TIME-ORIENTED MULTI-IMAGE CASE HISTORY – WAY TO THE “DISEASE IMAGE” ANALYSIS

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Abstract: Electron patient records clinical database allows creating integrative presentation links different types of medical information for individual patient on real-time scale. Resulting image, can be confront with "disease image" – non-formalised physician’s perceptions of nosology expression in individual patient’s disease. Normalization of parameters permits data processing based on case-to-case and case-to-cluster comparative and multivariate statistical analysis of the patient’s data.

1 INTRODUCTION

Recognition of diagnostic pictures, uniting different data and parameters in the process of deagnostic of individual patient’s disease can be naimed the creation of "disease image" (Vorobiev et al., 1999). Connecting individual features of patient suffering with general medical knowledge remains the main problem of medicine. This mission will never be solved completely at a tool level because Human Being is the extreme quantum device for making decisions of this kind of problems (Liberman et al., 1998). However organazing data and images from databases and collecting knowledge base about their possible interaction is a real problem for experts and should be studied by mathematic theory.

The verbal characteristic of creative thinking of a doctor hematologist-morphologist experienced in both macro and microscopic investigation of a patient can be put into words: "You are telling me nonsense about this patient! I do see - (hand wave in the air) - the picture of his bone marrow!».

Analysis of disease progression and treatment outcome requires great amount of data with reference to their occurrence on the time scale and causal connections. Most part of this data is avaliable via computer, but there is no instrument to extract them from different uncoordinated databases, to organize them, or at least to collect them on single screen. In this paper we propose a real-time computerized medical system for collecting and storage of clinical information on an individual patient with abilities of immediate verification, analysis and creation of integrated presentation which can be analyzed as the image of the individual case and “disease image”. The Sysem presents way to reduse number of analised variables, selecting the tamplete. The redused set of variables should retain as much of important for treatment information existed in the original variables as possible. Our previose experience was to solve similar problem with Dr. Watson Type System (Goldberg et al., 1995).

2 MATERIALS AND METHODS

We have taken advantage of a traditional system used for logical structuring of data known as “temperature sheets”. This system leading parameters and therapeutic assignments on one sheet of observation have a common time axis. This approach is common in Hematology/Oncology units and it has helped a lot to develop clinical parameters for treatment of acute radiation disease (biological dosimetry, in particular) (Vorobiev, 1970), as well as to improve protocols for treatment of hematological malignancies (Vorobiev, 1977). We used the following steps to generate this instrument:

1. Integration of data stored in different formats (text, tables, roentgenograms, microphotographs, videos etc.);

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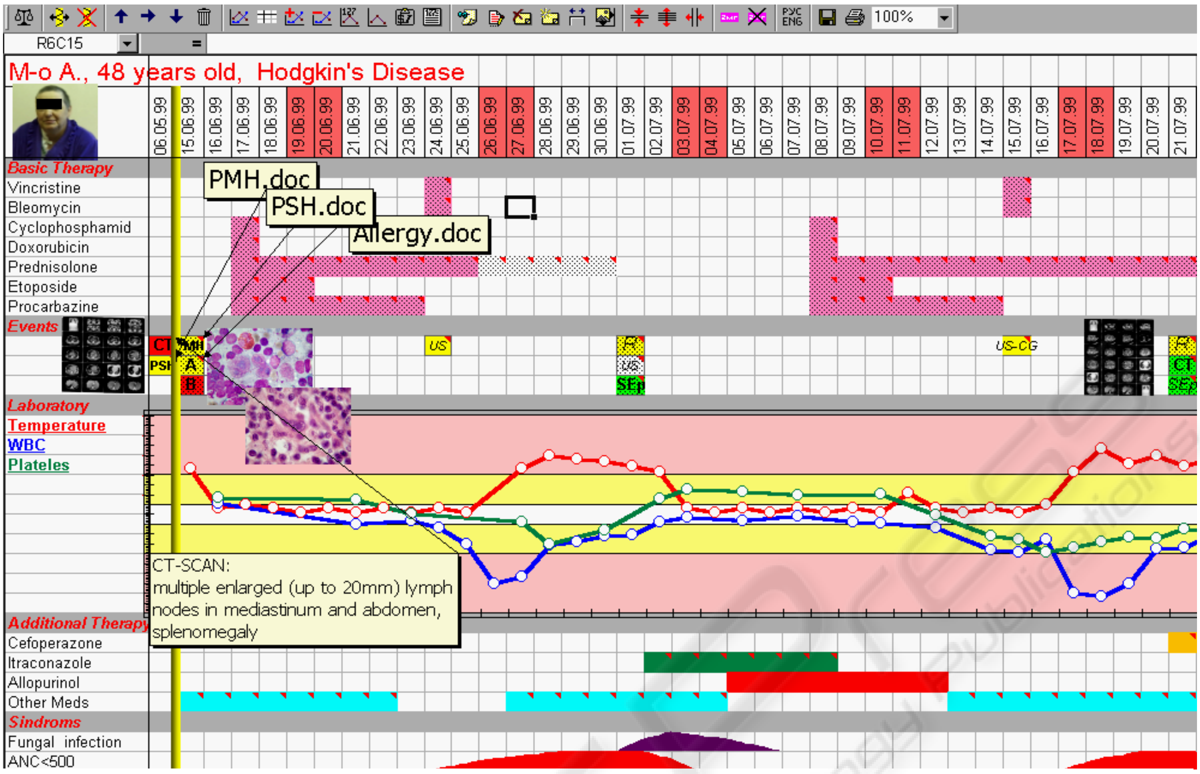

Figure 1: Example of the Page of Dynamic Observation of a patient underwent chemotherapy treatment. Some information presented as marks only, some as small windows. The dynamics of chosen parameters (Temperature, WBC and Platelet counts) are normalized and colour-coded.

2. Compression of clinical data by highlighting important and urgent information;

3. Display of information in an integrated fashion on the same screen;

Automatic matching of entered data with stored timetables derived from established protocols for diagnostic procedures and treatment.

Exit from the assigned limits of selected parameters is similarly controlled.

The data can be plotted manually on the basis of standard case history (wherein the physician acquires medical or diagnostic information and enters it manually on a Page of Dynamic Observation (PDO)), or based on a Time-Oriented Multi-Image Case History (TOMICH) (Shklovskiy-Kordi et al., 1998).

Manual method of entering data on PDO does not require additional devices or software besides a regular PC computer with Microsoft Office and a PDO template in an Excel format. PDO data entry form is an Excel spreadsheet, in which certain rows are reserved for specific type of information (i.e. clinical data, laboratory results, medications, etc.). The software contains a set of templates for widely used clinical protocols and a system for automatic detection of protocol violations.

When a standard protocol is used for management of a patient with known diagnosis, a template is provided with required laboratory data and medications to be used with a timetable for their administration.

The field of the graphical presentation of the “dynamic» indicators - any numerical indicators which change in the time (as temperature, blood pressure, blood counts) essential for the clinical case. The field of flags represent:

- icons which open physician notes,

-icons from which specific additional information can be open . The color of these icons corresponds to the expert evaluation of the importance: “red” - changes the opinion about the illness and lead to a change of the cure tactic; “green” - confirms the diagnosis and the cure tactic; “gray” - does not give a definite answer.

- icons of the planed research, which color depends on the fulfilling.

After filling the “event form”, a cursor tags the event to a “window” for a brief description (i.e. CT scan description on Fig.1). A double click opens a map of all pictures and text files linked to the event.

Normalization. All numeric clinical data is broken into normal, sub-normal and pathological range. This provides normalization of all parameters and presentation on common axes. To define the range of sub-normal values, a team of experts empirically established the scope of “acceptable” (for the given diagnosis and, in some cases, for an individual patient) parameters. If a parameter stays within the defined sub-normal or normal range, no special action is required. If the specific value is out of the acceptance limits, the program generates an automatic alarm signal.

Complications: Complications are recorded on a specific line in PDO and serves to visualize the dynamics of patient’s symptoms. After a symptom/syndrome is selected from a pre-loaded list, a window appears on the screen with a definition and criteria to assist in the diagnosis and management. 4-positions of scale, “x” - lack of the syndrome, “+” - the growth of the syndrome, “-“ - the decreasing of the syndrome, “0” - the state without any changes (stabilization).

3 DISCUSSION

TOMICH has a standard format for presenting key components of patient’s medical record (the constant form of a positional relationship of the basic semantic units of a case history), but also has the flexibility for adding new templates, as necessary for a specific diagnosis. These templates accumulate pre-defined lists of medications, required lab tests and syndromes, and define sub-normal and pathological range of values, as well as color palette for drugs and graphs. Also, the template may refer to the standard protocols for specific diseases or clinical trials stored in the database. Normalization of parameters makes future perspective of the data processing based on case-to-case and case-to-cluster comparative and multivariate statistical analysis of the patient’s data

The beforehand constructed template permits standard recognized images for diagnosis and helps to discriminate general characteristics and specific features for an individual patient. For example, there are accepted criteria for decrease in platelets, leukocyte and hemoglobin in response to chemotherapeutic treatment. We found that comparison of shapes of drug-dependent changes in blood counts is a valuable estimation of outcome (Shklovskiy-Kordi et al., 2004).

In a real-time mode, TOMICH automatically performed data validation and notified a user when selected parameters were beyond acceptable ranges or when the timetable set by the protocol was not followed. These software features permit health care personnel to monitor and correct, when needed, individual actions taken by medical personnel. TOMICH links the actions of medical staff with requirements set by the protocols. Attention of physicians and staff is prompted by a color indicator (Shklovskiy-Kordi et al., 2003).

4 CONCLUSIONS

TOMICH is a convenient and easily automated method for entering all available information about a patient. It may be classified as a decision-support and expert–oriented system, which allows a physician to select a pre-entered template and to modify it for creating the most appropriate template for a particular patient. It provides easy access to primary data and allows generation of a common time-line axis format for multimedia presentation of a patient’s record. The system links different medical information and forms a cognate image of diseases. This presentation allows real-time evaluation of disease and of the response to treatment. Use of TOMICH facilitates the analysis of clinical course and compliance and reduces the probability of medical errors.

Normalization of parameters makes future perspective of the data processing based on case-to-case and case-to-cluster comparative and multivariate statistical analysis of the patient’s data

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