Lab Reports and Information Design: Restructuring results to the user's knowledge

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Abstract

Usually, patients have difficulty in converting the clinic data information into useful knowledge. The objective of this project is to help patients to a better understanding of the lab reports, proposing a new model. Combining informatics, clinic data and the concepts of information design (design and restructuring). We propose the creation of an information system, which will improve the current presentation of the lab reports results: simplifying them, making them clearer, highlighting the relevant information, being easier to interpret and more relevant to the patient. For the development of the new model of lab report, the most requested laboratory tests was selected. In order to maintain interoperability with the existing information system in the lab, we use standard messages HL7 and Mirth integrator to convert the results in Portable Document Format (.pdf).

Keywords: Lab reports; Graphic design; Information design; Analytical results; Information Systems; Reference Range; Blood tests
1. Introduction

The aim of this project is to improve the laboratory reports without a distortion of the results. This is a meeting point between different areas of knowledge, lab reports and information design, providing the patients with the opportunity to be more involved in their health.

The development of this project involves the adoption of concepts such as visual grammar: dimensions, size, color, value, lines, shapes or scales. The reading and analysis, page by page, of lab results text, requires a powerful memory and a great capacity to absorb, store, sort and retrieve information. When information is presented in graphic form is shaped to the concepts being easier to see the relationship between different information items. The graphics can add a visual perspective of verbal descriptions and reveal no apparent connections that are not visible just through words (text or number) [1]. Currently, lab reports can result in hundreds of observations in one clinical trial, and many data are also provided in tabular data, spread across multiple documents. This is inefficient and can lead one incorrect interpretation. Out of the context, individual data can be difficult to interpret. We can build useful data and display graphs that allow making quick and accurate decisions. After realizing the sort order, data interpretation becomes intuitive. The classification shall be based on the function. The information obtained may vary by location (countries where it conducts research or site), giving rise to variability in the data [2].

The concept of lab reports is based in the area of clinical pathology and laboratory medicine diagnostic activity. This one have a direct impact for the diagnosis, with impact at different stages of specialty health: prevention, diagnosis, prognosis and therapeutic monitoring. The clinical trials allow the bacteria detection, abnormal cells, genetic alterations, antibodies and evaluate the functioning of the organs [3].

The lab reports depend on the analytical techniques used and the range of expected values as normal (reference values). The benchmarks consist of the performance of specific measures prior a large number of individuals without disease, usually grouped by age and sex, and subject to the same conditions made by the same method, which act as controls. The World Health Organization (WHO), the International Federation of Clinical Chemistry (IFCC) and the Institute for Clinical and Laboratory Standards Institute (CLSI), define value as a reference value (result) obtained by observation or quantitative measurement of an analytic in an individual selected, based on well defined criteria [4]. The greater distance from the lab report of the reference value, reduces the possibility of treatment and increases the tendency of pathological process, however the “normal” statistical term is not always synonymous with “no risk”. The presentation of lab reports very clear and well-designed never dispenses a medical consultation [5].

Information design is defined in Latin, from which proceeds, design means intent or purpose, as the term Information is defined in the bibliography as the result of processing, manipulating and organizing data. The design information means: defining, planning and preparing the content of a message to be used in one particular environment by user. In the context of information design, the user is someone who uses objects, services or information systems in an activity with the objective of accomplishing a task [6].

In the design of this study, we use the principles of visual grammar to combine the elements of visual language. These principles are: direction, which is to organize the graphic elements in order to guide the patient to look up important data of lab reports; unit, which is a quality of wholeness achieved by repetition of certain elements and principles in the presentation of lab reports; contrast, obtained by comparison and positioning of elements associated. The lab reports also use the principle of variety or alternation which translates differences in the use of color, size, area and value to create visual interest and the proportion which is a measure of the size and amount of the elements of visual composition of lab reports. To promote an enjoyable and enlightening set for the patient, in this study we combined unit, contrast, variety and other principles.

The application of Information Technology (IT) in pathology represents an evolution in diagnostic medicine. Enables the integration of multiple users and different areas (payments, service providers, suppliers). Also performs and controls procedures, techniques and promotes structural changes in clinical data [7].

The evolution of IT in health in Portugal, as in other countries, allows the establishment of standards for exchange of health information for registration and data exchange between agencies and between health care providers, so it is expected benefits, such as higher speed communication, reducing paper use, easy of obtaining data for epidemiological studies, conducting analyzes of costs, benefits and investments, reduce administrative costs, performance comparison between institutions and improving quality of health care [8].
The efficient use of Electronic Health Records (EHR) like in lab reports focuses on improving care through previous patient data. Some studies [9] with hospital doctors have been done to assess their basic knowledge about the EHR, and that are intended to identify difficulties in understanding and processing clinical data. For the less experienced physicians, the EHR systems came to help visualize the information, increasing their knowledge [9].

In this paper, we present the implementation and evaluation of a model that combines computer science with clinical data and information design, which improves the current results of lab reports: simplifying them, making them clear, highlighting the relevant information, facilitating the interpretation and making them relevant to the patient.

We propose here some examples related with the topic of this paper. Wired magazine with the article untitled "The blood test gets a makeover" [16], where also the modified design does not refer to the methods and techniques to get them. There are also mobile applications, such as the IMedicalApps called "pocket Lab Values", using computer technology but does not use the design [17].

This paper is organized as follows: Abstract, Introduction, Objectives, Methods, Discussion/Conclusion. In the abstract, we present a brief summary of the work; in the Introduction, we present the theoretical framework and approach of the state of the art; in Methods, we have identified the clinical concepts associated with the graphic layout and we identify the proposed architecture for implement the model; finally in Results, we represent the desired results in terms of implementation and final presentation of lab reports.

2. Objectives

We would like to present a new model of lab reports, using the association between informatics and information design, to help the patient to understand them and to be more involved and responsible for his health. It will be possible to improve that already exists and looking to maximize the early prevention of patient health, and not replace medical consultation when there are abnormal lab reports.

3. Methods

3.1. Clinical Concepts

To implement this project we selected the blood analysis of diabetes, cholesterol and uric acid, because there are the medical tests that are generally requested by physicians in medical consults [5, 10].

Table 1 shows the adopted blood analysis for the demonstration of the study, the reference ranges of lab reports and their treatment suggestions [4, 11, 12, 13, 14].

3.2. Graphic layout

The lab reports will be submitted to a computer processing associated with information design, including color schemes, graphics and formatting text synthesis, in partnership with design professionals. Preferred elements are defined: the tone, texture and scale. The emphasis of data is achieved by highlighting saturated colors applied on a soft background. In digital results, the more saturated color is the more pervasive [15]. However, the model of lab reports to be developed will also be printed in black or gray. The overwhelming majority of labs works with black ink printers to not increase costs.

3.3. Architectures proposals: HL7 Messaging and integrator Mirth (.pdf)

The HL7 provides standards for interoperability that improve care delivery, optimize workflow, reduce ambiguity and enhance knowledge transfer among all of our stakeholders, including healthcare providers, government agencies, the vendor community, fellow Standards Developing Organizations (SDO) and patients. "Level Seven" refers to the seventh level of the International Organization for Standardization (ISO), seven-layer communications model for Open Systems Interconnection (OSI) - the application level. The application level interfaces directly to and performs common application services for the application processes. Although other protocols have largely
superseded it, the OSI model remains valuable as a place to begin the study of network architecture [18]. Mirth Connect is a healthcare integration engines, specifically designed for HL7 message integration. It provides the necessary tools for developing, testing, deploying, and monitoring interfaces [19].

3.4. Contribution of clinical staff and/or patients in developing new lab reports

In this project, the clinical staff contributes in the previous execution of lab tests, in the delivery of new results and evaluation surveys. Patients receive and evaluate new lab reports, demonstrate the utility and validity of the approach proposed in the questionnaire responses.

Table 1. Table limits (reference range) and suggestions for clinical analysis adopted (based on [4,11, 12, 13, 14])

<table>
<thead>
<tr>
<th>GLUCOSE</th>
<th>SYMPTOMS</th>
<th>TREATMENT (SUGGESTIONS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPOGLYCEMIA: &lt;60 mg/dL.</td>
<td>- Tremors</td>
<td>- Sugar in the body Balance</td>
</tr>
<tr>
<td>(Pathological)</td>
<td>- Pallor</td>
<td>- Diet food (carbohydrate intake)</td>
</tr>
<tr>
<td></td>
<td>- Tachycardia</td>
<td>- Reduce consumption of alcohol / tobacco</td>
</tr>
<tr>
<td></td>
<td>- Mental impairment</td>
<td></td>
</tr>
<tr>
<td>NORMAL: 90-105 mg/dL.</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>HYPERGLYCEMIA: &gt; 126 mg/dL.</td>
<td>- Diuresis (loss of liquid)</td>
<td>- Diet food (avoid hydrates carbon)</td>
</tr>
<tr>
<td>(Pathological)</td>
<td>- Headquarters</td>
<td>- Regular exercise</td>
</tr>
<tr>
<td></td>
<td>- Hunger</td>
<td>- Reduce consumption of alcohol / tobacco</td>
</tr>
<tr>
<td></td>
<td>- Cardiac Arrhythmia</td>
<td></td>
</tr>
</tbody>
</table>

Glucose in the blood has the function of supplying the brain so that you can perform the necessary functions, regulates the body's commands and helps restore the body's energy.

<table>
<thead>
<tr>
<th>URIC ACID</th>
<th>SYMPTOMS</th>
<th>TREATMENT (SUGGESTIONS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL: 2,5 - 6,1 mg/dL.</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>LIMIT: 6,1 – 7,0 mg/dL.</td>
<td>Not Applicable</td>
<td>- Diet food (avoid purines)</td>
</tr>
<tr>
<td>HYPERURICEMIA: &gt; 7,0 mg/dL.</td>
<td>- Urate crystals in joints</td>
<td>- Reduce stress</td>
</tr>
<tr>
<td>(Pathological)</td>
<td>- Secondary Acute Arthritis</td>
<td>- Avoid diuretic/anti-inflammatory</td>
</tr>
<tr>
<td></td>
<td>- Drop</td>
<td>- Diet food (avoid purines)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Drinking water (about 2L/day)</td>
</tr>
</tbody>
</table>

Uric acid is a substance produced by the body and appears to result from the breakdown of purine molecules (protein contained in many foods).

<table>
<thead>
<tr>
<th>TOTAL CHOLESTEROL</th>
<th>SYMPTOMS</th>
<th>TREATMENT (SUGGESTIONS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL: 200 mg/dL.</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>LIMIT: 200-240 mg / dL.</td>
<td>Not Applicable</td>
<td>- Exercise (weight control)</td>
</tr>
<tr>
<td>HYPERCHOLESTEROLEMIA: &gt; 240 mg/dL.</td>
<td>Not Applicable</td>
<td>- Avoid stress</td>
</tr>
<tr>
<td>(Pathological)</td>
<td></td>
<td>- Diet food (fat-free)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Avoid smoking</td>
</tr>
</tbody>
</table>

Cholesterol is a fat which is connected to the lipids in the bloodstream and is part of the cell membrane of any cell in the human body. It is produced mainly in the liver and can cause excess cardiovascular pathologies.
4. Results

4.1. Implementation of the proposed model

After defining the project architecture, a new model to report clinics analyzes was proposed (Figure 1):

![Fig.1. Architecture of the new proposed model - Implementation](image)

The lab report is introduced in the Laboratory Information System (LIS) with the user's computer, then the LIS forwards the result in HL7 message to the Mirth integrator, new lab report was generate into PDF format, and returns to the LIS. Finally, it can be displayed on the user's computer and others supports, or printed.

4.2. Graphical representation of Lab Reports - Draft propose

Our model (Figure 2) of the lab report will be displayed in a graphic and colorful format with the patient identification in the top of the page, followed by the results of the analysis with reference range and patient outcome. In the end of the page the Lab report will propose suggestions for monitoring and treatment.
This project is under implementation and development, then it will be tested and submitted for assessment by patients. This proposal works for analytical tests proposed in this paper, the main challenge being the further development of this project in order to cover the largest possible number of patients and clinical tests.

5. Discussion / Conclusion

The next stage of this project will be to test the new lab report. This test will be performed in Ribeirão Preto, Brazil, with the collaboration of the University of São Paulo.

However we can conclude that it was possible to propose a scheme that incorporate the existing systems used for generate clinical analyses results.

To conclude, we would like to highlight the collaboration of three distinct areas: Clinical analyses, Information technologies and Information design to propose a new lab report model.

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References: