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Reference

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Reshaping the laboratory results presentation layer: three interfaces for handheld devices

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Abstract. The interpretation of laboratory results is a critical part of the clinical decision making process. The proper understanding of many clinical conditions depends on the identification of evidences in the laboratory reports. If the classic tabular presentation of laboratory results has demonstrated its efficiency since many years, the increase number of potential results, the increased complexity of cases and the time shortage to analyses cases raise the question of finding more efficient ways of displaying these results to clinicians. The presentation layer becomes even more crucial when it comes to small-sized interactive displays. In this work, we discuss three alternative graphical representations of laboratory results adapted to handheld devices.

Keywords. Mobile Applications, Laboratories, User-Computer Interface, Usability, Cognitive Science

Introduction

Laboratory results are one of the key elements in the medical decision process 1,2. The information provided by the laboratory is often key to progress in the hypothetico-deductive approach in diagnosis 3.

During the last two decades, it has been a tremendous evolution in the number, precision, reliability and speed of laboratory analyses. Not only does the spectrum of measurable parameters grow, but also the number of tests done in clinical situations is increasing. In most care settings, this translates into a clear increase of tests done for patients; this is especially noticeable in inpatient care settings.

To our knowledge, although the amount of information produced has strongly increased, the common tabular representation paradigm, inherited from paper, used to display laboratory results has not been questioned, except for specific cases such as antibiograms or immunoassays. The layout presentation is essentially a bi-dimensional tabular representation with analyses on the vertical axis and chronology on the horizontal ones (Figure 1).

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This type of representation, does not support optimally the cognitive processes characterizing the medical decision. Indeed, when clinicians get a set of laboratory results that were ordered with a specific intention, the results are, most of the time, shown in the context of other results rather than the ordering intention, thus losing the context of the specific condition. This lack of contextually induces a cognitive overload essentially due to limited working memory and split-attention effect. These problems are further emphasized when the display surface is reduced, such as the one available on the screens of many handheld devices.

1. Method

A literature survey allowed to identify possible data representations and to understand what factors may influence the comprehension of the results by the clinicians. A second phase of observations of the working process of voluntary clinicians from the University Hospitals of Geneva (HUG) using thinking aloud technique allowed refining the a priori knowledge. Then, a working prototype of three interfaces on handheld devices was implemented, using a HTML5/Javascript framework in order to ensure portability. The software developed connects to the clinical information system (CIS) of the HUG to display data from a selected patient. Finally, an informal evaluation has been performed with a clinician in order to get his opinion about the tool.

2. Results

2.1. Selecting laboratory results

On the developed software, before accessing the main visualization, clinicians can select the results of interest among a sorted list with the most recent results presented at the top. A colored tag is presented next to each laboratory result to indicate whether it belongs or not to the standard recommended range for the given analysis. This selection stage has the advantage of removing all unnecessary values for the validation of the clinician hypothesis, but doesn’t enable a completely explorative approach. Once a subset of laboratories selected, they can be presented as one of the three representations.

2.2. Three interface prototypes

On each representation (Figure 2) five analyses are presented. The “normal” zone is indicated by a green area and the results of two patients are displayed in red and purple.
Figure 2. Three representations of selected laboratory results (Chart, Radar, Histogram)

Chart model: This is the most common solution found in the literature and certainly the most familiar representation. This model facilitates the comparison between different patients since each can be identified by its specific fingerprint. The “normal” range for each laboratory analysis is denoted by a green zone and therefore results out of normal range can be easily identified.

Radar model: The radar model is interesting because additionally to similar advantages as the chart model, this model simplifies the comparison of different values. Whereas the comparison of two values in the chart model is dependant of their location in the graph, with the radar model, the distance is similar between every analysis.

Horizontal histogram model: This model represents each selected laboratory result on a separate line. Its advantage over the two other presentations is its good scalability. Indeed, each additional result can be easily accessed through the usual vertical scrolling gesture of tactile screens.

3. Conclusion

The common tabular presentation of laboratory results does not facilitate the interpretation of laboratory data when different results have to be put into relation to assess a hypothesis. This incompatibility with the clinicians’ cognitive process induces a high cognitive load. This problem is further emphasized on handheld devices because of the limited space available. In this article, we investigated three visual models as an attempt to display efficiently laboratory report on handheld devices. We highlight some advantages of the different representations such as easier comparisons for the radar model and better scalability for the horizontal histogram. This remains a preliminary work requiring a stricter evaluation in the next stage of this project.

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