LABORATORY INFORMATION SYSTEMS

S.S. Nabiyeva
Samarkand State Medical Institute
Assistant of the Department of Information Technology

O.B. Axmedov,
Assistant of the Department of Information Technology

M.R. Malikov
Head of the Department of Information Technologies Associate Professor

L.E. Shukurov
Master student Samarkand State University
Republic of Uzbekistan, Samarkand
E.mail: sevar0887@mail.ru
Tel: +998904506108

Abstract

This article is devoted to an overview of the field of laboratory information systems (LIS). The main definitions are given, the functions and requirements of the LIS are formulated, the history and current situation in this area are considered.

Key words

Information system, term, laboratory, analysis, automation.

1. Introduction

Definition and functions of LIS

At the current level of development of the treatment and diagnostic process, prompt access to the diverse information obtained in the laboratory is required. Laboratory information systems are a means of achieving this. Along with the English term “Laboratory Information System” (LIS) and the corresponding Russian “laboratory information system”, there is the term “Laboratory Information Management System” (LIMS), which translates as “laboratory information management system” or “laboratory information management system”.

The first translation is more semantic and emphasizes the role of the system in managing the laboratory's work, while the second is closer to the source in meaning. There is also a Russified version of the abbreviation LIMS - LIMS (laboratory information and management systems) [Manilevich].

Further, to designate information systems of this class, we will use the term "laboratory information systems" - LIS.

A laboratory information system is an information control system designed specifically for the automation of laboratory activities [Gibbon, 1996].

Typically, LIS connects laboratory analytical equipment to one or more workstations or personal computers (PCs). Such equipment - such as an analyzer - is used to collect data. An interface to this equipment - for example, an integrator - is used to transfer data from the analyzer to the PC, where this data is converted into meaningful information. Further, this information is processed and various reports are prepared on it.

Typical functions of LIS are as follows:
- registration of samples;
- input of regulatory documents;
- distribution of samples for processing and automatic creation of analytical sheets;
- input of test results;
- tracking the analysis process;
- automatic creation of certificates of analysis;
- creation of various reports.

A fully functional LIS should not only control all information processes in the laboratory - from posting of samples to the preparation of output reports, but also ensure interaction with the information management system of the institution.

Today, LIS is considered as an integral part of the information strategy of health care organization, as a system that supports the performance of all the functions of a specific working group within it [Gillespie, 1997]. Each member of this working group can use general information in a specific way, depending on their functional responsibilities.

2. Relevance of laboratory automation

The main task of the laboratory service is to maximize the satisfaction of clinical departments of medical institutions with laboratory information of the required quality of quantity for the entire range of indicators with minimum terms of implementation and obtaining results by the attending physicians [Nikushkin et al., 1998]. The growing need of clinicians for analyzes has now led to the fact that the proportion of laboratory tests in the overall structure of diagnostic procedures in a large multidisciplinary hospital reaches 90%, and the number of studies is increasing.

The nomenclature of laboratory parameters is constantly expanding, the total number of which today reaches 400 [Nikushkin et al., 1998]. This leads to the need to improve the laboratory's activities both structurally and organizationally, and in the direction of increasing its productivity, quality and reliability of research. The solution to such a problem can be achieved by various methodological, organizational and technical means, one of which is the automation and complex mechanization of the laboratory process by introducing automatic devices, specialized analysis systems, computer technology and automated laboratory systems created on their basis.

Recent advances in laboratory equipment, such as the use of automatic analyzers controlled by microprocessors or computers, have significantly increased the laboratory's analytical capabilities. These devices create significant amounts of information that must be processed by personnel, which makes more and more attention to information management.

The results of laboratory tests are an important source of diagnostic information for the modern level of organization of the treatment and diagnostic process. According to global statistics, over the past decades, the use of clinical laboratory research has increased exponentially, and this growth continues. The importance of introducing a modern treatment and diagnostic process of the laboratory information system and laboratory automation systems is confirmed by the fact that the laboratory occupies an important place in the structure of the patient's diagnostic studies, both in terms of the number of studies and the clinical significance of test results.

Available LIS offerings cover a wide range of capabilities and prices, from systems costing several thousand dollars running on a single personal computer to systems designed for huge mainframes and valued at millions of dollars.

Currently, there are about 50 different manufacturers of such systems. Such a dense population of this market sector and the willingness of laboratories to invest in the installation of these systems is determined by the high economic effect of their use.

The quality of laboratory diagnostics depends not only on the accuracy of the research results, but also on the timeliness of the research and the availability of the results. Computers, laboratory information systems and automation systems are those technological advances that are widely used in laboratories both for performing a large amount of research and for their correct interpretation.

Let us present the data on the cost of various stages of sample processing in the total cost of analysis (data from the consulting company Miles Diagnostics) [AMP] - tab. 1.

Table 1

The cost of various stages of sample processing

Processing stage	**Cost (% of the total cost of analysis)**
Physician prescription of the study	9 %
Sample preparation	19 %
Analyzer interface	28 %
Sample processing by the analyzer	35 %
Delivery of results	9 %

When compiling the table, it was taken into account that the doctor's appointment and sampling includes taking a patient sample, registering the patient and the sample (registration procedures) and transporting the sample to the laboratory. Sample preparation includes the cost of information input, sorting, dividing, centrifugation and the cost of the required consumables. The interface with the laboratory analyzer includes creating a working table of the analyzer load, transferring it to the instrument, and receiving test results from the instrument. Sample processing by the analyzer includes capital expenditures for purchasing equipment, reagents, control studies and retests. Issuance of results includes the total cost of archiving, moving, storing and issuing laboratory test results.

The use of laboratory automation systems affects the cost of components such as sample preparation, interface with a laboratory analyzer, and output of results. When choosing devices and automation systems, it is necessary to take into account the factor not of the absolute cost of devices and systems, but the cost of carrying out one test with their use.

The distribution of time for performing various operations during laboratory testing is presented in table. 2 [AMP; Merkulenko, 1999].

Table 2

Allocation of time to perform operations during laboratory testing

Operation	**Time (% of total time analysis)**
Acceptance of samples (taking samples, delivery to the laboratory)	20 %
Registration, preliminary processing of samples (sorting, division, centrifugation)	37 %
Processing on the analyzer (interface to the analyzer)	25 %
View (check results)	7 %
Create Record (Computer Input)	7 %
Communication of results	4 %

Sample collection covers the time from taking a sample from a patient to the moment the sample is received in the laboratory. Sample pre-processing summarizes the time required to perform various procedures with a sample before actually testing on the device, i.e. sorting, dividing the sample into secondary tubes, centrifugation. Analyzer processing includes the time from loading a sample into the analyzer to obtaining an analytical result. Review is the time required to confirm a laboratory result (including the average time taken to verify control test results). Creation of a computer record - the time until the moment when the confirmed result is entered into the laboratory information system. A parcel is the time it takes to inform a doctor about the results of laboratory testing, either by means of a document, or by telephone, or through a computer system.

The analysis of the given data shows that a significant part of the time - 57% (20% + 37%) - is taken by the procedures included in the pre-analytical stage of laboratory testing. Thus, the most effective is the use of devices and automation systems for the pre-analytical stage of testing.

To increase the productivity of laboratory personnel at the analytical and post-analytical stages, it is effective to use a laboratory information system, and for processing on a laboratory analyzer, the key moment for increasing productivity is the presence of an interface for connecting the analyzer to the laboratory information system.

Despite the existing difficulties, in Russia and the CIS countries the process of technical re-equipment of laboratories has not stopped: new modern methods, analytical instruments and computers are being introduced. However, the effective use of the capabilities of modern analytical control of computer technology remains impossible due to the application in the laboratory of the "old" information processing system, which is focused on classical methods of analysis with the collection and processing of data manually, with numerous entries in the journals of performers of different levels.

What are the main disadvantages of the "old" system? These include:

- lack of efficiency in the transfer of information about the results of analyzes;
- multiple rewriting of the same information manually by different performers;
- impossibility of operational management of the laboratory, time-consuming access to the initial data;
- significant time spent in processing and calculating long-term characteristics of product quality;
- non-compliance with the requirements of the ISO9001 standard (an international quality standard currently accepted as a state standard).

Understanding of these problems even 10 years ago led to the fact that a number of analytical laboratories of large enterprises began to create their own laboratory information management systems using ACS on the computers of that time. Today, when the ideology of building information systems has changed and the requirements for the integration of such systems have arisen, enterprises refuse to operate them. With the modern dynamics of the development of computer technology, everyone understands that the creation of new, modern information systems and the maintenance of their operability by the company's own resources will require unreasonably large costs, therefore, interest in ready-made solutions is growing.

Method

The use of the laboratory information system in the laboratory helps to increase the clinical significance of laboratory diagnostics through the implementation of modern technologies and algorithms for laboratory diagnostics. The cost of treatment is reduced by increasing the validity of prescriptions for laboratory diagnostics, reducing the number of laboratory tests that are not of clinical interest, and the possibility of the laboratory effectively executing a larger number of applications for diagnostics, since LIS solves the problem of automated processing of a larger number of samples**.**

Conclusions.

The laboratory gets the opportunity to more adequately correspond to the modern level of organization of the treatment and diagnostic process. LIS significantly frees the laboratory from routine research, and the laboratory has the opportunity to focus on new directions and methods of laboratory diagnostics at the stages following the implementation of LIS. Laboratory diagnostics becomes manageable with the ability to implement modern laboratory testing technologies.

Literature

1. Sakiev T., Nabieva S. Architecture of the medical information system. International Scientific Journal Theoretical & Applied Science. Section 4. Computer science, computer injineering and automation. Issue: 05 Volume: 61. Published: 14/05/2018. p. 35-39
2. Brian Dixon “Health Information Exchange: Navigating and Managing a Network of Health Information Systems”, Academic Press, vol. 1, 2016, 376 p.

3. Qarshiev A.B. S.S. Nabieva, A.Sh. Egamqulov Medical information Systems // Internotianal Scientific Journal Theretical & Applied Science Issue 04, Vol. 72, 2019 y.
4. V. V. Bogoslovsky, “Prediction of productivity, adaptation capacity of species and hybrids of the silkworm for enzyme systems and proteins spectra the Text .: dissertation of candidate of biological Sciences,” / V. V. Theological, Stavropol, 2009.
5. S.A. Feylamazov, "Information technologies in medicine: A manual for medical colleges", Makhachkala: DBMK, 2016, -163p.
6. Karshiev A., Nabieva S., Nabiyeva I. Medical information systems. International Scientific Journal Theoretical & Applied Science. SECTION 4. Computer science, computer injineering and automation. Issue: 04 Volume: 72. Published: 30/04/2019. p.505-508
7. Sakiev T., Nabieva S. Typical processes of AWP. International scientific and practical journal "Theory and Practice of Modern Science" Issue No. 7 (25) (July, 2017).
8. Scott Coplan "Project Management for Healthcare", Information Technology McGraw-Hill, Education; vol. 1, 2011, 288 p.
9. Sakiev T., Nabieva S. Principles of computer design. International scientific and practical journal "Theory and Practice of Modern Science" Issue No. 7 (25) (July, 2017).
10. Primova H. Sakiev T., Nabieva S. Development of medical information systems. XIII International scientific and technical conference "Dynamics of Systems, Mechanisms and Machines" November 2019, Omsk, Russia. (Scopus).