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Iconic Visualization of Sickle Cell Patients Current and Past Health Status

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Abstract. Rapid access to patient overall health status is essential for a physician during a medical consultation. The use of a HIS for the management of neonatal screening and follow-up of sickle cell disease patients at CERPAD in the Saint-Louis region of Senegal leads the patient electronic records growing in volume and complexity. To facilitate access to relevant information and shortens the time required to analyze and understand these clinical data, an original solution is to set up a data visualization system. In this article, we propose the integration of two iconic visualization tools into the SIMENS-CERPAD module designed for sickle cell screening and healthcare. The two tools use the VCM iconic language and consist of a simplified anatomical schema showing the current health status of the patient and a timeline to visualize its temporal evolution.

Keywords. Visualization, VCM Icons, Timeline, Sickle Cell Disease, Computer Graphics, Nonverbal Communication

1. Introduction

The amount of medical data in health facilities is increasing, in Senegal as in the rest of the world. This data includes, on the one hand, the patient records from consultations carried out by doctors and on the other hand, the results of biological and radiological analyses. Thus, physicians are faced with an increasingly complex medical history with extensive data, on the basis of which they must make critical diagnostic and therapeutic decisions. Thus, it is easy to miss important information [1]. In the laboratory, one of the main challenges for biologists is to take advantage of the flood of data without being overwhelmed by it [2]. A possible solution would be the visualization of this medical data.

Visualization tools facilitate the medical decision-making process by reducing the time required to analyze and understand clinical data despite their complexity [3]. In biology, visualization allows a better understanding of biological processes and facilitates the interpretation of a biological examination [2, 4].

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In Senegal, the integration of a medical knowledge visualization system into a Health Information System (HIS) represents a new innovative scientific dimension in local medical practice. An example of initiatives is the National Medical Information System for Senegal (SIMENS) project [5], a modular HIS, initially designed for the medical services of level 3 health facilities in Senegal's health pyramid [6].

In this article, we propose the use of the VCM iconic language (Visualization of Medical Concepts) [7] for facilitating the access to the information in patient records. We integrated VCM into the SIMENS module designed for the Center for Research and Ambulatory Care of the Sickle cell disease (CERPAD) in the Saint-Louis region of Senegal. CERPAD systematically screens newborns in maternity hospitals in the region, and ensures early follow-up and management of sickle cell disease adapted to the Senegalese public health system [8]. We also demonstrate the use of VCM for monitoring sickle cell disease in Senegal on real data.

2. Material and Methods

VCM is an iconic language for medical concepts [9]. It allows representing with icons the main concepts (clinical conditions, pathologies, treatments, monitoring ...) found in medical records. These icons can be used to identify the excerpts of interest in a medical document; they are not intended to replace the text but rather to help find more quickly the excerpts that interest the physician and those that do not, especially during the consultation. Mr. VCM is an anatomical schema that allows summarizing a set of VCM icons [7] on a small visual interface.

We used VCM icons to visualize the sickle cell patient's medical problems contained in the results of biological analyses carried out in the laboratory and those contained in the conclusion (such as diagnosis) of consultations carried out in the medical service. In the SIMENS-CERPAD database, we identified the actual terms used in the conclusion of laboratory tests and consultations that were useful to visualize. In a second step, we manually made a correspondence between these terms and VCM icons. Similar terms (e.g. lab tests evaluating the same physiologic function) were mapped to the same icons. In order to facilitate the identification of the important points in a patient record, we retained only the icons for the lab tests associated with non-normal results (e.g. glycemia above 1 g/l).

We combined two icon-based visual approaches: an “instantaneous” anatomical approach with Mr. VCM showing the current state of the patient, and temporal approach with a timeline to visualize its historical evolution.

We collected the opinions of users using a questionnaire with four questions regarding their overall satisfaction with the use of Mr. VCM, the performance of the tool, the quality of the icons displayed and the quality of the information provided by the icons. Among these users, we have the biologists for the interpretation of new test results and the doctors for diagnosis and therapeutic decision-making. For each question, they could express a positive or negative opinion, with the opportunity to add free comments.

3. Results

We identified 76 terms in the CERPAD database, that were candidates for iconization, and we mapped them to 20 different VCM icons. Figure 1 shows a screenshot of the

integration of Mr. VCM into the SIMENS-CERPAD module showing the current status of the patient. In this example, icon #1 represents red blood cells, with a combination of two disorders: anemia and malaria, as shown by the popup tooltip. Information on anemia is obtained from the patient's latest blood count and information on malaria is obtained from the thick drop analysis. Icon #2 represents parasitic infections (here, in blood cells, i.e. malaria). Icon #3 shows that the patient suffers from an inflammation, but the location is unknown; it corresponds to a high value of C-reactive protein (CRP), a biological marker of inflammation. Other anatomic pictograms on Mr. VCM are grayed, indicating at a glance that there are no abnormalities observed for these organs (e.g. heart, liver and kidney): either there is no available lab test, or their results are normal.

Figure 1 also shows the timeline, featuring VCM icons and textual labels. To open it, click on the button circled in red on the left of the interface. It shows the icons of the disorders from which the patient has suffered from birth to the current date. It is also possible to visualize the evolution of a given disorder by filtering the icon of the chosen disorder in the legend panel on the right. Icon #4 shows a risk of rhythm disorder in February 2015 (orange color representing risk disorder in VCM). Cardiac pathology was finally diagnosed in November 2017 (icon #5, red color representing current disorder in VCM). A zoom allows the user extending or shrinking the timeline, and permits obtaining more accurate information about the exact date where the diagnosis was made. By clicking on the icon, text information is displayed in a tooltip with more details: biologist's conclusion and/or doctor's diagnosis. It is also possible to get details on the entire results of the laboratory tests or the consultations from which the information comes from.

Figure 1. Visualization of a patient record with Mr. VCM and with the iconic timeline.

All 6 (six) users questioned gave a positive opinion on their overall satisfaction with the use of the icons, the performance of the tools (VCM and timeline) and the quality of the icons displayed. They find that the icons provide reliable and sure information. They think that icons make it easier to interpret data by reducing the time required to analyze and understand the data.

4. Discussion and Conclusions

Many medical data visualization tools exist [2], and timeline is a common approach for visualizing patient records. On the contrary, the use of icons and iconic summaries like

Mr. VCM is innovative, especially for visualizing sickle cell disease specialized health records. Moreover, timeline and icons can be combined together, as we propose here. We have integrated two visualization tools and applied them to the follow-up of sickle cell patients. This approach can be used to monitor sickle cell disease in sub-Saharan Africa.

Thanks to the icons, VCM brings out information that might otherwise go unnoticed in the text data. It enables the biologist to identify in a temporal and instantaneous manner the relevant information that facilitates his tasks when interpreting and writing the conclusion of the results of lab tests. Similarly, the doctor can visualize Mr. VCM and immediately get an idea of the patient's health state and his main disorders.

The timeline provides a very intuitive representation that gives a quick and general overview of the patient's state of health. It makes it possible to present the data from medical records in an iconic and chronological format that meets the expectations of biologists and physicians who want a flexible access to all possible information within a given period of time.

In conclusion, the proposed visual approaches allow biologists and doctors obtaining quick information on the history, pathologies, symptoms, treatments, monitoring... for a given patient. The anatomical schema and the timeline are complementary, but both use the same icons. Our perspectives include a more comprehensive evaluation of this approach, and its extension in other SIMENS modules, beyond sickle cell disease.

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