MODELING STRUCTURES FOR INTEGRATED OBSTETRICS, GYNECOLOGY, AND NEONATAL INFORMATION SYSTEM

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INTRODUCTION

The problem of accessibility, quality and safety of medical care is a critical thread nowadays. In 2013 Ministry of Health of Ukraine began implementing an all-Ukrainian Electronic Registry of Patients (ERP) [1] and with it, the problem of collecting and storing information associated with paper medical records have not been solved yet. Hospitals of the most territory of Ukraine practically don't have any experience of the transition to electronic principle of storing and processing information. Paper medical records are kept at the place of residence of the patient and associated with the long-term bureaucratic procedures. Sometimes due to human factors, medical information is lost irreversibly. Difficulties arise in the process of history taking when the patient enters the health care facility in the state of the acute emergency without a medical card. Another problem with the health information exchange originates when the patient moves between departments. Also, same exchange problem exists between medical and laboratory diagnostic departments.

The absence of real-time data about performed treatment or analyses may lead to medical errors and endanger the patient's life. Quite often, these problems occur in the provision of obstetric and neonatal care, when health care takes place in the various divisions of this profile and there is a need for relevant clinical patient data. Also, it should be noted the following possible causes of failures in the delivery of obstetric and neonatal care: labyrinth of experience, lack of time for decision-making, poor discussion and analysis, the fragmentation of approaches in the various structural units et al. At the same time, deficiency of modern protocols and guidelines, common requirements for the provision of health care, makes it difficult to ensure a systematic, integrated and coherent health care system. Therewith, health record, routes of patient and documenting inpatient care in gynecology and obstetrics are unique to medicine. Current electronic health record systems are often limited in their usefulness for the practice of obstetrics and gynecology in the absence of specialty-specific requirements and functions [2].

Summarizing all above-mentioned, the importance and potential benefit of information technology and electronic health records for providing quality care for women is obvious. Therefore development of a system for collecting, storing, processing and transmission of information will significantly increase the efficiency and qual-

ity of women's' health care and provides coordinated work of specialists and departments in a single information space.

The work presented in this paper prepares a framework for flexible and quick development of obstetrics, gynecology, and neonatal information system offers comprehensive integration and interoperability.

RELATED WORKS IN OBSTETRICS AND GYNECOLOGY INFORMATION SYSTEMS

Nowadays, many countries are implementing programs oriented on consolidating information in the health sector. There were designed and introduced a number of solutions for electronic health records (EHR). Along with that, the requirements for electronic medical record of women's health services differ from other medical specialties:

- obstetrics and gynecology at the same time are medical and surgical specialties;
- they are both hospital-based and clinical-based;
- obstetric care requires specific data fields and image displays, unlike other medical or surgical disciplines.

As it is mentioned in [2] even with hospital-wide solutions, there are no completely integrated systems for obstetric and gynecologic care. Systems designed for workflows of other medical specialties, fail to accommodate the visits of antenatal care with displaying flow sheets. That why, research in health information in this field is topical. In 2011, the United States has launched a new project on integration of outpatient Ob/Gyn EHR and information system for perinatal institutions [3]. The authors of [4] presented a draft basic architecture of the model-based approach to the development of an information system for obstetric and gynecological departments. Health Information System (HIS) is planned for entering, storing and reading medical records of the patient. A novel integrated semantic data model the Health-e-Child project is presented in [5]. The project provides the disease modeling, decision support, identifying knowledge, data mining, and working in a distributed (grid-based) environment. In [6] authors have developed the medical system, which focuses on the development of intellectual knowledge, classifies knowledge associated with clinical algorithms to provide intelligent decision support during treatment. Medical errors, lack of patient information or other cases that interrupt to share information between providers are described in [3].

The problems of share and exchange information are described in [7]. In this paper, authors give critical review success factors for better implementation of information system. Investigation of workflow in medical institutions was held in Virginia and, as a result, the key factors for success of medical information system were identified. Another research on existing structure of information system and discussion how EHR and various approaches can help in medical care is presented in [8].

PROBLEM DEFINITION

Analysis of publication in the field of designing and implementing HIS bring us to the conclusion that for at this moment in Ukraine specialized medical information system for obstetric and gynecologic services has not implemented. Wherefore, the objective of this paper is the analysis of information flows and interaction of patient data between the obstetrics and gynecologic departments in real-time to improve the quality of health information exchange and support effective clinical decision-making.

MODELING STRUCTURES FOR OBGYNEOIS

The effectiveness of healthcare operations depends heavily on the extent of the integration of information across all obstetrics, gynecology, and neonatal sectors.

Modeling the document flows and data exchange enables integrate data of healthcare operations seamlessly and provides developing effective information system. We assign five separate phases for modeling structures for integrated obstetrics, gynecology, and neonatal information system (ObGyNeoIS):

- formalization of obstetric-gynecologic and neonatal care;
- identify the linkages and coherence between healthcare divisions and services;
- identification of sources of information, participants, key users, definition of user assess rights;
- analysis and consolidation of data in the information flow in the structural units;
- database designing.

For developing the basic structures of ObGyNeoIS, we used the regulatory framework of the Ministry of Health of Ukraine [8,10], ICD-10 [11,12], the HL7 CDA standards [13], and other vocabularies [14,15].

The data sources are the medical records based on the specific medical forms No. 025/o, 030/o, 096/o, 111/o, №113/o, the laboratory and diagnostic reports, accounting and statistics.

DOCUMENT WORKFLOW

Basing on the analysis of information flows were identified main sectors of information exchange. The primary structural units for information exchange between Ob-Gyn and Neonatal departments are shown in Fig. 1. They are maternity welfare clinics, admission departments in maternity hospitals, gynecological, maternity and neonatal departments, the pathology of pregnancy departments, ambulance and emergency medical services, laboratories and diagnostic departments.

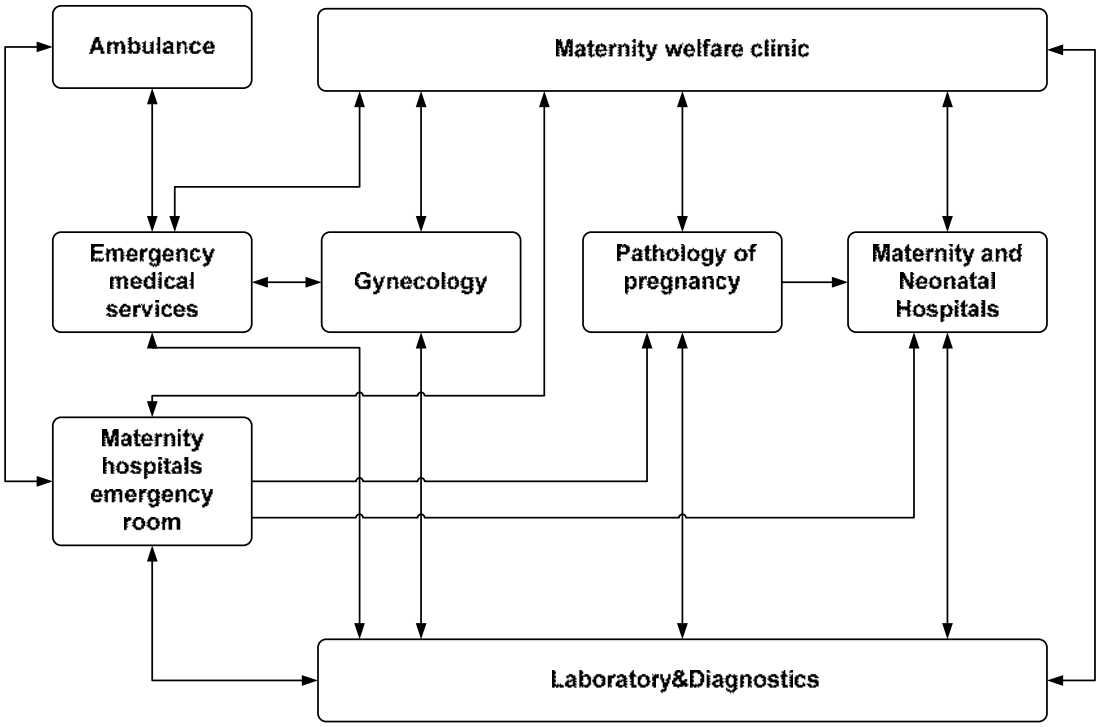

Figure1. The structure of data exchange between Ob-Gyn and Neonatal departments

BASIC COMPONENTS OF OBGYNEOIS MODEL

Information interaction of structural units ensures the access to relevant patient data, reduces time on the processing hospitalization, supports on-time delivery of diagnostic tests. The provision of ambulance and emergency medical services ensures direct access to the patient data.

Fig. 2 shows the main components of the ObGyNeoIS model. Development of the system is carried out in accordance with the international standards World Health Organization, Documents and Regulations of Ministry of Health Ukraine and includes Electronic Health Record related to the event-based model, vocabularies, reporting components, user interfaces, clinical decision and guidelines support components. HIS implementation process is quite complex. It includes detailed investigation of processes occurring in the system.

All stages of case history filling in Ob-Gyn and Neonatal institutions should be strictly formalized.

For the full-fledged implementation of HIS in Ukraine the Ob-Gyn and Neonatal processes using a single classifiers and dictionaries [11,12], medical and economic standards [13,14,15], orders of delivery of health care must be standardized. Therefore, we consider this approach as a basis for implementation a universal solution in Ob-Gyn and Neonatal departments and development electronic health record for women's health services.

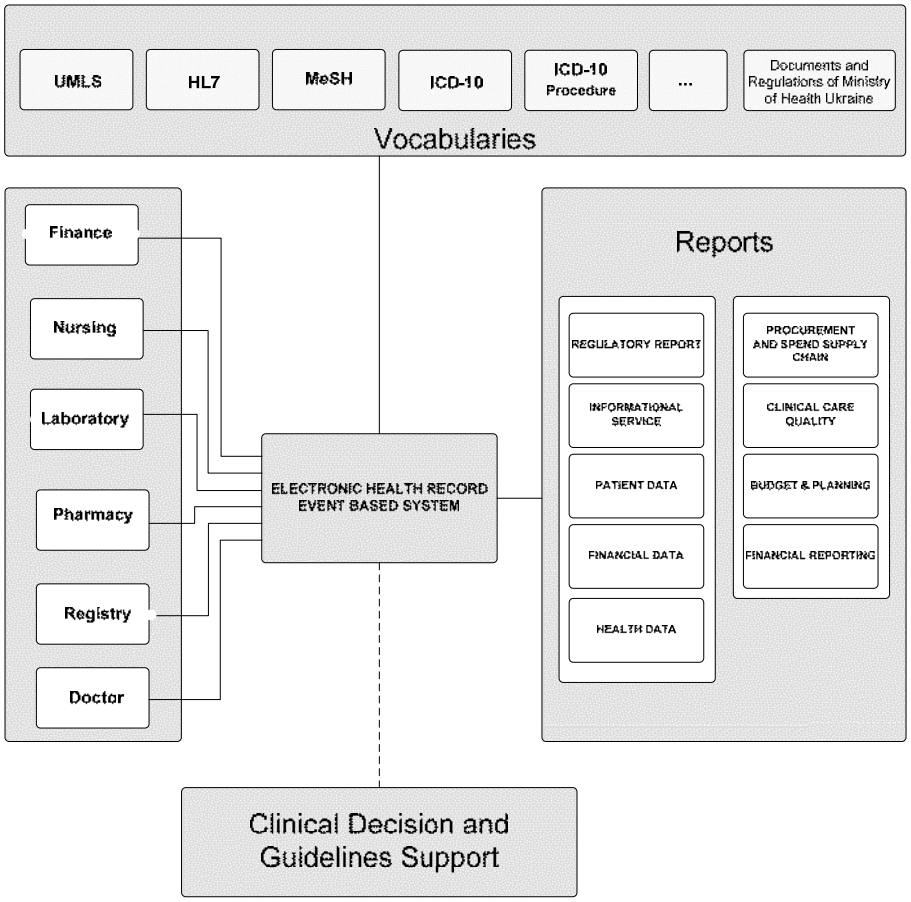

Figure 2. The concept of the HIS model

To providing data fusion in integrated ObGyNeoIS, we combine and mark out the principal stages of delivery of health care as it is described in the next subsection.

Structuring the main stages of Ob-Gyn and Neonatal care. The main stages of Ob-Gyn and Neonatal care in outpatient settings with low level of details are shown in Fig. 3.

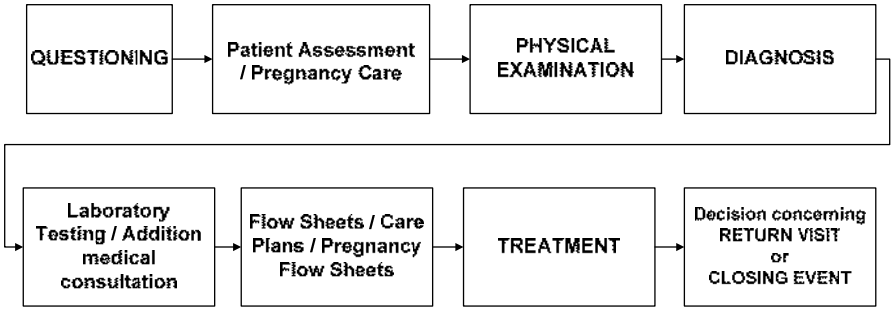

Figure 3 .The main stages of Ob-Gyn and Neonatal care in outpatient settings

Doctor begins primary or repeated visit with a "Questioning" recording complaints, medical history / status, and life history (Fig. 4). Then, if necessary, he/she examines the patient with recording data of "Physical examination" and moves to the next process "Diagnosis". Provisional diagnosis is based on a questioning, patient assessment, and physical examination while final diagnosis makes on the basis of the subjective, objective, and assessment data combined with laboratory tests, medical images and chronologic documentation.

On the next step, if needed, the doctor adds the required laboratory and diagnostic examinations or referral for advice to another health professional.

The next stage includes flow sheets and care plans. This stage of the visit contains also the algorithms for women with abnormal pregnancy or unwanted pregnancy care. At the stage of "Treatment", the doctor can select the tactics and methods of treatment in accordance with accepted standards.

The final stage is "Decision concerning return visits or closing event". In case the revisit is required, the doctor chooses the next appointment date and closes current event.

The process of medical care is presented in the form of blocks of data, each containing a set of input and output data structured in a certain way. All processes contain the sub-data in a greater detail form as it shown in Fig. 4 and Fig.5.

Figure 4. Specification of process "QUESTIONING"

For example, the sub-process "Medical History" from general process "QUESTIONING" presented in Fig. 4 contains a set of data:

General:

– the date of the last menstrual period;

During pregnancy from 28 weeks:

– the date and time of fetal movements;

In the presence of specific pathology or complication of pregnancy:

– the date and time of onset;
– the nature of onset of the disease;
– under any circumstances began disease;
– initial symptoms of the disease, especially their manifestations, dynamics and chronology of the development;
– presence of the prodromal period;
– the rate of complications, recurrences;
– medication;
– periods of improvement and deterioration.

Depending on the level of medical care, this data set can be changed or supplemented. For example, for the maternity hospital and neonatologist the same sub-process contains a set of the following data:

– start rooming-in with the mother after childbirth;
– beginning of breastfeeding after birth;
– adequacy of lactation;
– type of feeding;
– the day when the stump of umbilical cord dropped.

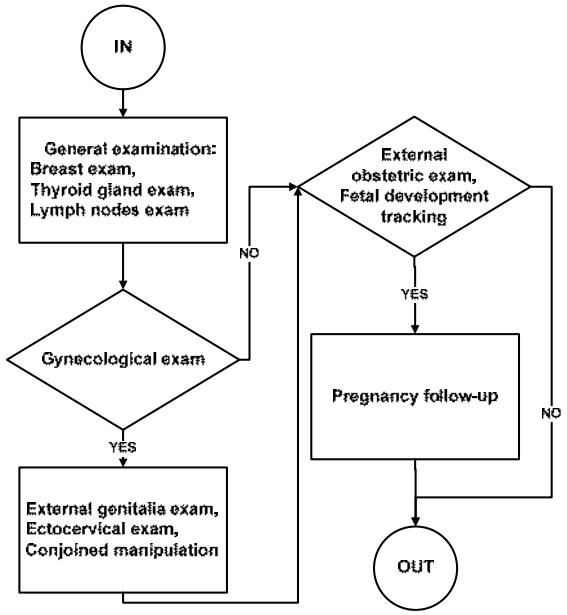

Figure 5. Specification of process "PHYSICAL EXAMINATION"

The process "PHYSICAL EXAMINATION" shown in Fig. 5 contains a set of following data:

– arterial tension;
– height, weight;
– body temperature;
– state of consciousness;
– the position of the patient;
– physique;
– changing face;
– lingua, mucocutaneous;
– subcutaneous fat;

– male / female pattern of hair distribution;
– breast examination;
– palpation of the abdomen.

Using this approach, the specifications of all processes for all target groups are obtained in a similar way. The principal participants in the Ob-Gyn and Neonatal care are the patient, a nurse of ambulatory clinics, obstetrician-gynecologist of ambulatory clinics, obstetrician-gynecologist of external agencies, specialty care provider, laboratory and diagnostic provider, laboratory assistant, chief of department.

DATABASE AREA OF OBGYNEOIS

he ObGyNeoIS database was developed from the basic components and structures of data in Ob-Gyn and Neonatal care. A fragment of the ER diagram is shown in Fig. 6. It presents 18 entities: Person, Staff, Apptnt_Staff, Blood_Type, Sp_RhBlood, Sp_Bloodt, Offices, Office_ICD, Appointments, Type_Appointments, Patient, Patient_ Sector, Sectors, C_Forms, Forms, Medical_Tests, Type_ Medical_Test, Medical_Tests_Data.

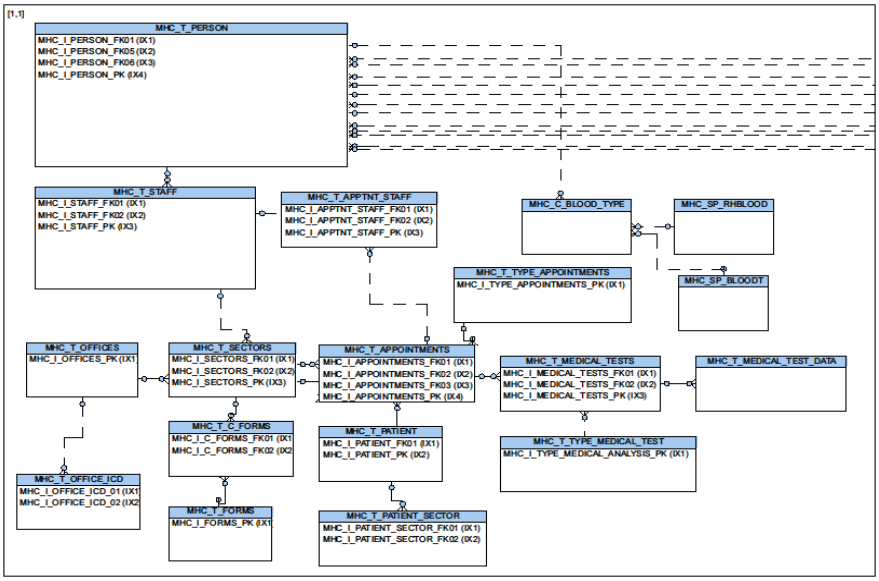

Figure 6. The fragment of ObGyNeoIS Database

The whole ER diagram contains more entities: Medications, ICD-10, other vocabularies (abbreviations, definitions, normalized naming system for generic and branded drugs, Systematized Nomenclature of Medicine--Clinical Terms, etc.), person details and other related EHR entities (SP_Invalid_Group, SP_Allergen, Type_Allergen, React_Allergen, Diabetics and Infectious_Disease based on SP_ICD et al.) This ER diagram provides an overview of the ObGyNeoIS and describes the object and information structures used by information system.

CONCLUSIONS

The paper presents the base structures for developing integrated obstetrics-gynecology and neonatal information system. The document flows and data exchange in Ukrainian obstetrics, gynecology, and neonatology institutions were studied, the main routes of patients in the outpatient departments of women's health care were marked. As a result, there were formalized the scheme of information flows, defined the ways of data exchange between the structural units of Ob-Gyn and Neonatal departments in the information system. We suppose that developed models allow give a full detail of the all the structural units of information system and integrate data from all services: outpatient, inpatient, laboratory and diagnostic and that would serve not only to store and transfer data, and provide assistance in the process of medical care.

Based on the experience of implemented systems, we tried to extract the best deal and avoid their mistakes. For the future implementation of a medical system, we offer the option of a system of health information exchange and sharing of health care. To facilitate interoperability between systems is supposed to use flexible integration solutions both

imports and exports. All terms, vocabularies and classifiers are represented in English, Ukrainian and Russian languages. Such flexible structure of medical information system designed specifically for Ukraine and may be fully integrated into world medical space owing to the fact that it meets the requirements of the international standards and regulations.

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