# Decision Support Information System for Patient Treatment Procedures in Hospital*

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**Abstract.** The article presents the experience of designing and developing an information system to support decision-making in the context of the procedure for treating patients in a hospital. The relevance and timeliness of the development of issues related to the design and modeling of medical decision support systems for the daily practice of medical organizations are presented. The analogs of the software being developed are described, the subject area and functions of the tasks to be solved in a hospital are presented, business processes for automating procedures are modeled, and a subject area model is developed. Recommendations are proposed for the use of this system, the main goal of which is to increase the efficiency of the medical institution, the quality and efficiency of medical care with the functions of supporting medical decisions.

**Keywords:** Health Informatization, Decision Support Systems, Information System.

## 1 Introduction

Along with the widespread introduction of information and telecommunication technologies in all spheres of life, deep processes of digital transformation in modern Russian society, many researchers have recently been actively talking about digital healthcare and digital hospitals. Software and hardware systems, which are actively being introduced today in medical institutions, telemedicine, and artificial intelligence technologies can reduce the number of medical errors associated with the human factor, based on warning signals from control systems.

This article outlines the design and development of an information system to support decision-making in a hospital treatment procedure.

Among Russian researchers in the field of information technology, the most complete definition of an information system was formulated by M.R. Kogalovsky, according to whom "in addition to data, software, hardware, and human resources, the concept

of an information system should also include communication equipment, linguistic means, and information resources, which together form a system that provides“ support for a dynamic information model of some part of the real world to satisfy information needs of users ”[1].

## 2 Presentation of the Main Material

Various software applications, hardware and software systems, as well as medical information systems are widely introduced into the modern health care system for prompt decision-making on the treatment of patients, as well as to prevent errors of medical personnel. Medical organizations are starting to work with decision support systems. Medical Decision Support System (MDSS) is a software that allows, by collecting and analyzing information, to influence the doctor's decision during the examination, diagnosis, and prescribing treatment to a patient to reduce the number of errors and improve the quality of medical care and the speed of medical care [2].

Today, medical decision support systems are most often used in medical practice directly for information support in the diagnosis of diseases, the appointment, and adjustment of treatment. There are the following medical decision support systems:

1. Information and reference (reference and library systems; electronic medical records; integral history; automation of medical appointments; automatic control of the requirements of regulatory legal acts; automatic support of clinical guidelines; automatic control of quality criteria for medical care) [3, 4].
2. Intelligent (systems that imitate or simulate the reasoning of a doctor).
3. Hybrid (combine information and reference and intelligence).

Today, in the practice of medical workers, SPPVS plays the role of an alternative opinion, which a doctor can take into account when making a decision or not accept, therefore these systems are sometimes called advisory systems [5].

In the course of the research, some Russian analogs of medical decision support systems were considered. They were divided into 5 groups according to the directions:

## 3 Diagnostics

AUTOPLAN MDSS (https://autoplan.clinic/) helps to analyze medical images and generate examination protocols. The AUTOPLAN line of software has been developed with the practical knowledge of the work of radiographers and surgeons in mind and has advanced functionality for imaging, medical image storage, preoperative planning, and postoperative assessment.

AUTOPLAN [6] offers the following technological solutions (Table 1):

**Table 1.** Technological solutions of the company-developer of the MDSS.

| | AUTOPLAN-VIEVER | AUTOPLAN-PACS | AUTOPLAN EXPERT |
|---|---|---|---|
| Storage of medical data | - | + | + |
| View | + | + | + |
| Planning | - | - | + |
| Diagnostic imaging | + | + | + |
| Building a personalized 3D model | - | - | + |

## 4 Prevention

MDSS Webiomed.DHRA (https://webiomed.ai/) provides a comprehensive assessment of anonymized medical data to identify risk factors, predict disease progression, and identify suspected missed disease.

The system analyzes depersonalized electronic medical records, builds forecasts for the development of patient's diseases, shows high-risk patients, and also makes recommendations for a doctor and a patient [7].

## 5 Treatment Recommendations

MDSS Lexema-Medicine (http://lexema.ru/solutions/lexema-medicine/) automatically evaluates the effectiveness of treatment for each patient and builds optimal recommendations for the appointment of therapy.

As the developers point out, “artificial intelligence-based algorithms do not replace the doctor but are another additional tool. The system makes it possible to quickly get a second expert opinion right at the moment of admission to the patient ”[8]

The information system considers a large number of factors that affect the effectiveness of treatment, it also builds recommendations for drugs taking into account analogs, takes into account individual drug intolerance, taking into account the history of the disease, considers rare cases affecting the effectiveness of treatment (performed operations, concomitant diseases).

## 6 Patient Health Monitoring

Medsenger (https://medsenger.ru/about#) is a cloud service for remote consultation and medical support of patients. The system invites patients to ask a question of interest on the website or in the application. The doctor answers at any convenient time, at any distance and device. There is a possibility of video communication at the initiative of a doctor, adding an emergency telephone number and medical history. Among the wide

functionality of the system, there is also the ability to request the results of physiological measurements, informing patients about taking medications, and the doctor evaluates the effectiveness of the patient's treatment remotely [9].

## 7 Wearable Devices and Equipment

CardioQVARK (https://cardioqvark.ru/) is a personal electrocardiograph that connects to a smartphone, using it anywhere and at any time, you can record your cardiogram. The patient is allowed to keep a diary of his health, all data is automatically fed into the medical information system for the doctor to access. The system allows you to monitor the dynamics of the disease and control drug therapy. Every month, a report on the work of a doctor is automatically generated for each patient [10].

To start using this technology, you need to purchase a CardioQVARK case, connect it to your phone, install the CardioQVARK app, and register your profile. After that, you can put your fingers to the sensors and take a cardiogram, the report is sent automatically to the doctor. You can view the saved cardiograms and the doctor will give the patient recommendations on them.

In the course of the research, the task was formulated - to develop an educational prototype of the "Expert-Hospital" information system, the main purpose of which is to increase the efficiency of the medical institution, the quality and efficiency of medical care with the functions of supporting medical decisions.

Further, the analysis of the subject area was carried out, as a result of which the IDEF0 model was modeled, and its graphical notation (Fig. 1) was presented, designed to formalize and describe the business processes taking place in a medical institution [11].

Figure 1 shows that for the presented inpatient treatment, the input signals are data about the patient (name, date of birth, SNILS, passport data, medical policy number, date of arrival, diagnosis). The output data will be:

- electronic medical record - a patient's medical record in electronic form;
- recommendations of the patient's treatment options by the system - the examination results analyzed by the system, based on which the system displays recommendations for treatment planning;
- patient treatment plan - the final treatment option, adopted by the doctor, taking into account the recommendations of the system being developed.

Control signals are:

- federal laws - legislative acts of the Russian Federation, based on which the activities of a medical organization take place;
- rules and procedures of treatment enshrined in regulations and standards (see Fig. 1).

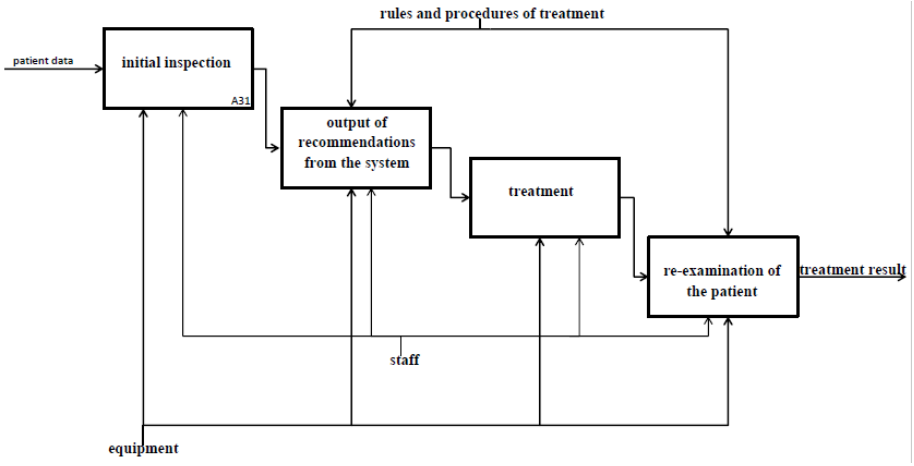


**Fig. 1.** Second level decomposition diagram.

During the development of the "Expert-Stationar" information system, the language PHP was used, which is a scripting language and today is very often used in the development of web applications. Also, to implement the prototype of the information system, in addition to the PHP language, Html, Css, and JavaScript were used.

MySQL was chosen as the DBMS for the Expert-Stationar system. This database management system is a relational management system. It is the most flexible and versatile among the existing analogs on the market. MySQL DBMS is licensed for free for educational purposes. At the same time, it has sufficient functionality and can work with large amounts of information. The communication between PHP and MySQL has been configured using phpMyAdmin, which allows you to administer the MySQL server, execute SQL commands, and view the contents of tables and databases.

In the next step, the ER model of the database was developed, shown in Fig. 2.

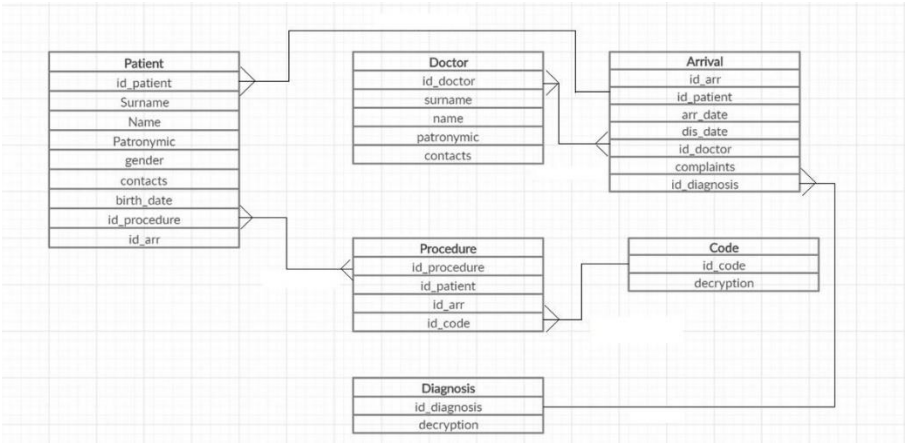


**Fig. 2.** ER-diagram of the database of the developed information system "Expert-Stationar".

Further, at the input of the research, the physical model of the database MDSS "Expert-Stationar" was implemented using the MySQL DBMS. After creating all the tables, the database structure looks like this (see Fig. 3):

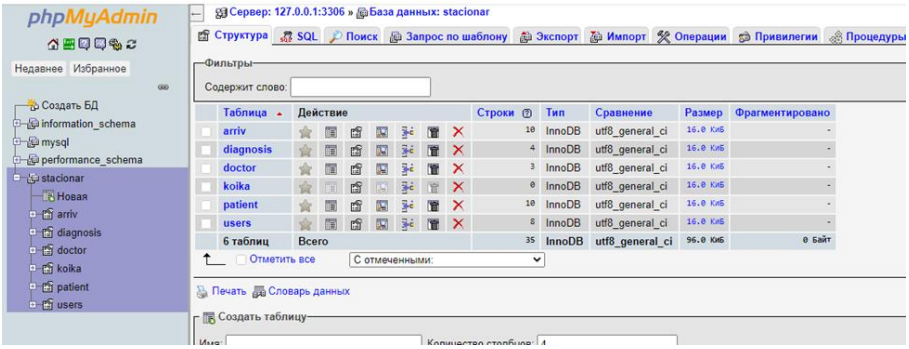


**Fig. 3.** The physical implementation of the database MDSS "Expert-Stationar".

Information security tools were analyzed and implemented by the established standards.

1.differentiation of access rights by the system administrator;

2. maintaining the integrity and consistency of data;

3. absence of malicious components on users' clients;

4. regular backups of the database;

5.The md5 hashing algorithm is used. This ensures their safety and increases the security of the system as a whole.

The developed information system implements the following functionality:

Adding an employee to the system. The function "Add an employee to the system" belongs to the "Chief of the hospital" account.

Removing an employee. The function "Deleting an employee" belongs to the "Hospital Chief" account.

Entering information about the employee (name, position, contacts).

Assigning a login and password in the system.

5. View all hospital patients. This feature is available to all system accounts.

6. View all doctors in the hospital. This feature is available to all system accounts.

7. Maintaining and editing the patient's medical record. The function belongs to the "Employee" account.

8. Viewing the patient's medical record. The function belongs to the "Employee" account.

9. Registration of the patient in the hospital. The function belongs to the "Employee" account.

10. Viewing the system's recommendations for treating the patient. The function belongs to the "Employee" account.

The interface of the developed information system of the MDSS is shown in Fig. 4.


**Fig. 4.** The interface of the information system - the function of deleting patients of the "Expert-Hospital" information system.

Information system MDSS "Expert-Stationar" is cross-browser, which is confirmed by the results of testing in browsers Yandex, Google Chrome, Microsoft Edge. It was found that in the specified browsers all the elements of the page were supported, when the page was scaled, the integrity was not violated, the font, images, and other elements were also proportional to the page size.

It is planned that in the future, after the final stage of testing and correction of possible errors, as well as filling in the database of treatment recommendations, the MDSS "Expert-Hospital" system will provide decision support to assist medical personnel in diagnostics, diagnosis, and in drawing up a patient treatment plan.

## 8 Conclusions

Thus, the educational medical information system for supporting medical decision-making, developed in the course of the study, is a tool that helps doctors in the implementation of their professional functions. MDSS "Expert-Hospital" can assist in choosing a drug treatment, when recommending a set of procedures, facilitate the work of a medical worker, prompt and warn during medical examinations and treatment in a hospital. In connection with the use of such systems, the appointment time, doctors' mistakes are significantly reduced, and patients are provided with timely and high-quality care.

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