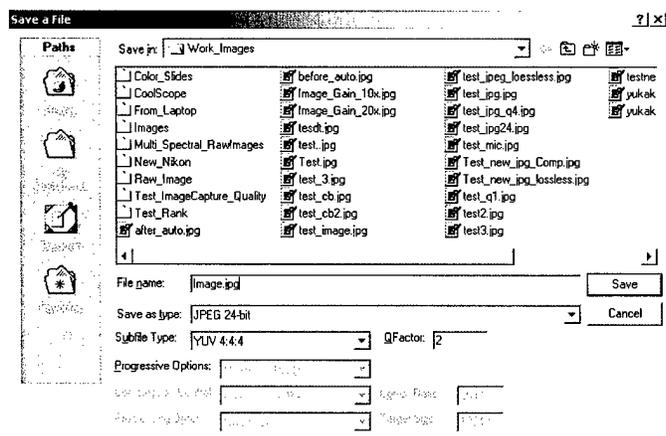


Figure 20: Save a file to disk dialog.

### **Auto Gain**

To enable Auto Gain, press **Enable Auto Gain** button. Auto gain can be used while in camera live mode and switching between different objectives without changing objective selection in the camera control dialog. To disable auto gain, press **Disable Auto Gain** button.

### **Exit**

To exit Image Capture, first be sure the camera is not in live mode, if in live mode press **Stop Live** button. Exit any displayed dialogs. From the **File** menu select **Exit** or press **X** button located in the upper right corner of the main application window.

All camera setup parameters and white balance parameters will be saved.

### **Image Capture Troubleshooting**

1. When I press **Grab Single** or **Live mode** the captured camera image is black.  
 Check that the **Optical Path Selection** lever of the microscope is set to **Eyepiece and Camera**.  
 Check that the microscope switch is **ON**.  
 Check that one of the objectives is properly selected.  
 Check for proper camera exposure time for the selected objective, increase exposure time using camera control dialog.  
 Check that there is a slide in the stage slide holder.  
 Check that the camera is properly connected to the computer.
  
2. When I press **Initialize Camera** I get an error that the camera can't be initialized.  
 Check that the camera is properly connected to the computer.

3. When I press **Grab Single** or **Live mode** the resulting camera image is too dark.  
Increase camera exposure time using **Camera Exposure Dialog**.
4. When I press **Grab Single** or **Live mode** the resulting image is too bright.  
Decrease camera exposure time using **Camera Exposure Dialog**.
5. When I press **Grab Single** or **Live mode** I get error camera can't grab single or live.  
Check that the camera is properly connected to the computer.
6. When I try to move the slide along the x or y-axis using the stage joystick, the slide does not move.  
Check that the stage is **ON**.  
Check that the stage slide holder didn't reach the slide movements limits.
7. I can't focus along the z-axis.  
Check that the stage is **ON**.
8. I see dark regions in the captured image near the image corners.  
You need to perform Koehler illumination, please check microscope user manual.
9. If the problem still not resolved yet, please call UPMC HealthSystem technical support.

## N. TP2\_Pre-Implementation Survey Results

**IMITS Telepathology Project  
Pre-Implementation Survey  
Preliminary Findings – Time Point 1  
Time Point 1: n = 9**

**Position:**

	<b>Total</b>
Pathologist	7
System Admin	2

<b>Total</b>	<b>9</b>
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**Hours/week using a computer for work-related tasks:**

	<b>Hrs/Wk</b>
Pathologist	19.57
System Admin	18

**Self-report on level of computer sophistication:**

<b>Position</b>	<b>Time Point 1</b>				
	<b>Very sophisticated</b>	<b>Sophisticated</b>	<b>Neither</b>	<b>Unsophisticated</b>	<b>Very unsophisticated</b>
Pathologist	0	2	5	0	0
System Admin	1	1	0	0	0
<b>Total</b>	<b>1</b>	<b>3</b>	<b>5</b>	<b>0</b>	<b>0</b>

<b>Participant responses: 5 Point Scale: 5 = Strongly Agree / 1 = Strongly disagree</b>	<b>Time Point 1</b>			
	<b>Pathologist</b>	<b>System Admin</b>	<b>MEAN</b>	<b>RANGE</b>
The Static Image System will facilitate attainment of second opinions from pathologists at remote locations?	3.86	5.00	4.43	3-5
It will be easy to capture and load images into the Static Image System?	4.14	4.50	4.32	4-5
It will be easy to enter case specific data into the Static Image System?	4.14	4.50	4.32	3-5
Patient images can be selected and displayed in a timely manner?	4.33	4.50	4.42	4-5
Static Image System image quality will be suitable for diagnosis?	4.00	4.50	4.25	3-5

Image management will be intuitive or easy to figure out?	3.66	4.50	4.08	2-5
The Static Image System interactive chat environment will be easy to use?	3.66	4.50	4.08	3-5
The interactive chat environment will facilitate better diagnoses and better service?	3.83	4.50	4.17	3-5
The Static Image System will facilitate quality assurance?	4.00	4.00	4.00	3-5
Images and patient data will be comprehensive and relevant to the case?	3.83	4.50	4.17	3-5
The Static Image System will improve pathologist-to-pathologist communications?	4.00	4.50	4.25	3-5
The Static Image System will improve pathologist-to-clinician communications?	3.00	4.00	3.50	1-5
The Static Image System will improve the promptness of outside consultations?	3.71	4.50	4.11	3-5
The Static Image System will improve patient care?	3.57	4.50	4.04	3-5
<b>RANGE</b>	<b>1-5</b>	<b>3-5</b>	<b>1-5</b>	

### Written Responses

#### 10 individual comments

#### Best Features (n = 3 comments)

- Ease of use.
- Ability to use for tumor board is most effective if connected to KAFB Intranet. Ability to send/receive images from other sites.
- The interactive chat environment is probably the strongest feature.

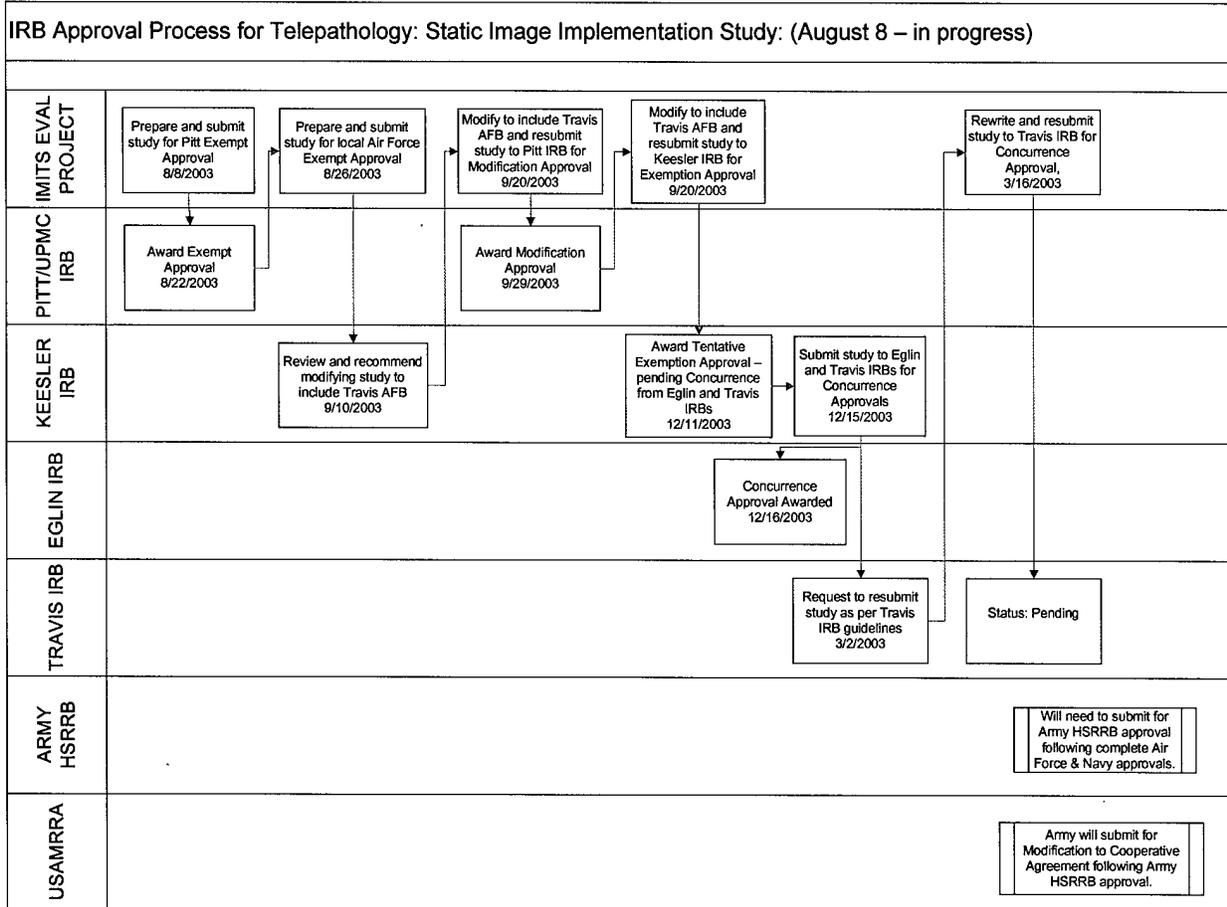
#### Concerns (n = 4 comments)

- Expense.
- The system, as I was shown it, did not have real-time "instant messaging" capabilities.
- Pathologists interested should receive the video imaging at their desk. Familiarity with electronic images to sign out cases with confidence ensuring best practices.
- Capture of static images seems cumbersome.

#### Suggestions (n = 3 comments)

- Needs instant messaging capacity.
- A single image capture/chat environment would be more efficient than two systems. Although, the consultant pathologist would do well using just the chat environment.
- Put video camera on pathologist's scopes with monitoring and load soft image to hard drive so pathologist can become comfortable with electronic images and can immediately compare with light microscope image to build knowledge base for electronic images sign outs. Only pathologists interested should receive the video imaging at their desk.

## O. TP\_3 Static Image Study IRB Approval Process



## **P. Pediatric Tele-echocardiography Standard Operating Procedure**

**Air Force Medical Service  
Keesler Medical Center  
301 Fisher Street  
Kessler AFB, MS 39534-2519**

### **Pediatric Tele-echocardiography Clinical Operating Procedure**

#### **1. Introduction**

This Pediatric Tele-echocardiography Clinical Operating Procedure is provided as a guide to Air Force health care providers for requesting and implementing a Pediatric Tele-echocardiography consultation.

#### **2. Definitions**

Teleconsultation – remote patient evaluation and consultation via a telecommunications system

Referring Physician or Provider – the physician or healthcare provider who requests the teleconsultation

Consulting Physician or Provider – the physician or healthcare provider whose expertise is requested via a teleconsultation

Tele-echo Technician – the healthcare provider that will perform the echocardiogram via the telecommunications system

Originating Site – site where the patient is located at the time of the teleconsultation

Consulting Site – site where the physician or healthcare provider is located at the time of the teleconsultation

#### **3. Scope of Tele-echocardiography Services**

Services are provided for those patients who have suspected or known congenital or acquired pediatric cardiac disease who may need urgent evaluation or triage. This includes, but is not limited to: newborn infants with suspected severe congenital defects, pediatric patients with shock or other life-threatening illness that may be due to a cardiac etiology (e.g. pericarditis, myocarditis, etc.), or established patients with known cardiac disease with acute changes in clinical status in which the heart is felt to be the etiology and routine outpatient clinical evaluation would not be timely.

#### **4. Referral and Scheduling Procedure**

Procedure for initiating a teleconsultation

- Referring physician or provider should directly contact the consulting physician (Dr. Boris) as follows:
  - i. During Duty Hours (7am to 5pm) in the following order
    1. Call direct to Dr. Boris office (228) 377-6808
    2. Call the Pediatric Specialty Clinic (228) 377-8613

- ii. After Duty Hours in the following order
  1. Call direct to Dr. Boris's home (228) 872-6578
  2. Call Keesler Medical Center Information Desk (228) 377-6550 and ask to have Dr. Boris paged.
  3. Call Keesler Medical Center Information Desk (228) 377-6550 and ask to have the Pediatric resident on-call paged and they will notify Dr. Boris.
- Referring physician or provider should notify the tele-echo technician
  - i. Each originating site should develop internal policies for notification of tele-echo technician.

## 5. Responsibilities

### Referring Physician

#### Prior to Teleconsultation

- Contact consulting physician to request teleconsultation
- Follow originating site protocol for notification of tele-echo technician

#### Following Consultation

- Review result of consultation in CHC

### Tele-echo Technician

#### Prior to Teleconsultation

- Contact consulting physician and determine teleconsultation time
- Determine location for teleconsultation
- Move appropriate equipment to the location
- Inform patient and family about the teleconsultation procedure

#### During Teleconsultation

- Set up and operate tele-echocardiography equipment
- Perform pediatric tele-echocardiogram under the direction of teleconsultant
- Ensure privacy and confidentiality of patient and patient information
- Ensure comfort and safety of patient and family

#### After Teleconsultation

- Distribute and collect pediatric tele-echocardiography evaluation forms
- Log tele-echocardiography activity
- Return evaluation forms to study coordinator

### Consulting Physician

#### Prior to Teleconsultation

- Access patient medical record in CHCS when applicable
- Communicate with Tele-echo technician regarding time for teleconsultation
- Communicate with Tele-echo Technician regarding any special procedures or techniques that may be required.

#### During the Teleconsultation

- Ensure privacy and confidentiality of the patient
- Ensure comfort and safety of patient and family
- Explain examination to patient and family by interactive videoconferencing when appropriate
- Determine if the tele-echocardiography system and connection are functioning properly and providing sufficient quality to evaluate the patient appropriately
- Provide direction to the tele-echo technician while he/she performs the exam.

#### After the Teleconsultation

- Discuss the results of the teleconsultation with the patient and family when appropriate
- Document the results of the teleconsultation using CHCS
- Communicate the results of the teleconsultation to the referring physician as applicable

### **6. Privacy and Confidentiality**

All existing policies regarding privacy and confidentiality at the consulting and originating site will be in effect for the teleconsultation. Every attempt will be made to ensure patient privacy and confidentiality during the teleconsultation including but not limited to:

- Limiting the number of and introducing all persons at the originating and consulting sites
- Explain policy on videotaping the examination
- Provide a private room for teleconsultation if possible and appropriate

### **7. Documentation**

#### Tele-echo Technician

- Note in patient record the date and time that the teleconsultation was performed
- Fill out the Tele-echocardiography log sheet

#### Consulting physician

- Document the results of the teleconsultation in CHCS
- Maintain provider continuity file at the consulting site

### **8. Safety and Infection Control**

All local policies for infection control and equipment safety will be in effect at the originating and consulting site.

## Q. TE\_2 Tele-Echocardiography Study IRB Process

