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Getting statistical data of examinations in decision support system for ultrasound diagnostics SonaRes*

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Abstract

In this article an approach to get statistical data about ultrasound examinations, carried out in the framework of SonaRes, the decision support system for ultrasound diagnostics, is described. A list and description of respective queries for data base of patients' examinations sessions is provided to get the information interesting for ultrasonographers and the system developers.

Key words: ultrasound diagnostics, examination process, Data Base, statistical data, decision support system, queries, parameters.

1 Introduction

Main (primary) goal of the system SonaRes creating [1,2] is support for decision-making process in ultrasound diagnostics. For information support of the examination process (session) the information entered during the examination process is stored in the system. With the completion and/or interruption of this process the information can be saved at user's (ultrasonographer) will in database (DB) of ultrasonographic examination sessions.

At that several types of information saving are foreseen:

- date of session carrying out;

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- data that do not follow directly from the observed by doctor image and can be entered during registration:
  - general information about patient (gender, date of birth, first name, last name);
  - place of residence - rural/urban;
- data that follow directly from the observed by doctor image and can be entered by him as answers to the system's questions:
  - for example, organ's dimension, location, etc;
- auxiliary data that user enters into the system to establish his desired mode for work:
  - language for dialogue;
  - mode (urgent, normal, detailed);
  - examination type (step by step or from pathology);
  - session name;
- data concerning examinations' results (report) arranging:
  - revealed pathologies;
  - possible recommendations for additional examinations and analyses, etc.

The user has the possibility to:

- save current session;
- load previously saved session;
- create new session.

Naturally that availability of such information (DB of ultrasonographic examination sessions) serves not only for its original purpose – information support of the examination process, but also as the information base for the secondary goals, which are not of less importance:

- documenting;
- standardization;

- obtaining statistical information of various kinds (for example, about the most common diseases in various age categories of examined patients).

It should be noted that in the field of medicine quite a lot of information systems are being developed for which these objectives are the primary ones [3-6]. Moreover, there are examples of systems for diagnostics support, the results of usage of which and survey of physicians-users have shown that they (physicians-users) rated the usefulness of systems for documentation, standardization, and receiving the statistical information higher than for direct diagnostics of the patient. So the analysis of experience of the system SonoConsult usage in clinical routine for more than 2 years showed the following [7]: "The evaluation focuses on the following aspects from the clinical point of view: quality of documentation, quality of diagnostic conclusions, training effects, and research effects. In contrast to wide-spread expectations in the knowledge-based community, the diagnostic conclusions were less important than the other aspects, being much more welcomed by clinicians".

Exactly therefore, when developing the system SonaRes, a lot of attention was given also to ensure the possibility to get statistical data based on stored information about the examination sessions.

In this connection:

- there was analyzed the reporting and the statistical information of interest to physicians and administrators of health institutions;

- in the structure of examination sessions DB there was foreseen the possibility to save some additional information, which is not necessary for examination process itself, but is important from the point of view of statistical data obtaining (e.g., patient's date of birth and gender).

- in the system structure the module for statistical characteristics "calculation" and respective interface were included.

2 Queries and their parameters for obtaining statistical data of examination

Based on the analysis (made on statistical information and system capabilities of interest to physicians) an approach was developed to form queries to the DB, which underlie the implementation of the analytical part of the system SonaRes. The proposed approach is based on:

- 11 queries with parameters, that allow to extract necessary information from the DB;
- 13 parameters for queries.

More over, there was determined at what stage of the work the system should ask the user and save necessary information for statistical analysis. Thus, in order not to overload the process of examination for collection and storage of "additional" information, it was agreed that the system will "ask" the relevant questions at the stages of patient registration and examination report generation.

Initially the system SonaRes is conceived as a decision support system for ultrasound examination, and not as a system for statistical analysis and management. Therefore, at the first stage only those queries for statistics are implemented, which are easily and naturally solved along the way with the main task. That which requires significant additional effort and loads the interface, has been postponed for further development of the system.

2.1 Queries' parameters

For working out in detail the type of chosen information and its management the user is allowed to set values of some parameters of queries (e.g., gender and age of the patient). If the value is not selected, the data for all values of this parameter are taken into account (e.g., data for all examined patients, regardless of gender and age).

The work with the system while examining a patient can be conventionally divided into the following stages:

- patient registration;
- selection of organ for examination;
- examination process itself, in which the system offers questions and the doctor-ultrasonografist answers these questions in accordance with that he sees in the ultrasound image;
- generating reports on the examination results. And here, except the pathologies proposed by the system in accordance with the information on the organ state entered by physician, he is given an opportunity to input some additional information and to agree or disagree with the conclusion, formed by the system.

Below there is a description of 13 proposed parameters for queries, with the indication of the stage of the system work, at which the relevant data are entered.

1. Date of examination

At the registration stage the examination date is recorded. When forming the query, the examination date is used for selection of examinations carried out in a given period of time. For example, examinations from 1.01.2007 till 31.12.2007.

2. Patient's age

At the registration stage the patient's date of birth is recorded. Patient's age on the moment of examination execution may be calculated. Also on the basis of age it is determined whether the patient is an adult or child. Up to 18 years old the patient is considered a child. Age of child under one year is calculated by month, more than one year – by year. When forming the query the patient's age is used for the selection of patients for the age group. When specifying the age group, minimum and maximum age of patients of interest are specified. For example, from 40 to 60 years.

3. Gender

It is recorded *at the registration stage.* There are, as physicians usually use, three values: "male" / "female" / "data are not indicated".

4. Resident of city or village

At the registration stage there is recorded: "city" / "village" / "data are not indicated". The default value is "data are not indicated".

5. Primary visit

It is calculated automatically *at the registration stage* on the basis of the current date and search results through DB: if there were no examinations in the current year, the visit is considered as "primary"; otherwise it is considered as "secondary".

6. Urgent or planned patient

It is recorded *at the registration stage.*

7. On an empty stomach or after eating (it is important how many hours after eating)

It is recorded *at the registration stage.*

8. First detected pathology

The first detected pathology in the sense that this pathology was found in this patient for the first time. The information is recorded *at the stage of report generation* in the words of the patient. At that it is necessary to perform database search to ensure that the patient does not make mistakes and there are no records in the DB about his examination with this pathology being identified. If not the first time, it is also established in the words of the patient or on the basis of documents that the patient has brought about other examinations not in this clinic.

9. Intrinsic (proper) pathology / extrinsic (improper) pathology from neighborhood / extrinsic (improper) nonspecific pathology

It should be recorded *at the stage of report generation.*

To realize this possibility it is necessary for medical experts to make the appropriate classification of pathologies, and to save it in the systems Knowledge Base:

a) Intrinsic (proper) pathology;

b) Extrinsic (improper) pathology from neighborhood;

c) Extrinsic (improper) nonspecific pathology;

d) Mixed pathology.

Then, for each pathology of the groups a), b), c) the system itself may give the type of pathology (name of the group) without possibility to change it. For the pathology of the group d) "Mixed pathology" it is necessary to give the possibility for the user to specify the type of the pathology in this case: "Intrinsic (proper) pathology", "Extrinsic (improper) pathology from neighborhood", "Extrinsic (improper) nonspecific pathology". In addition, if for the pathology of the group d) the user doesn't select the type a), b) or c), then it is set by default as "not specified". To clarify the situation of "Extrinsic (improper) pathology from neighborhood", it is necessary to provide a text box where the user can specify the neighboring organ which has the influence.

10. Nonvisualization of organ / organ is visible in other non-standard place

At the stage of organ selection for examination it is necessary to indicate: the organ is "visible" / "not visible". If the value "not visible" is selected, then there is given the possibility to indicate the cause:

- congenital lack;
- lack because of being removed;
- present, but a rudimentary one;
- present, but reduced physiologically;
- present, but reduced pathologically;
- not visible because of poorly prepared patient;
- not visible because the patient is obese;
- other cause.

Also the situation "organ is visible in other non-standard place" is possible. Then there should be the ability to choose from several options for the typical non-standard locations. In report there should be included the text box for the doctor-user to be able to describe where the organ actually is.

In current version of the system only the situation when organ is visible is provided.

11. Examination, which finished with "doctor does not agree with the conclusion"

It should be fixed *at the stage of report generation* for that (those) of the specific pathologies that the system has proposed, but the doctor does not agree with the conclusion, proposed by the system. Then this information later will be analyzed by the experts for adjusting the knowledge base.

12. Pathology, that requires additional diagnostic methods

It should be fixed *at the stage of report generation* for that (those) of the specific pathologies that the system has proposed, and for which the doctor recommends to carry out additional analyses: blood, urine, etc.

13. Pathology, that requires repeated examinations

It should be fixed *at the stage of report generation* for that (those) of the specific pathologies that the system has proposed, and for which the doctor recommends to carry out repeated ultrasound examination in some time.

2.2 Queries

Each query has a list of parameters. The answer to the query is based on information from the database. This information is filtered in accordance with the values of query parameters. For example, if for parameter "sex" the value is "female", the answer to the query is received on the basis of all examination sessions carried out for the patients-women.

Below there is the list and short description of queries with indication of parameters which can be applied to the given query.

1. How many patients had carried out the examination

The possibility to select (simultaneously or separately) values for the following parameters is given:

- period of time;
- equipment, which was used for examination;

- patient gender;
- age category (from "patient age at the moment of examination" to "patient age at the moment of examination");
- resident of city or village;
- urgent or planned patient;
- patient with primary/secondary visit;
- first detected pathology is revealed;
- on an empty stomach or after eating;
- "intrinsic (proper) pathology" / "extrinsic (improper) pathology from neighborhood" / "extrinsic (improper) nonspecific pathology" is revealed;
- examined organ;
- nonvisualization of organ;
- how many of them had the examination, which finished with "doctor does not agree with the conclusion";
- pathology, that requires additional diagnostic methods, is revealed;
- pathology, that requires repeated examinations, is revealed.

The answer to the question will be the number of examined patients, corresponding to given values of parameters. If a patient was examined several times, he is counted only once.

More over, one of the parameters can be defined as the "main". In this case the result will be also the percentage of the number of examined patients corresponding to all the selected parameters, to the number of examined patients, corresponding to all the selected parameters except the main.

For example, three parameters are set in the query:

- examined organ - gallbladder;
- patient gender - female;
- period of time - from 1.01.2007 to 31.12.2007.

Parameter "patient gender" was chosen as the main. The answer is the number of patients-women with gallbladder being examined in the period from 1.01.2007 to 31.12.2007. Also, a percentage of the number of such patients-women to the number of all patients (regardless of gender), with gallbladder being examined in the period from 1.01.2007 to 31.12.2007 will be shown.

2. How many examinations were carried out

The possibility to select (simultaneously or separately) values for the following parameters is given:

- period of time;
- equipment, which was used for examination;
- patient gender;
- age category;
- resident of city or village;
- urgent or planned patient;
- patient with primary/secondary visit;
- first detected pathology is revealed;
- on an empty stomach or after eating;
- "intrinsic (proper) pathology" / "extrinsic (improper) pathology from neighborhood" / "extrinsic (improper) nonspecific pathology" is revealed;
- examined organ;
- nonvisualization of organ;
- examination, which finished with "doctor does not agree with the conclusion";
- pathology, that requires additional diagnostic methods, is revealed;
- pathology, that requires repeated examinations, is revealed.

The answer to the question will be the number of examinations, corresponding to given values of parameters. If a patient was examined several times, all these examinations are counted.

As in the previous query, one of the parameters can be defined as the "main". At that the result will be also the percentage of the

number of sessions, corresponding to all the selected parameters, to the number of sessions, corresponding to all the selected parameters except the main.

3. List of pathologies with the indication of the number of their revealing, sorted in the descending order (of this number) with the possibility to select (simultaneously or separately) values for the following parameters:

- period of time;
- equipment, which was used for examination;
- patient gender;
- age category;
- resident of city or village;
- urgent or planned patient;
- patient with primary/secondary visit;
- first detected pathology is revealed;
- on an empty stomach or after eating;
- referring to one of the types "intrinsic (proper) pathology" / "extrinsic (improper) pathology from neighborhood" / "extrinsic (improper) nonspecific pathology" (or the list of pathologies of all these types, sorted by types);
- examined organ;
- pathology, with which "doctor disagrees when generating conclusion";
- that requires additional diagnostic methods;
- that requires repeated examinations.

4. List of pathologies for specific patient with the possibility to indicate (simultaneously or separately) values, when selecting the following parameters:

- period of time;
- equipment, which was used for examination;
- first detected pathology (i.e., the list of only first detected pathologies will be got);
- examined organ;

- referring to one of the types "intrinsic (proper) pathology" / "extrinsic (improper) pathology from neighborhood" / "extrinsic (improper) nonspecific pathology" (or the list of pathologies of all these types, sorted by types);
- pathology, with which "doctor disagrees when generating conclusion";
- that requires additional diagnostic methods;
- that requires repeated examinations.

5. Number of conclusions stated step by step and number of those stated when started from the presumed pathology

This information can be calculated by analysing the history of the session, stored in a database.

The information of this type is interesting for the system developers rather then for the physicians.

6. Number of pathologies that require repeated examinations

The possibility to select (simultaneously or separately) values for the following parameters is given:

- period of time;
- equipment, which was used for examination;
- patient gender;
- age category;
- resident of city or village;
- urgent or planned patient;
- patient with primary/secondary visit;
- first detected pathology is revealed;
- on an empty stomach or after eating;
- examined organ;
- referring to one of the types "intrinsic (proper) pathology" / "extrinsic (improper) pathology from neighborhood" / "extrinsic (improper) nonspecific pathology".

7. Number of pathologies, that require additional diagnostic methods with the possibility to select (simultaneously or separately) values for the following parameters:

- period of time;
- equipment, which was used for examination;
- patient gender;
- age category;
- resident of city or village;
- urgent or planned patient;
- patient with primary/secondary visit;
- first detected pathology is revealed;
- on an empty stomach or after eating;
- examined organ;
- referring to one of the types "intrinsic (proper) pathology" / "extrinsic (improper) pathology from neighborhood" / "extrinsic (improper) nonspecific pathology".

8. List of pathologies detected in given person

The possibility to select (simultaneously or separately) values for the following parameters is given:

- period of time;
- first detected pathology (i.e., the list of only first detected pathologies will be got);
- referring to one of the types "intrinsic (proper) pathology" / "extrinsic (improper) pathology from neighborhood" / "extrinsic (improper) nonspecific pathology" (or the list of pathologies of all these types, sorted by types).

9. List of sessions - what examinations (of what organs) the given patient had passed:

- in general or in the indicated period of time.

It is supposed that during one session several organs can be examined.

10. List of images (and/or video), associated with the given person:

- in general;
- in the indicated period of time;
- of specific organ;
- during specific session.

11. Number of questions, that the physician answered before getting the result, with indication of number of such examinations

For example, there are 500 examinations where physician had answered 20 questions, 110 examinations - with answered 16 questions, etc.

At that the following cases are interesting:

- to calculate this index in general through the whole DB;
- to calculate maximal number of questions, answered before the moment of report generation;
- to calculate minimal number of questions, answered before the moment of report generation;
- to calculate this index for a specific pathology or for all pathologies from the list (with pathology indication).

This information is interesting for the case of the system usage in the process of teaching the ultrasonography staff.

3 Conclusion

At the current stage of the system SonaRes development a part of queries described above is implemented. Current version is in testing by ultrasonographers. Preliminary analysis of testing shows that indexes provided in the queries are really useful.

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