Laboratory Information System (LIS)

Tony C T Chan

Sun Yat-Sen University Research Centre of Clinical Laboratory Standard

Corresponding Author : Tony C T Chan
(Sun Yat-Sen University Research Centre of Clinical Laboratory Standard)

Address : Suite 2408, 24th Floor, Block A, Gao Ke Building, 906 TianHe Bei Lu, Guangzhou, Guangdong, China

Abstract

Clinical Laboratories provide one of the most important services in the process of patient care. Samples taken from patients, such as blood, tissues and other body fluids, are examined and analyzed in different laboratories. Results of examinations and tests will be reported to clinicians who can then decide the appropriate treatments to the patients.

The Clinical Laboratory Information System (LIS) provides facilities for clinical laboratory staff to produce comprehensive, accurate and legible test result reports. It also helps provide timely and precise laboratory information to clinicians. With LIS, the laboratory staff can focus their efforts on providing professional services rather than doing other things like answering phone enquiries and compiling statistics. By using the LIS analyzer interface (bi-directional and uni-directional) and bar coding technology, laboratory workflow and procedures can further simplified and streamlined. LIS can also produce adequate, reliable and rapid management information for laboratory to review various aspects of its services to the patients.

Key word

Clinical Laboratory Information Systems, Humans, Laboratories, Quality Control

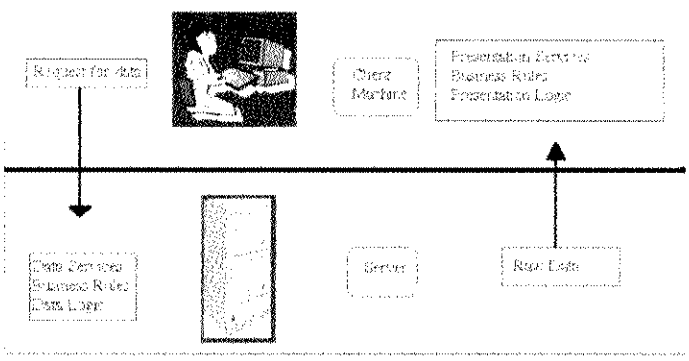
Historical Perspective

Before we can discuss Laboratory Information Systems (LIS), we must first understand the technology and tools that enabled the creation of these sophisticated software packages that are replacing scientist's notebooks. The evolution of LIS is an interesting one. In the beginning, there were scientists with laboratory notebooks and everything was hand-written: dates, experimental designs, results, comments, observations, and more. systems connected to terminals by serial lines: all of the processing was performed on the host. Upon completion of the processing, the host would post results to the terminals within the laboratory. These systems lacked flexibility.

Only very wealthy laboratories had access to these early systems and advanced technology. They made a commitment to the LIS concept despite the high cost becausethey realized that those who could deliver the correct information, ahead of their competition and at a competitive price, would emerge as the market leader. These laboratories understood that knowledge truly is power. The same is true today. Only today, in addition to faster and better, the market also demands even more affordable LIS.

Rather than central mainframes, the LIS can now use "servers" on a network that interfaces with "clients" or workstations. This client/server LIS architecture as shown in Figure 1 is increasingly popular.

Figure 1. Schematic diagram of client/server architecture.



Modern LIS and enterprise computing hinge on a concept of sharing: information, resources, and processing power. As more and more computers are brought into a network to work together, they are organized into logical architecture so that each computer's role and function are clearly delineated. The client/server architecture, how firmly established, divides information processing between front-end (client) components and back-end (server) components. By distributing the workload between front-end and back-end modules, client/server computing gives a system a great deal of flexibility as well as high performance.

Client/server computing arose in response to limitations in the single processing, mainframe-based processing and file server processing architectures. Client/server computing is also a form of distributed computing and is comprised of three components: client, server, and intercommunications between client and server components. The client/server architecture is well suited for database systems. Many database software products conform to the relational data model that is a framework for organizing data

and provide efficient and powerful tools for structuring and manipulating data.

LIS Fundamentals

All Laboratory Information Systems (LIS) must provide certain basic functionality: sample accessioning, sample tracking, data entry, quality control/quality assurance, and reporting. Sample accessioning involves entering information about the sample: who submitted the sample, what analysis taking place, when should the sample be completed by, and how is the analysis going to be performed. After this information is entered, the LIS must allow results to be entered for the sample together with appropriate quality control (QC)/quality assurance (QA) data. Finally, a report combining the sample information with the results is generated. Although most LIS provide these basic functions, they typically perform them in different ways, some more efficiently and intuitively than others.

Many LIS features are common to a wide range of laboratories. Requirements of a typical LIS in an analytical testing laboratory might include the following:

- Sample Accessioning/Login
- Sample tracking/barcode support
- Scheduling
- Chain of custody
- Instrument integration
- Result entry/audit trai
- QC/QA/specification checking
- Result reporting
- Web integration/lines to enterprise software
- Chemical and reagent inventory
- Personnel training record tracking/instrument maintenance
- Archiving/data warehousing

Why implement an LIS?

The prime objective of implementing an LIS is to provide a more efficient support system for the processing of laboratory tests. LIS will reduce the manual work required for receiving test requests, reporting results and maintaining records; minimise the manual transfer of data from one source to another reduce transcription errors by building interfaces between the LIS and laboratory equipment as far as practicable; provide a more effective means for handling enquiries about test results; and reduce the lead time and effort for producing management information.

Objectives of implement an LIS

a. Better patient care

- To provide on-line facilities for the medical staff in the ward to access timely and accurate laboratory information including:
  - i. Specimen laboratory number, date, location and status
  - ii. Current and past laboratory result reports by patient ID, patient name, specimen laboratory number, type or date, etc.
- To eliminate the unavailability of laboratory reports under manual procedures and to minimize human errors by automatic and reliable internal verification and quality control procedures.

b. More effective use of Staff

- To provide facilities for the laboratory staff to produce comprehensive accurate and legible test results more rapidly by providing laboratory technologist automatic functions such as reflex testing based on rules, cancel tests based on rules, handle critical results, handle discrepant results, handle special orders, append coded comments, and handle QC issues.
- To reduce laboratory staff time spent on non-technical work such as answering telephone enquiries and compiling laboratory statistics.
- To provide real-time, automated verification of laboratory results, and can transmit data electronically to patient care areas via automatic faxing or remote printing, as well as to the patient's electronic medical record (EMR). The entire reporting process can be paper-less. E-mail, automatic paging, and wireless communication allowing the laboratory to quickly report data to the attending physician.
- To enhance the work interest, responsibility and satisfaction of all grades of staff, including clerical and filing staff.

c. More efficient use of support services/faster communications

- To streamline operational procedures in the clinical laboratories including labelling samples with bar coded labels and bi-directional interfaces with laboratory instruments and consequent improvements in both the efficiency of test results reporting and the utilization of technical staff.

d. Improved quality of management information

- To generate accurate, reliable and rapid workload statistics and provide a basis for future hospital costing to be built upon.
- To provide facility to manage efficiently the large volume of numerical data generated by automated analyzers.

Benefits of Laboratory Information System

I. Direct Benefits to Patient

Improved availability of laboratory test results

Status of laboratory test will be properly tracked and availability of results for the next clinical consultation is guaranteed. Hence, there is a potential of shortening patient stay while duplicated collection of specimen and consequential follow-up visit can be avoided.

II. *Benefits to Nursing Staff*

a. Increased Productivity

i. Decrease telephone communicationNo moretelephone communication with the Laboratory staff is required for enquiring about the status of urgent tests and tracing of misplaced laboratory reports since the information is provided by the on-line enquires of the LIS system.

ii. Streamline discharge and transfer process Information regarding the discharge and transfer of patients can be captured and retrieved on-line and this eliminates cumbersome paperwork.

iii. Easy to obtain patients; demographic data System interface with the patient database would facilitate the retrieval of patient information.

b. Increase time for Nursing Care

As a result of the above benefits, nursing staff would have more time to provide their professional nursing care to patients.

How to select an LIS?

Surprisingly, in some hospitals the decision to purchase and select a laboratory information system (LIS) is being made by a team of non-laboratory people, and the laboratorian is left out of this critically important decision. How then can laboratorians ensure that they are involved in the selection of an LIS? The answer is simple: laboratorians must develop the skill and knowledge to provide useful input into this important decision.

Understanding the most important aspects of selecting an LIS is an effective way to establish competency in this area. The many features and functions of a complex laboratory information system can be distilled down to four major characteristics: speed, reliability, connectivity, and adaptability.

An acceptable LIS must have a rapid response time. The system should load a program in no more than 5 seconds and navigate screen-to-screen in interactive programs in 2-3 seconds. Systems with longer response times are considered "slow systems" and can become a problem rather than a solution for the laboratory. Two major factors that determine LIS speed are the application software and storage capabilities. The intuitive design of the application software use of icons, function keys, between-screen and on-screen navigation, on-screen help menus, and data attributes can enhance the speed of the system. Another factor to consider is that LIS speed is more related to the efficiency of disk storage and retrieval than raw computer processing power.

The second most important aspect of an LIS is reliability. An LIS should be so reliable that it rarely crosses your mind that it is running. A reliable LIS is rarely down except for planned maintenance and backup of files. In the past, redundant systems were frequently necessary to avoid unplanned down time; however, newer systems have more reliable disk drives. Nevertheless, spending the extra funds for disk mirroring, or real-time backup, is a good investment.

Connectivity concerns access to data on the LIS from the laboratory, patient's room, hospital floor, clinic, doctor's office, and even from the physician's home. In planning the purchase of an LIS, the laboratorian can enhance the laboratory service by ensuring that clients gain easy access to laboratory results. Connectivity to the laboratory's current network capability is also important. A good strategy is to consider the cabling, personal computers, printers, and other peripherals as permanent components of your laboratory computer system. In this scheme, the LIS processor takes on the role of the "server". By properly networking the entire system, you can replace or upgrade the LIS in the future without changing the existing components. Another advantage of this scheme is that attaching a new PC to the laboratory system should be no more complicated than connecting a phone to a wall jack.

Selection of an LIS should also include interfaces with the hospital information system (HIS). These are typically handled using interface standards (HL7, ASTM).

Other considerations include attaching instruments to the LIS. For instruments that conform to ASTM standards, this should be a simple process. In addition, bar-code labels and bi-directional instrument communication should be a "must have" capability.

Laboratory needs are changing rapidly, and therefore an adaptable LIS is essential. A hard-coded computer system that is difficult to program and modify will rapidly become a problem.

Selecting a database system that can make decisions in real time or data events will help the laboratory achieve the quality and efficiency that the new health care system demands. Poorly designed and programmed systems have more so-called "workarounds" ways to trick the system into doing the required function than real solutions. Vendors that claim to be one release or upgrade away from having the system your laboratory actually needs may not be a good choice.

Many laboratories today find themselves with a hodgepodge of laboratory information systems that have been acquired with no real plan or vision for the future. Those laboratories should begin immediately to plan the installation of an LIS network in order to embrace the coming explosion of information system technology. Laboratories should plan their system with an eye to future growth and to providing the ability to connect and interface with newer computer platforms. Accordingly, it is advisable to stick to the industry standards and select vendors who represent the clear leaders in the computer industry, both in terms of software and hardware. Since laboratory's clients will continue to expect better services at lower prices. Computers and automation offer the only feasible solution to this problem.