SESSION 38
Experience Providing a Complete Online Multimedia Patient Record

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INTRODUCTION

Complete online patient data including traditional medical chart information and clinical images is essential in providing healthcare in a distributed environment. The contents of the patient record can be divided into four categories:

- The portion of the paper patient chart that can be rendered in textual format;
- Computable data such as laboratory results that can be used in calculations, graphing, searching, or decision logic to provide additional value to the user
- The multimedia portion of the patient’s record that does not traditionally reside in the paper chart, but rather is located in various departments throughout the medical center. These supporting elements include radiographs, other diagnostic images such as ultrasonography, Doppler waveforms, pathology, GI, surgery, dermatology and cardiology images and many others. The disparate media of paper, film, and magnetic tape and the sheer volume of this data have prevented the filing of these supporting elements in the traditional medical record.
- The remainder of the paper patient chart contents, including signed forms, hand-drawn figures, spreadsheets, and papers brought in from outside. This portion may include graphic elements like wound, pathology, or fundus photographs, diagrams embedded within progress notes, the electrocardiogram tracing, and charts of fluid input and output or an anesthesia record.

It is essential to have all this data available from every workstation in order for clinicians to use the system widely. The user interface to such an electronic multimedia record can be enhanced to present data in ways not possible with a paper chart or other physical image media (see Figure 1). The ultimate goal is to increase clinician productivity, facilitate medical decision-making, and improve quality of care.

The Dept of Veterans Affairs has been working on the multimedia online patient record for over ten years, and has significant experience with medical center use. There have been other research projects related to the development of multimedia online patient records, but no other multispecialty multimedia patient record systems are in widespread use. The electronic multimedia patient record developed by the VA and described here is an example of the functionality that can be provided with today’s technology. In addition to serving the nation’s veterans, the VA’s system may allow other hospitals to benefit through use of this system as a model for multimedia patient records in the future.

Figure 1: A patient’s multimedia medical record includes images (left) integrated with online computerized patient chart (lower right). Users sign onto the workstation with their hospital information system security logon codes. Privileges are verified by the HIS. The user selects a patient and then views the patient’s multimedia longitudinal medical record. A number of windows are used to display the patient’s image and text data. The online patient chart window allows the user to access traditional chart tabs like cover sheet, problem list, medications, orders, progress notes, consults, lab results, and reports. Various image windows can be placed on the screen by the user, generally around the chart window. This allows simultaneous viewing of chart and images.
The VA is combining several major system development efforts to deliver a complete online multimedia patient record containing all of the above elements to its hospitals. The Computerized Patient Record System (CPRS) uses the patient chart paradigm with tabs for cover sheet, problem list, medications, orders, progress notes, consults, lab results, and reports. The clinician may enter information and orders using the same software. A number of decision support tools are provided to enhance the patient chart capability. In addition, workflow tracking tools assist in management of the medical record. The CPRS software has over 100,000 daily users in the VA.

The VistA Imaging System brings x-rays and other radiology images, drawings, medical photographs, endoscopic pictures, scanned documents, and graphical data such as electrocardiograms to the electronic clinical desktop in an integrated manner. Various image windows can be placed on the clinical workstation screen by the user, generally surrounding the patient chart window (see Figure 1). With today’s technology, the VA is digitizing, storing and distributing medical images along with the electronic patient record using workstations located throughout hospitals and across the wide area network. 1,2,5,6

The major goal of the multimedia patient record is to provide complete patient data in an integrated manner that facilitates the clinician’s decision making. Images and associated text data are available at any time anywhere throughout the hospital on windows-based workstations that are interfaced to the main hospital system in a client-server architecture. The system handles high quality image data from many specialties including cardiology, pulmonary and gastrointestinal medicine, pathology, radiology, hematology, and nuclear medicine, as well as textual reports from the hospital information system, scanned documents and electrocardiograms (see Figure 2). The Imaging System is being used at a number of VA Medical Centers. It improves the quality of patient care, enhances clinicians’ communication, and is used routinely for daily work, at conferences, morning report, and during ward rounds.

**Figure 2:** Multimedia patient record containing cystoscopy, pathology, EKG, and radiology images. A menu of small thumbnail images allows the user to select images for more detailed viewing. Special windows are provided for color, grayscale, and document images and electro-cardiograms. Procedure reports pertinent to the image are available through CPRS or directly from the image window. This “visual chart” capability is typically used by treating clinicians reviewing the patient’s course and determining treatment plans. Specialists review procedure data when interpreting studies and dictating their reports.

**VA SYSTEM ARCHITECTURE**

The Department of Veterans Affairs healthcare enterprise consists of a nationwide network of 172 VA Medical Centers (VAMCs) and numerous outpatient clinics serving a patient population of 25 million veterans. The VistA Hospital Information System (HIS) is used at all of these sites. VistA is an internally developed comprehensive HIS that supports all the clinical services, and uses a client server architecture that allows clinical workstation clients to communicate with HIS servers.

The VA has installed a local area network at each medical center to support its client-server architecture, and all of these facilities are connected together by a national wide area network. The local area
network at each medical center connects clinical workstations to multiple magnetic and optical disk image file servers, to the V A's hospital information system, and to commercial systems. The local area network uses Ethernet (up to gigabit/sec). The wide area packet-switched network connecting VA facilities consists of 23,000 miles of fully digital optical fiber network with four backbone nodes and twenty-two tributary nodes. Frame relay running at 1.544 megabits/second connects a large number of V.A. medical centers. Additional T1 or ATM communications lines have been installed between centers that share a large amount of data. The wide area network carries TCP/IP traffic to all sites, thus moving images, HIS communications, and DICOM messages.

A Remote Procedure Call (RPC) paradigm allows communication between windows-based clients and the HIS. All clinical database access requests are processed through an RPC broker that performs the desired operations on the HIS and returns the results to the workstation via a TCP/IP message. Security logon and server connection is handled by the HIS via the broker software. With the proper security privileges, a workstation user may connect to any HIS server on the wide area network and access the computerized patient record through the graphical user interface software.

The HIS provides extensive support for Imaging and contains a full image management infrastructure. Image acquisition, exportation, display, networking, long-term archiving capabilities, and integration with the clinical database are all supported. Images are acquired by a variety of methods: using frame capture boards in the workstations, TWAIN or SCSI interfaces, DICOM interfaces, or imported from local workstation hard drives. Magnetic and optical disk storage is automatically handled by the HIS image management software and is indistinguishable to the user. The HIS stores the information about the patient’s images and their association with other patient record data.

Clinical workstations are located in most departments and patient care areas. Images are accessed and displayed on the workstation client from image file servers or via calls to an API for electrocardiogram waveforms. Radiologists are field testing a diagnostic-quality reading capability that is totally integrated with the radiology HIS module, resulting in a seamless operation and streamlined workflow. Image capture may be performed directly on the workstations.

The multimedia workstation platform is based on PCI-bus Pentium systems containing video display boards with at least four megabytes of video memory. Workstations generally run the Microsoft Windows NT operating system. Software running on the workstations is written in Inprise’s Delphi, except for integrated commercial off-the-shelf products.

DATA PRESENTATION AND CAPTURE FOR EFFECTIVE PATIENT CARE

The clinical workstation software allows users to view the multimedia electronic medical record, a record which goes far beyond the paper chart in functionality and ready availability of information. It serves both treating clinicians and consulting specialists, and provides traditional patient chart functions such as progress notes, problem list, discharge summary, ordering, report display as well as image display and capture, and telemedicine functionality.

The workstation’s user interface displays integrated data from different sources, including:

- Traditional patient chart online components such as progress notes, problem list, medications, consults, laboratory results, discharge summary;
- HIS components such as laboratory, radiology, pharmacy, health summary, discharge summary reports;
- a variety of images from the VA's Imaging system;
- images from commercial image systems such as Radiology Picture Archiving and Communications System (PACS);
- other graphical data from commercial systems such as electrocardiogram systems.

Critical user functionality provided by the clinical workstation includes: (1) completeness of patient information, (2) ability for user to take action on data from a single desktop environment; (3) ability to navigate seamlessly among a variety of data and actions; (4) ability to make longitudinal comparisons; (5) ability to drill down from summary to detail level.

PROVIDING CHART COMPONENTS AND COMPUTABLE DATA

The VA’s online patient chart software was designed to resemble a paper chart and includes functional components that are displayed as chart tabs. These tabs include Cover Sheet, Progress Notes, Medications, Labs, Consults, Discharge Summaries, Problem List, Orders and Reports. Most tabs include browsing and searching capabilities in addition to supporting the collection of clinical
information. Clinicians may enter progress notes, update the problem list, write orders, enter vital measurements and record other data that must be collected with each patient encounter.

The online patient chart is always available for access by health care providers and may be used by multiple providers simultaneously. Many clinicians review the status of their patients from their homes via remote dial-in access. Remotely, health care providers can act on abnormal clinical results by entering medication, lab, dietetic, consult, procedure, radiology, and patient care orders that will be electronically transmitted to the responsible service for immediate action.

The application uses a hierarchically structured set of parameters to allow the behavior of the software to be adapted to specific settings. A baseline set of parameters is provided which sites may override by exception. So the behavior that is seen generally can be changed for specific hospital locations or even specific clinicians. For example, a baseline set of clinical reminders may be used throughout the hospital while a different subset is used in specific clinics. This capability for fine-tuning is particularly important where the software is used by so many different and varied health care facilities.

The major functional areas are described below. These areas are generally represented by and accessed via tabs on the patient chart (see Figures 1 and 4).

Cover Sheet. The online patient chart cover sheet facilitates quick orientation to a patient by providing a condensed view of relevant clinical information on one screen. Included are active problems, allergies, active medications, recent lab results and vital signs, a list of appointments and admissions, crisis notes, warnings, and reminders. Clicking a cover sheet item provides immediate access to a greater level of detail for that item. For example, clicking an admission displays the discharge summary for that admission while clicking a recent lab test displays the results and reference ranges.

Problem List. The patient's problem list may be maintained through the application. Problems may be added, inactivated and annotated. Pick lists may be customized to specific user settings to allow easier addition of new problems. Additionally, there is a mechanism to automatically update the problem list with new information when documenting a patient encounter.

Order Entry. Orders may be entered and maintained in the online patient chart. Patient orders may be sorted and viewed in a variety of ways. The most common view is of all active orders. Examples of custom views include orders that are about to expire, orders for a specific service, orders that have been written for discharge, orders that have been recently completed, or orders that still require a signature (such as verbal/telephone orders).

Order entry can benefit the clinician by assisting in obtaining all the information necessary to complete an order. If specific information about a patient is required before a procedure may be performed, the clinician is prompted for that information. If additional signatures must be obtained for a particular procedure or treatment, this information may be displayed so that the clinician knows immediately whom to contact. Once an order has been signed, it is transmitted directly to the receiving service. The electronic transmission, completeness, and legibility of the order allow for prompt action. The clinician is able to electronically track the order to completion.

The order entry process may be highly customized to meet the differing needs of clinicians throughout the hospital. Indeed, the degree of customization effort is closely related to the success of an electronic order entry system. Using the parameters described above allows customization at the individual clinician level, if necessary. Menus may be used to organize the ordering process in addition to providing some information about policies and protocols for certain areas of ordering. Quick orders may be set up with some or all prompts answered. In situations where there is a large amount of consistency among the orders that are placed or where certain protocols are in place, quick orders can speed the ordering process, decrease typographical errors and reduce ambiguities in the order.

Order sets are another time saver, allowing a group of orders to be entered at once and the associated activities to be managed consistently.

Orders are allowed to be entered in advance and saved for release to a service at a time in the future. Admission orders may be written weeks ahead of an admission. Discharge orders may be written throughout a hospital stay and modified as needed. These orders are easily available for review. Similarly, when writing admission orders, a patient's current outpatient prescriptions are easily viewed and may be transferred to become inpatient orders, if appropriate.

Order checking alerts the clinician during the process of ordering to potential problems that could exist if the order is processed. A message is displayed when a potential problem is detected. If the clinician decides to continue processing the order, and if the potential severity of the problem is high, an override reason must be entered. This justification is retained with the order and passed to the service that is processing the order. Some of the order checks that are available include:
• Allergies to contrast media or medication ingredients
• Potential drug-drug interactions
• Duplicate orders or orders for the same drug class
• Laboratory values that may contra-indicate an order
• Lab tests that have been ordered too frequently

The order entry system retains a complete, time-stamped history of all orders placed along with a record of all activity for each order.

**Progress Note and Discharge Summary.** Progress notes and discharge summaries may be both viewed and entered through the online patient chart application. Extensive facilities exist to define rules for different note types. These rules are based on user roles along with actions taken on a given type of document. It is possible, for example, to restrict who may view, write, or sign a particular type of note. Viewing capabilities within the application allow a variety of filters and sort orders to be applied. Progress notes may be organized by clinic/hospital location, author, title, or time of note.

A template mechanism is available to reduce typing and to accelerate the entry of notes. A note type may have default text, or templates may be used as the note is written. Templates may include items that are interpreted at run time. These items expand into text appropriate to the patient. For example, the patient’s active medication list and recent vital measurements are the kind of items that may be instantiated at run time. Clinicians have the ability to define their own templates. There are also facilities that allow notes to be uploaded from transcription services.

**Encounter Form.** An online encounter form is available when writing progress notes. Each clinic has the ability to set up pick lists of encounter form items that are relevant to that clinic. The encounter form can be used to collect data related to patient education, immunizations, skin tests, health factors, diagnoses, procedures, examinations and vital signs. The collected encounter form information is displayed whenever a note that relates to the same patient visit is displayed. The collected data is used for workload measurement and billing. It is also used extensively to support clinical reminders. The encounter form information is used to determine if a particular patient meets the criteria that would cause a specific reminder to be issued. For example, a diagnosis of diabetes would cause some reminders, such as a foot exam reminder, to apply.

**Clinical Reminders.** The clinical reminder system exists to improve preventive health care and to encourage timely clinical interventions to be initiated. Reminders may be viewed on the cover sheet and also when writing progress notes. They alert the clinician to certain actions that should be performed. Examples of these actions include examinations, immunizations, patient education, and laboratory tests. Reminders assist in identifying patients who are at risk for Hepatitis C, breast cancer, colorectal cancer, hypertension, etc. Some of the actions a clinician may take upon receipt of a reminder include performing an examination, ordering a test, or collecting specific patient information. The information collected in response to a clinical reminder may be automatically appended to the current progress note. Figure 3 shows the clinical reminder dialog that is displayed when tobacco screening is due.

**Figure 3: Clinical Reminder dialog when tobacco use screening is due.**

**Reports.** A wide variety of reports are available on the online patient chart. These include reports for various procedures, medication profiles, order summaries, nutritional assessments, pathology reports, and Health Summary. Health Summary is a special report that makes available a wide variety of clinical reporting components. These components may be configured to create custom reports that provide relevant information for a particular situation.
When a patient has been seen at multiple VA medical centers, a button at the top of the screen indicates that remote data is available. Pressing the button shows the list of sites where the patient has been seen and the date of last activity. Any or all of the sites may be selected (see Figure 4). When this is done, a row of tabs appears above the reports. This allows the reports from the other sites to be selected and viewed. Clinicians can directly access data from other sites rather than relying on the patient’s memory.

Notifications. Whenever a patient is selected, a list of current notifications is displayed. These alert the clinician to significant events. Some of the areas for which there are available notifications include:

- Abnormal results for lab tests and imaging procedures
- Medication orders that are about to expire
- Consults that have been completed or cancelled
- Signatures that are required for orders or notes
- Patient movements (admissions, transfers)

Some of the notifications have built in follow-up actions, allowing the clinician to immediately respond. For example, when an unsigned order notification is received, selection of the notification will display the unsigned orders and allow a signature to be entered.

PROVIDING MULTIMEDIA ELEMENTS OF THE PATIENT RECORD

Database Schema
A common object-oriented approach is used for interfacing all multimedia data to the online patient record. Image management information is stored in the VistA HIS database, in the same manner as all of the rest of the patient text data.

Information about each image is stored in a multimedia object table. Each image entry in the table points to an image file stored on a server outside of the HIS database. The image entry also contains information about the object type and the patient. Figure 5 shows three image objects in the multimedia object table. Each image object points to its corresponding image file.

A set of related multimedia objects are collectively joined together into a multimedia group. The multimedia group is then associated with the specific patient study record, for example, a radiology report, a medicine procedure, or an ophthalmology note. This association allows the user to navigate from the patient to the images and then to the corresponding study, or from the patient to the study and then to the corresponding images. In Figure 5, the three image objects are joined together to form a multimedia group in the multimedia object table. The multimedia group is associated with a medicine procedure in the medicine procedure table. Other studies in the radiology report table and the progress notes table are associated to other multimedia groups in the multimedia object table.
Both text and image data are collected at the point of care. Multimedia data including images, scanned documents, motion video, and DICOM still and cine files is captured using either a clinical capture workstation or via a DICOM interface. Electro-cardiogram data is captured on a commercial system and accessed by clinical workstations directly from the commercial storage system. Proper patient and study identification is essential to incorporating data into the electronic patient record. This can be a difficult task with different data sources.

Clinical Workstation Capture

The VA has almost a decade of experience acquiring non-DICOM images in non-radiology disciplines and considerable experience with DICOM for radiology. About a half million non-DICOM images have been acquired for the twenty or so disciplines listed in Table I.

Images may be captured by clinical workstation users by a frame grab board, a TWAIN interface, or by importing from a disk drive, they may be transmitted from independent systems (via a DICOM or other interface), or they may be accessed by the workstation’s display software using a vendor-provided API (application program interface). Workstation image capture within the VA is done in a number of locations throughout the hospital (see Table I).

Table 1: Diagnostic Disciplines Supporting by Imaging

<table>
<thead>
<tr>
<th>Cardiology</th>
<th>Surgery</th>
<th>Vascular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronchoscopy</td>
<td>Nuclear Medicine</td>
<td>Urology</td>
</tr>
<tr>
<td>Gastrointestinal Endoscopy</td>
<td>Dental</td>
<td>Nursing</td>
</tr>
<tr>
<td>Hematology</td>
<td>Radiology</td>
<td>Electrocardiography</td>
</tr>
<tr>
<td>Anatomic Pathology</td>
<td>Dermatology</td>
<td>Documents</td>
</tr>
<tr>
<td>Ophthalmology</td>
<td>Podiatry</td>
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</tr>
</tbody>
</table>

Consulting services generally collect images during a medical procedure for diagnostic or follow-up purposes. After logging into the capture workstation, the clinical user identifies the patient and the study being performed. Image capture requires only the click of a mouse button. The user then enters any pertinent descriptive information related to the image, and clicks a button to save it to the patient’s record. This simple procedure takes less than thirty seconds, and the result is more informative than a textual description of the image.

Typically, the clinician performing the procedure selects images for capture that are significant to the patient’s diagnosis or treatment course. Most images are linked to the procedure report in the hospital information system. The number of images captured per procedure varies by the specialty and is determined by the users themselves.
Most recently, the system has been tested for home-based patient care. In this case, images are captured at the patient’s home using a still video camera and are later input into the patient’s online record.

**Waveform Data**
Electrocardiogram waveform data is accessed from the workstation in a different manner. In this case, a commercial system acquires data directly from EKG carts, and stores and manages all waveform data. A vendor-provided API is used to access patients’ waveforms from the clinical workstations. This approach has the advantage that the entire electrocardiogram system is supported by the vendor. Unfortunately, the current implementation does not include Modality Worklist capability to ensure that the patient identification information matches that on the HIS exactly. Matching is done using patient social security number and name, with manual intervention to resolve discrepancies.

**DICOM Image Capture**
Standard DICOM interfaces allow capture of images directly from radiology devices such as CT and MR scanners, ultrasound systems, Computed Radiography (CR), angiography systems, and others. Images can also be obtained via DICOM from commercial radiology PACS systems. More than fifteen million radiological DICOM images have been obtained. Handling DICOM images outside of radiology is quite new and is currently in field test with gastrointestinal endoscopy and ophthalmology systems.

**DICOM Overview.** Image data may pass through a number of different electronic systems before becoming part of the longitudinal patient record. The task is to communicate the required patient and study order text data from the HIS to the image producing modalities and the commercial PACS (if present), so that images identified with this data can be transferred back.

In the VA, DICOM is used to handle all transfer of text and image data between these systems. The VA uses a DICOM Gateway to enable the HIS to communicate using the DICOM protocols. The gateway application runs on an NT workstation and has access to the VistA HIS system database. The gateway performs all the DICOM services and can send and receive text data and image data.

**Flow of DICOM Image Data Objects between Modalities and HIS.** Two DICOM services are required to be implemented at the image acquisition device and the VistA HIS: Modality Worklist and Storage. The VistA HIS provides these services to the modality user.

**DICOM Modality Worklist Service.** In order for a DICOM image to be properly matched to its corresponding study, it must contain the correct HIS patient and study identification information. The patient name, patient identifier, and study accession number must be present in each DICOM image header, in order that the image can be properly associated with the correct patient and study. Image producing modalities need to have this data prior to performing the study so that it can be placed into the image headers.

In order to accomplish this, the modality and the HIS must communicate using the DICOM Modality Worklist capability. This standard functionality allows the acquisition device to query the patient identification source to obtain correct identification information. In some cases, the user selects from a list of exams ordered on the acquisition device (see Figure 6). In other cases, the user enters the accession number for the exam, and the worklist source provides the patient and study information to the acquisition device. This identification information is then placed in the standard DICOM image object when the image is returned to the HIS or other PACS system. Thus, the image can be properly linked to the electronic patient record.

VistA Modality Worklist can also access the patient database directly as a source of information about old studies when old films are being scanned. The ability to utilize the patient database is one of the important benefits of the integration of the Modality Worklist Provider with the HIS that is not available to standalone commercial units.

Without DICOM Worklist Modality there is a high percentage of misidentified image data objects. Therefore, this capability is mandated on all new image acquisition equipment purchased. This functionality is also being required by the Integrating the Healthcare Enterprise (IHE) initiative jointly sponsored by RSNA and HIMSS.

**DICOM Storage and Image Processing.** After receiving the corresponding patient and study information, the images are acquired and sent to a DIOM image gateway which can acquire DICOM images from any source and send DICOM images to any destination. It can also interrogate an external DICOM image storage system and obtain images from it.

Images that are acquired by the DICOM Image Gateway are matched to the corresponding patient and study on the HIS. Management information about the image files is stored in the main hospital database. The images are then stored on centrally located NT file servers, where they can be accessed by VistA image display applications running on windows workstations located throughout the facility.

2001 HIMSS Proceedings: Volume 1
Session 38 / Page 9
The incorporation of DICOM images into the multimedia patient record involves several steps:

- Get Patient Name, Identifier and Accession # from image header
- Lookup patient and study in the corresponding clinical subsystem
- If it doesn’t match, put image on a correction list
- Create an entry for each study component in the Multimedia Object Table
- Associate the entry with the patient study in clinical subsystem of the HIS
- Create an entry in the Multimedia Object Table for each image
- Store the image on the file server
- Technologist verifies images on clinical workstation before completing examination

**Flow of DICOM Text and Image Data Objects Between Commercial PACS and HIS.** Commercial PACS need to have HIS/RIS event data in order to operate efficiently. The VistA DICOM Text Gateway supplies the following set of text information messages to the commercial PACS:

- Patient Demographic Change
- ADT (Admission, Discharge, and Transfer)
- Order Entry (when a patient arrives for an examination)
- Exam Changes (Cancels)
- Exam Verification (completion of image acquisition)
- Report Transfer (Preliminary and Final)

All images on a commercial PACS are “pulled” to the VistA system by the DICOM Image Gateway. The images are then added to the online patient record so that they can be displayed on clinical workstations throughout the facility. The capability to display image data as an integral part of the online patient record is essential in enabling a hospital to operate filmlessly.

The “handshaking” with the commercial PACS involves several steps (see Figure 7):

- Order Entry message is sent by VistA to the PACS when the patient arrives for the examination
- When the patient goes to the instrument, a modality worklist query is performed to get patient and study related data from VistA
- The images are acquired and the images, and the patient and study data are combined into image data objects that are sent to the commercial PACS
- The technologist records the end of the examination on the VistA system and an Examination Verification message is sent to the PACS
- The PACS sends an Examination Complete message to VistA, containing the unique study identifier (the Study Instance UID)
VistA requests that PACS send it the images for the study (that is, issues a C-MOVE request using the Study Instance UID)

The image data objects are sent from the PACS to VistA, where they can be incorporated into the patient medical record

DICOM for Non-Radiology Modalities. We are just beginning to interface DICOM imaging modalities outside of the Radiology Department. We acquired about a half million non-DICOM frame-grabbed color images for the non-radiology services over the last decade and have developed the techniques of integrating images into the online patient record. This is more complicated than it may appear. In VistA, the way the study data is stored is different for each specialty. Workflow is different too, particularly in terms of order placement and examination. Some specialties routinely report their findings using progress notes, while others use structured data, and others (primarily radiology) use unstructured report text. Interfacing DICOM image acquisition to the whole HIS is a bit more challenging than just doing the radiology portion alone.

IMPACT ON PATIENT CARE

The VA currently has over fifteen million images online across a number of medical centers running this software. Clinicians find that the online multimedia patient record provides a number of benefits to care providers and patients including:

- improvements in the quality of patient care by providing all patient data, automated reminders and alerts
- reductions in errors based on lack of data or nonstandard terminology used to describe images
- increases in communication among clinicians, improving continuity of care when multiple specialists are involved
- reductions in physician time spent searching for data
- improved in physician education
- reductions in costs by avoiding film printing,
- decreased hospital admissions (chest pain in particular)
- reductions in repeat procedures
- decreased ordering errors through electronic placement of orders and consult requests
- increased efficiency in pharmacy in filling prescriptions and restocking because of online ordering
- reductions in patient transfers between facilities
- assistance to patients in understanding their problems
• reductions in patient wait times
• increased clinician and technologist productivity

Clinicians use the Imaging System during conferences, rounds, in the emergency room, operating rooms and intensive care units, on wards, in clinics, and in their offices. For consultation and medical record access for patients at distant locations, clinicians connect to systems across the VA’s wide area network.

CONCLUSIONS

Experience at a number of VA medical centers indicates that seamless integration of all types of patient data is a critical feature for clinical workstation software. Users must be able to capture patient data in their procedure room and view their patients’ online multimedia record on a single workstation anywhere in the medical center. Accurate, synchronized patient identification is essential on all systems that will capture data for inclusion in the online multimedia patient record.

The availability of a full range of patient data from a single source—the clinical workstation—is a key factor in system efficiency, usability and user acceptance. Because the system is integrated, data that is entered into any part of the system serves all users. This results in a system that contains a “critical mass” of information. Users are more likely to find what they need from the system, therefore they look first to the system, and find it cost effective to place information in the system. Reaching this critical mass is essential to achieve the maximum benefits from an integrated patient record system.

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