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ARCHITECTURE OF A HOSPITAL INFORMATION SYSTEM BASED ON ELECTRONIC HEALTH RECORDS

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Abstract. Information technologies have become an integral part of healthcare, and the hospital information system (HIS) is their core. Paper records are slow, hard to share and prone to loss and errors. This article proposes a layered architecture of a hospital information system built around a single electronic health record (EHR). The architecture has four levels: user access, functional modules, integration services and a central database. The main modules are patient registration, the electronic health record, laboratory, radiology with image archiving, pharmacy, and management and statistics. Data exchange between modules and with external systems is based on the HL7 FHIR and DICOM standards. Information security is ensured by role-based access, encryption and an audit log. The proposed architecture can serve as a basis for introducing information systems in medical institutions and for teaching medical informatics to students.

Keywords: information technologies, hospital information system, electronic health record, HL7 FHIR, DICOM, medical informatics, data security.

1. Introduction

Modern healthcare produces large volumes of data: medical histories, laboratory results, images, prescriptions and administrative records. When these data are kept on paper or in separate programs, doctors lose time searching for information, tests are repeated and errors occur when data are copied by hand [1].

A hospital information system collects these data in one place and makes them available to every authorized participant of care. Its core is the electronic health record, which stores the complete history of a patient's treatment [2]. Reviews show that well-implemented health information technology can improve adherence to clinical guidelines, reduce medication errors and support decision making [3].

In Uzbekistan, the use of distance learning in medical education [6] and the methodology of teaching informatics and information technologies in medicine [7, 9, 10] have been studied by several authors.

The success of such a system depends largely on its architecture: how modules are divided, how they exchange data and how data are protected. The aim of this work is to propose an architecture of a hospital information system based on the electronic health record and to describe the function of its components.

2. Materials and methods

The architecture was developed by analysing the information flows of a multidisciplinary hospital: the path of a patient from registration through examination, tests, treatment and discharge,

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and the documents created at each step. International interoperability standards were reviewed: HL7 FHIR for the exchange of clinical data [4] and DICOM for medical images [5].

A layered (multi-tier) approach was chosen, in which each level has its own task and communicates only with the neighbouring levels. This approach makes it possible to add new modules or user devices without rebuilding the whole system.

3. Results

The proposed architecture has four levels, with the electronic health record as the single source of patient data (Figure 1).

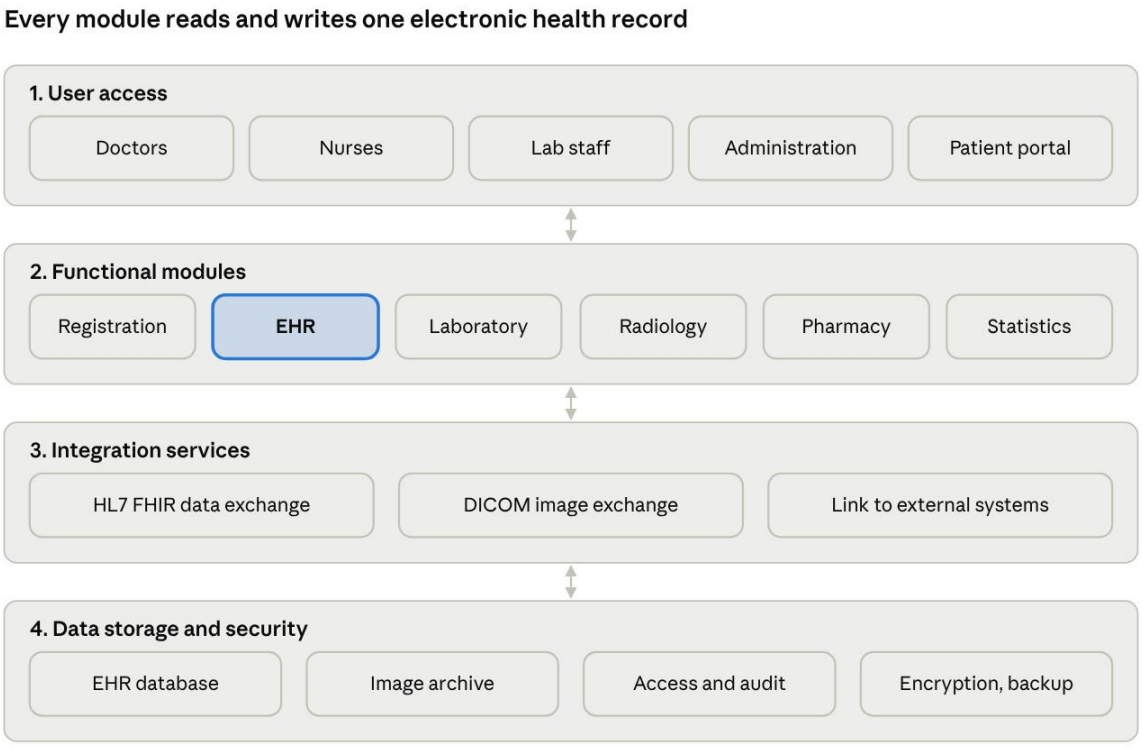


Figure 1. Four-level architecture of the hospital information system.

Level 1 — User access. Doctors, nurses, laboratory staff, administrators and patients work through workstations, tablets or a web portal. Each user sees only the functions allowed by his or her role.

Level 2 — Functional modules (Table 1).

Table 1. Functional modules of the hospital information system

Module	Main functions	Data it adds to the EHR
Registration	Patient identification, appointments, admission and discharge	Personal data, visit history
Electronic health record	Examinations, diagnoses, treatment plans, discharge summaries	Clinical notes, diagnoses
Laboratory	Test orders, sample tracking, results	Test results

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Module	Main functions	Data it adds to the EHR
Radiology and PACS	Imaging orders, storage and viewing of images	Images and reports
Pharmacy	Electronic prescriptions, stock control, interaction checks	Prescriptions, dispensed drugs
Management and statistics	Bed occupancy, workload, reports to health authorities	Aggregated indicators

Level 3 — Integration services. Modules exchange data through a common integration layer using HL7 FHIR resources (Patient, Observation, MedicationRequest and others). Imaging equipment connects through DICOM. The same layer links the hospital with external systems: other clinics, laboratories and national health registries.

Level 4 — Data storage and security. The central database holds the electronic health records; the image archive stores large DICOM files. Security is provided by role-based access control, encryption of data in transit and at rest, an audit log of every access and regular backups.

4. Discussion

The main advantage of the proposed architecture is a single electronic health record shared by all modules. A doctor sees the patient's laboratory results, images and prescriptions in one place, which saves time and reduces repeated tests. Electronic prescriptions with automatic interaction checks reduce medication errors [3].

The use of international standards is essential. Without HL7 FHIR and DICOM, each module would need its own connection to every other module, and data exchange with other hospitals would be almost impossible. The integration layer turns many point-to-point connections into one common channel.

Implementation also has difficulties. It requires investment in equipment and networks, staff training and a transition period when paper and electronic records exist side by side. Protection of personal medical data must comply with national legislation. Teaching medical informatics to students helps prepare future doctors to work effectively with such systems.

Modern requirements for the course "Information technology in medicine" and creative approaches to teaching it [9, 10] make it possible to train doctors who can use hospital information systems from the first day of practice. Research on new materials for sensors and optical devices [8] also expands the range of medical equipment that such systems will have to serve.

5. Conclusion

A four-level architecture of a hospital information system was proposed: user access, functional modules, integration services and data storage with security. The electronic health record is the single source of patient data, and modules exchange information through HL7 FHIR and DICOM standards. The architecture can be used when introducing information systems in medical institutions and as a teaching model in medical informatics courses.

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