DESIGN OF THE MEDICAL LABORATORY INFORMATION SYSTEM

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Abstract

We present our experience of creating and deploying a medical laboratory information system, designed to support medical personnel by effective tools of control laboratory workflow. Requirements to construction of laboratory information system are considered. The ER-diagram of medical laboratory is proposed. Results of development laboratory information system are represented.

1 Introduction

The time that physicians and nurses spend finding and organizing clinical information is excessive and increasing as the volume of patient information expands. As the field of medicine develops, the information related to examinations, management, and treatment of patients is increasing at a geometric rate [6]. One hospitalization can produce tens of thousands of separate observations, counting laboratory tests, physiologic monitor output, diagnostic imaging, patient surveys, nursing assessments, and visit notes [2]. Therefore, it is important that a hospital has an information system to arrange the medical information that originates from patients and their medical services.

A Medical Diagnostic Laboratory (MDL) occupies a large part of the structure of diagnostic research, both in the quantity of research and the clinical importance of test results - which are an important source of diagnostic information for modern medical diagnostic processes. According to world statistics, in previous decades the quantity of performed clinical laboratory tests and their diagnostic importance exponentially increased - and continues to increase [3]. The outpatient and inpatient revenues for hospitals that introduced a Laboratory Information System (LIS) were significantly greater than those of the hospitals that did not [6, 8].

As a result, the automation of MDL processes is an actual problem with significant practical value. In this paper, we describe issues of development LIS, propose the ER-diagram of MDL and present some results.

2 LIS requirements

There are two main directions of laboratory activity automation. The first direction provides the use of computers for automating information and technical processes inside
laboratories. The second direction of laboratory activity automation deals with solving the problems of the interaction of laboratories with clinical departments.

General requirements for an LIS should allow for [4]:

- the integration (interface with Public Health Information Networks, as well as other local and state organizations);
- the security (LIS must be configured to address the extremely confidential nature of the database);
- research order creation from outside as well as from inside laboratory;
- the ability to manage input data flows of research orders;
- L/H visualisation and calculated indexes support, norms bounds checking in accordance with patient’s age, gender and used reagents;
- preparation of operational and statistical reports in different slices.

3 Medical diagnostic laboratory analysis

To provide a basis for the development of LIS which really meet the requirements of health care workers, a domain analysis for EHRs (Electronic Health Record) has been undertaken in close cooperation of computer scientists with several domain experts [7].

A macro model of MDL functioning follows a certain sequence of events. First, during input, research orders and biomaterial samples are registered and brought into correspondence with each other. Next, analyses (a set of laboratory tests) are carried out automatically or manually. Then, the obtained results of these tests are passed to a requester. The following peculiarities can be outlined at this stage:

- there is an availability of efficient automatic analyzers;
- there is a necessity to improve the reliability and quality of laboratory research;
- the necessity of laboratory operational and scientific statistics.

All of these factors work together to propel the necessity to solve the problems of transferring and storing data, as well as the need to act responsibly to ensure the reliability and quality of publicly available laboratory research results.

The database of a MDL contains relevant information concerning entities and relationships in which the MDL is interested. A complete description of an entity or relationship may not be recorded in the database of an MDL. It is impossible (and, perhaps, unnecessary) to record every potentially available piece of information about entities and relationships [1].

Entity Relationship Diagrams illustrate the logical structure of databases. An entity is an object or concept about which you want to store information. Relationships illustrate how two entities share information in the database structure.
On the basis of domain analysis, the high-level (not detailed) ER-diagram of MDL is presented in Fig. 1. An explanation of the model is given as follows. Analysis (entity ANALYSIS) is a set of the laboratory tests (entity TEST). For example, biochemical blood analysis includes whole protein, albumin, glucose, etc.

Reference range of the test depends on method of testing, patient’s gender and age.

Result values of some tests can be verbal. Verbal values are collected in the entity TERM. In some cases, entities can be self-linked. For example, tests can include other tests (relationship component).

The entity FORM collects all information on analysis (patient ID, doctor, date of sampling, etc.). All patients’ analyses are contained in the entity FORM, which is linked to the entity EHR by relationship form-EHR. The entity RESULT is intended to store the results of laboratory tests. The list of laboratory employees is represented as the entity LABORATORIAN.

Representation of TEST as a separate entity lays in the basis of our approach [5]. According to this approach the database scheme does not depend on quantity and structure of laboratory subdivisions and tests in MDL.

4 Implementation and Results

Following the principles and the requirements summarized in the previous sections, we have designed a Medical Diagnostic Laboratory Information System (MDLIS) based on the data model shown in Fig. 1. MDLIS is integrated into hospital informational analytical system on the basis of EHR. Common information space gives optimal way to solve a task of construction of intellectual analytical systems on the basis of the information from a database.

In a research order the following data are taken into account: biographical particulars of patient, number of a patient card, patient status (inpatient care, outpatient care, etc.), department and also laboratory, type of research, lists of tests, attending physician and notes.

The form of research results includes biographical particulars of patient, tests names, tests results, units of measure, normal values, date of carrying out, state (re-
search order, in process, completed, printed, etc.), notes and the executors.

MDLIS was implemented both as stand-alone and integrated into an Hospital Information System in hospitals across Belarus and Russia, with the number of beds ranging from 200 to 1300, as well as in a variety of different kinds of laboratories.

5 Conclusions

We have reported in this paper our experience in building MDLIS, a laboratory information system intended for use in hospitals.

A MDLIS improves the quality of medical treatment by increasing the satisfaction of medical personnel and patients, improving the laboratory process, and improving decision-making assistance.

The main goal for future work in this area is the realisation of information exchange between the diagnostic laboratories of multiple hospitals.

References