MIS, LIS, HIS, PAC-Industry Nears Canned Solutions for Alphabet Soup

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The need for instant information is often tempered by an enormous amount of data ...

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The sheer weight of data can often confuse the situation and hide knowledge. Finding a way to integrate data into records in such a way that illuminates instead of overshadows knowledge is essential. Management Information Systems (MIS) can link billing, cost information, insurance data, and payments to Laboratory Information Systems (LIS) that connect data gathered from different testing and diagnostic devices. These systems connect to Hospital Information Systems (HIS), often called Enterprise Systems. More acronyms are identified as ADT (admit-discharge, transfer systems, which keeps track of the current location of a patient), RIS (radiology information systems), and PACS (picture and communication systems). These systems are integrated into the overall system that can be tailored to the needs of the client.

A single system that gathers and integrates all of a patient's records is difficult. Even more difficult is the ability to integrate the patient's records into an overall system that permits analysis of the amount of time required to do each separate test, spots trends in testing, identifies problem tests, determines cost efficiency, tracks insurance records and payments, and reports on all those aspects of patient care while ensuring that privacy is respected. This difficulty increases even more when dealing with different sites and varying levels of laboratory automation. When centralized systems were first developed, the problems were numerous. Some problems proved simple to solve. For example, a particular device required entry by month, followed by year, then the date; while another device required the data to be entered in reverse order.

A total package system would include a business system in conjunction with laboratory data (including radiological results in picture forms). Administrative staff and laboratory professionals do not always agree on even the most basic of functions. A key to a successful total package solution is that the priorities of all of the groups are clearly defined.

Major LIS suppliers offer flexible systems that combine different modules, such as blood banking, pathology, microbiology, and general laboratory. Linking laboratory systems into an overall system that offers end-to-end coverage for major hospital and laboratory chains means linking developed systems together. Some systems have a number of facilities linked to an overall quality control chain that can interface with outside vendors. Niche specialty systems may cover a single facility that specializes in extremely esoteric tests that must be reported immediately.

Laboratory information systems have been around for more than 2 decades. The early systems were generally custom built, often by internal IS departments, around specific needs. Elinore Craig, the Product Line Director for Laboratory and Financial Applications of Sunquests' LIS products, stated, "Every installation was unique. The upgrades that pushed LIS systems were certainly helped by Y2K." The Y2K concern caused a number of hospitals and laboratories to select more standard systems, which leveled the playing field. The competition between LIS and software companies is now great enough that the differentiator has become service.

Craig does not see a need for further customization to solve continuing problems over time. She worked as a medical technologist both in the Unites States and Saudi Arabia, and has found that while some laboratory staffs are more computer savvy than others, most can work with the current systems and can integrate new equipment when necessary. However, the changes that have occurred within the last few years have been designed for easier connections between the various elements within a hospital or multiple-hospital system. It takes a consortium of users, instrument manufacturers, hardware and software designers, and vendors to insure the ability to connect a new device into the overall system.

End–To–End Systems

Hospital-wide systems include information from a number of data systems that use different nomenclature. A group of data professionals, device manufacturers, and software specialists, called Integrating the Healthcare Enterprise (IHE) established integration profiles for a 2001 to 2002 cycle that supplement communication standards, which gives a precise definition designed to meet clinical needs. These definitions have been published and accepted by major vendors. In fact, many of the vendors took part in the testing that produced these definitions. The purpose behind the voluntary development of systems to link individual devices was sponsored jointly by the Radiological Society of North America (RSNA) and the Healthcare Information and Management Systems Society (HIMSS). The mission statement of the group states, "Using established standards and working with direction from medical and information technology professionals, industry leaders in health care information and imaging systems are cooperating under IHE to agree upon simple implementation profiles for the transactions used to communicate images and patient data within the enterprise." The integration profile includes:

Scheduled Workflow. Intended to establish a seamless flow of information that supports patient care workflow in a typical, imaging encounter. This includes enterprise-wide information systems that manage patient registration (ADT and HIS) plus radiology data (RIS), image management/archiving (PACS), and acquisition modalities.

Patient Information Reconciliation. Extends scheduled workflow by providing the means to match images for an unidentified patient with the patient's registration and order history.

Consistent Presentation of Images (CPI). Specifies a number of transactions that maintain consistency of presentation for grayscale images. This also maintains the requirements for presentation, such as annotations, flip/rotate, display area, and zoom. The CPI defines a standard contrast curve (Grayscale Standard Display Function), and supports hard copy, soft copy, and mixed environments.

Presentation of Grouped Images (PGP). Addresses complex information management problems that occur when multiple information is obtained in a single acquisition step. The PGP allows separate viewing and interpretation of each subset of im-

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ages. This permits reports to be generated to match local billing policies without separation.

Access to Radiology Information (ARI). Supports access including that of images and related reports. This access can extend to non-radiology information if it is available in DICOM format.

Key Image Note Integration Profile. Allows a user to flag images as significant by referencing them in a note linked with the study. A key image note can allow physicians to refer to select teaching files, consult with other departments, or question quality. The integration profile can include department imaging systems or hospital-wide systems.

Simple Image and Numeric Report. Facilitates the increased use of digital dictation, voice recognition, and reporting packages by separating the functions of reporting into discrete actions for creation, management, storage, viewing, and defining transactions to exchange reports. Exchanged reports have a simple structure, including a title, observation context, image references, and coded measurements if necessary. Elements may be coded to facilitate computer searches. Both department images and hospital-wide information can be affected by this integration, including review or soft copy image displays, or reporting stations that may stand alone or are integrated with a HIS, RIS, PAC, or Modality.

These integration profiles have been implemented and tested by approximately 30 vendors that represent a major share of the imaging systems market. The goal of the IHE initiative is to stimulate integration of the health care resources so that the information is available on demand.

Vendors who have worked with IHE use HL7 (Health Level 7) as an interface to permit different databases to translate information into a single format. The other "language," DICOM (Digital Imaging and Communication in Medicine), also speaks through interfaces. As an example, an interface would allow a RIS to communicate with a HIS.

Issues in Linking Laboratory and Hospital-Wide Systems

Point-of-Care Testing (POCT). Results that may be received verbally, manually logged, or downloaded from isolated workstations offers opportunities for errors. The standards developed first by the Connectivity Consortium, a non-profit organization of device manufacturers, information systems marketers, and health care providers, working with HL7 and the Institute of Electrical and Electronics Engineers (IEEE), were published by NCCLS in May 2001. The standards are a series of specifications that provide a framework for the engineers who develop workstations, interfaces, data concentrators, and laboratory information systems for a number of different vendors. This allows individual devices to place information into an institution's diagnostic information management system. The approved standard, POCT-1, can be purchased from NCCLS at www.nccls.org.

Not all device manufacturers were ready to participate in the IME when its testing sessions were held in late 2000. Many other device companies are now working to integrate their sys-

[**F**1] The new system by GE Medical Systems Information Technologies, named GE Integriti, provides medical professionals with critical patient information any time and place at the touch of a computer through secured technology. Now as patients move through hospital care areas, caregivers have timely historical and "real-time" patient data.

tems into the overall system. The concept of overall connectivity is clear to most companies, and most are racing toward completion of connections systems. The use of these front-end systems is described by Greg Menke, President of Medical Automation Systems **M** (Charlottesville, VA) as an "electronic extension cord" that enables users to link products from nearly any device vendor into a system that can be reached by other systems. Medical Automation Systems' product, called the RALS-Plus System, will interface with 75% of the leading point-of-care vendors by the fall of 2002.

Automated tests. As the reason for automating laboratories moves from cost and labor savings toward enabling tests to be done despite shortages of trained personnel, the need to capture the results of automated tests quickly into LIS and ultimately into hospital systems is integral to the process. Automated tests require immediate verification of results or a way to verify later if required. This could mean storing data for numerous samples while emphasizing the need for immediate verification.

Maintaining Compliance. If information is not fed into the overall system promptly and accurately, even the best system will not be very effective. Traccess SOP was launched about a year ago, based on comments, feedback and input from laboratory and nursing professionals. It is a web-based application that delivers, tracks, and reports on employee policy and procedure compliance. The application can link all employees or individual groups to all policies, standard operating procedures, and associated learning materials that are used for maintaining compliance. The system provides an individualized SOP portfolio for each employee, which can be used by administrators to create user-defined reports that display compliance status in real-time. The developer of this system is TTG Systems **M**, (Edmonton, Ontario).

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Original Members of the EHI

The following companies were actively involved with testing and developing the interconnectivity standards for the Exchanging Health Information (EHI). Others were involved with connectivity development, so that the various segments connect more easily. The following list of companies made advances it both the imaging technology and in information management.

- ALI Technologies **M**, Richmond, British Columbia
- Agfa **M**, Ridgefield Park, NJ
- Cedara Software **M**, Mississauga, Ontario
- Cerner **M**, Kansas City, MO
- Eastman Kodak **M**, Rochester, NY
- Emageon **M**, Birmingham, AL
- Fujifilm Medical Systems USA **M**, Stamford, CT
- GE Medical Systems **M**, Milwaukee, WI
- Hologic **M**, Bedford, MA
- IDX Systems Corp **M**, Burlington, VT
- IMCO Technologies **M**, Cerritos, CA
- Konica Medical Imaging **M**, Wayne, NJ
- Marotech **M**, Saint-Augustin-de-Desmaures, Quebec
- Mediface **M**, Seoul, Korea
- Merge Technologies **M**, Milwaukee, WI
- Mitra **M**, Ontario, CA
- Philips Medical Systems **M**, Bothell, WA
- RASNA Imaging Systems **M**, Firenze, Italy.
- Siemens Medical Solutions **M**, Malvern, PA
- SoftMedical **M**, Mount Royal, Quebec
- StorComm **M**, Jacksonville, FL
- Swissray **M**, Elmsford, NY
- Tiani Medgraph **M**, Liebermannstrasse, Austria.
- Toshiba Medical Systems **M**, Tustin, CA
- Vital Images **M**, Plymouth, MN

Advances in Imaging Technology

Cedara is an independent software developer that serves the large health care sector with technology for diagnostic imaging, image management, and image-guided therapy. Software can be used at every clinical workflow stage. **Cerner** introduced Pro Vision, the image management system that integrates all medical images, including radiology and oncology, into the electronic medical record. The system includes comprehensive integration between image archives and clinical information. Cerner was listed by *Business Week* in last year's technology issue, where it was noted that Cerner was a "leading light" in the sector. Cerner also developed the new system at the University of Illinois at Chicago Hospital. Cerner offers custom integration with other information systems. The systems are highly automated and filmless. **Kodak's** Health Imaging Division is a leading participant in info-imaging. The division develops, manufactures, and markets products for the capture, processing, presentation, distribution, and printing of health-related images

and information. Among its products are picture archiving and communications systems, radiology information systems, computed radiography, digital radiography, teleradiology, laser imagers, desktop medical imagers, traditional mammography, and x-ray films. Info-imaging unites 3 closely related imaging markets that enable people to more easily take and share images as information: devices, such as computed radiography and digital radiography systems; infrastructure, such as networks; and services/media. **Emageon** supports an image cache that speeds access to images using any TCP/IP network. The images are cached in an Active Patient Image Repository (APIR) for faster access to images at the point of patient care. The archive uses multi-protocol data streaming technology to maximize server performance. **Fujifilm Medical Systems USA** offers the Synapse which manages images and information, linking radiology, physicians offices, outpatient management sites, the ICU, and other sites, using conventional PC software and computer hardware. **Hologic** introduced the Integrated Radiology Informatics System (IRIS), now available for all Delphi QDR 4500 densitometers. The IRIS package defines the standard for paperless densitometry and vertebral imaging by allowing transmission, remote interpretation, and electronic reporting of patient scans. The IRIS system is a suite of features designed to streamline workflow by minimizing technologist time and facilitating physician reporting, resulting in improved patient throughput. **IMCO Technologies**, graphical user interface movable icons are associated with IMCO-RAD's functions. The configuration file allows different functions to be switched on or off and allows function keys to be assigned to IMCO-RAD's functions. The window distribution matrix can be defined by the user or defined automatically by the system. All image windows can be removed from the screen with a single function. An international leader in direct digital radiography, **Swissray** is interested in optimizing customer benefits and linkages in imaging. **Vital Images** software allows medical personnel to use 3-dimensional images of anatomical structures. Originally designed for UNIX platforms, the Intel Pentium III processor with its Streaming Extensions (SSE) allows for cheaper medical visualization software. Vital also shows great promise for improved evaluation of liver, lung, and brain masses.

Advances in Information Management

The **ALI** UltraPACS is a solution designed to meet the needs of many different types of facilities (small to very large, regional, multi-site integrated organizations, including multimodality, ultrasound/obgyn, vascular, and cardiology). **Agfa** installed in the Ohio State University Health System. The IMPAX PACS was awarded the Nicholas R. Davies Award for a system-wide computerized patient record (CPR) which uses Agfa's picture archiving system. **GE Medical Systems** information technologies' comprehensive patient information system represents a breakthrough in technology that electronically and instantaneously integrates patient data from all major medical areas and tracks it throughout an entire life span of an individual. The system, named GE Integriti, provides medical profes-

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sionals with critical patient information through secured technology. Patient information moves through a hospital setting such that the medical staff has historical and "real-time" patient data [F1]. **IDX** offers a series of systems covering the continuum of care. The systems include leading integrated delivery networks; large, medium, and small group practices; academic medical centers; radiology centers; and others. IDX is involved with projects sponsored by the United States Commerce Department's National Institute of Standards and Technology, where it is developing infrastructure aimed at reducing errors and improving health care. **Konica's** image management solutions upgrades existing diagnostic modalities, provides remote access, distributes studies to remote points where they are displayed for review, and adds diagnostic workstations and image archives. **Marotech's** largest product is Marosis Enterprise, a software solution for large-scale use. It specializes in systems with high speed and large files. **Mediface** offers designs for PACS that are DICOM-based, or may contain non-DICOM elements, TV and web-viewers, and other modalities. **Merge Technologies** has Next Generation MergePort radiology work solution and other applications. **Mitra** specializing in enterprise integration and offers linkages between PACS, RIS, imaging, and waveforms. **Philips Medical Systems** specializes in Integrated Product Systems. The **RASNA Imaging Systems** include a DICOM scalable multiprocessor server for medical imaging and long-term archiving for Linux and IRIX review,

and a flexible Microsoft Windows 2000/XP workbench for cross-sectional imaging productivity. **Siemens Medical Solutions** can provide interconnectivity of financial data, clinical information, executive, physicians data, and home health care data. **SoftMedical** produces Ubimed, a scalable solution for image and medical data distribution within and outside an individual or group health care institution. Ubimed is Java-based and completely platform independent. This enables any existing network computer to virtually become a diagnostic workstation. **StorComm** designed and implemented the highly scalable Clinical Image Management Systems (CIMS). These systems range from teleradiology and Picture Archive and Communication Systems (PACS) for clinic or departmental use to enterprise-wide CIMS for multi-facility health care systems. **Tiani Medgraph** produces an integrated RIS-like software for individually supporting workflow. By delivering information directly to a radiologist's desk in real-time, Tiani reengineered the dynamics of a radiology department. Their information systems also reach beyond the radiology department by linking modalities and HIS throughout the hospital. Already, more than 200 of these systems are in operation across Europe. **Toshiba Medical Systems** acquire, distribute, and store digital formats that support delivery of care. Networking solutions from Toshiba are dedicated to achieving an affordable data management model through network design and implementation, as well as training and multi-vendor PACS services.

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