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Technical Requirements to Design a Personal Medical History Visualization Tool for Doctors

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ABSTRACT

A doctor needs to know the patients' medical history to investigate the root cause of symptoms. Traditionally it is done by a questionnaire at the clinic's reception desk, or the doctor asks a series of questions to obtain a relevant medical history. An incomplete or wrong medical history affects the doctor's decision. The challenge for a busy doctor is to obtain all the relevant medical history in a short period of time accurately and without missing any important history. Affordable clinics employ an assistant or junior doctor to sort out all the paper-based medical history and mark the important points. It increases doctors' work performance by saving doctors time and making rooms for consulting more patients. But not all the small clinics can afford such assistants. This paper lists the technical requirements to develop a personal medical history visualization tool to increase doctors' productivity.

Keywords: Health data visualization, Visualization for doctors, Lifelong medical history, Digital health, Portable health clinic

INTRODUCTION

Knowledge about a patient's medical history allows a doctor to gain a good understanding of the patient's problems. It helps to identify the root cause of the current health complexities. Also, it helps to track the health problems and treatments. Usually, a doctor wants to reduce per patient consultation time to accommodate more patients in the queue. Medical 'history taking' takes a longer time during the doctor's consultation. Studies conducted in the United States, India, and Brazil reported that history-taking was responsible for 76%, 78.6%, and 77.8% of all diagnoses made, respectively, and that investigations played complementary roles in excluding other diagnostic options and increased physicians' self-confidence (Benseñor 2003, Roshan & Rao 2000, Peterson et al. 1992). Medical record keeping has evolved into a science of itself. This will be the only way for the doctor to prove that the treatment was carried out properly (Thomas, 2009). Traditionally medical history like prescriptions, diagnosis reports etc. are recorded in paper-based

documents. It is difficult to properly manage them from the patient side. It becomes more challenging for patients who travel a lot to carry all the paper-based past medical records. Thanks to the recent digital transformation movement, most of the hospital/clinics/health service providers maintain digital health records for their patients and it became easier to search the medical history.

However, there are three major limitations- (i) The clinics maintain the medical history of their own patients recorded by them, therefore they cannot see any medical history from other clinics (ii) these medical history/records are not structured in a standard manner, therefore medical history are not interoperable (iii) these medical histories are not allowed to be accessed by physicians from other clinics.

Alabbasi and his team introduced the concept of Personal Health Book (PHB), where a patient can own, operate, and manage his/her own medical history (Alabbasi et al. 2014). A patient can also share his/her own data with other authorized parties such as family members and doctors. Saripalle and others explore and critically analyze HL7 FHIR to design and prototype an interoperable mobile PHR that conforms to the HL7 PHR Functional Model and allows bi-directional communication with OpenEMR (Saripalle et al. 2019). HL7 FHIR ensures the data standards in EHR, EMR or PHRs. To reduce the data sharing limitations Sun & Fang proposed a secure EHR system, based on cryptographic constructions, to enable secure sharing of sensitive patient data during cooperation and preserve patient data privacy. This EHR system further incorporates advanced mechanisms for fine-grained access control, and on-demand revocation, as enhancements to the basic access control offered by the delegation mechanism, and the basic revocation mechanism, respectively. The EHR system proposed by (Sun & Fang, 2010) was demonstrated to fulfill objectives specific to the cross-domain delegation scenario of interest.

There are big advantages to managing personal medical history. It helps the doctors in decision making, it reduces medical errors, it can reduce medical cost and improve the overall performance of medical treatment. Digital health services like Portable Health Clinic (Ahmed et al. 2020) help to maintain individual medical health records for the doctor, patient, and researchers. To understand the medical history of an individual there is a need for the appropriate visualization. Standard medical history record and visualization can help the doctor for effective decision making.

There are existing research activities for medical history visualization. "AnamneVis" (Zhang et al. 2011) uses ICD code for universality, "hGraph" (Ledesma et al. 2016) uses a single graph to visualize limited health data, "Health Timeline" (Ledesma et al. (2019) collects data from multiple EMR/EHRs but selective, "PatientsLikeMe" (Frost & Massagli, 2008) uses a modified Gantt chart to visualize the patient's symptoms and treatment history but no data standardization and integration. However, each of these tools has some limitations and is not fully designed to collect, integrate and visualize the entire health history of a patient and not fully dedicated to the doctor. Our previous work proposed a unique personal health data visualization tool concept named "myHealth View", where a patient's entire medical history

will be visualized in a smart health Gantt chart in one window (Hossain, F & Ahmed 2021). Hypothetically, a standard visualization tool for personal medical history visualization should have the following characteristics: a) visualization of individual health data, b) visualization of the entire health history of a person, c) doctor-friendly, d) easy and quickly understandable health history and e) accurate health history for making the correct decision and providing quality treatment by a doctor. Existing visualization tools have some unique features but those are not sufficient to make quick and effective decisions for doctors.

The rest of the paper is organized as follows- in section, "motivation and objective, we explain current practices and limitations of the maintenance of personal medical history, section "Technical Requirements" lists technical requirements deemed necessary to implement the myHealthView visualization tool. Section "Discussion" discusses the pros and cons of the concept. Finally, we conclude with the current status and future work in the section "Conclusion".

MOTIVATION AND OBJECTIVE

Personal medical history maintenance is not a common practice in developing countries. Usually, people maintain hardcopy prescriptions and diagnostic reports for a few years, not for their entire life. It is quite difficult to maintain an entire life's medical reports manually. Although in developed countries health service providers and doctors maintain electronic health records for their patients, that is only limited for that specific service provider. Standards for archiving and exchanging medical records exist but are not popular even in developed countries.

The World Health Organization's (WHO) draft four-year global strategy on digital health aims to "improve health for everyone, everywhere by accelerating the adoption of appropriate digital health" (WHO, 2019). Maintaining medical records in Electronic Health Records (EHR), Electronic Medical Records (EMR) and Personal Health Records (PHR) are key issues to achieve the digital health goal. These are helpful for the doctors to check the individual medical history of a particular patient. The existing personal health visualization tools have many features to gain different objectives but there is no such tool dedicated for the doctors.

The objective of this paper is to list the technical requirements to develop such a personal medical history visualization tool for doctors to increase his/her working efficiency.

TECHNICAL REQUIREMENTS

This section lists the technical requirements for the visualization tool.

Quick and Accurate View

A smart mechanism is required for a doctor to view the most relevant medical history of a patient quickly and accurately. Figure 1. shows a hypothetical view of the tool. The following components will be required.

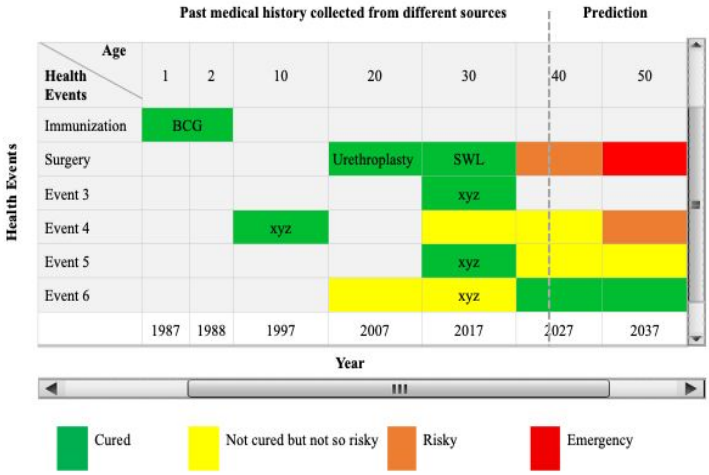

Figure 1: Smart health gantt chart.

Two-dimensional window: X-axis represents the timeline from birth year to standard life expectancy age. Y-axis represents the health events. Each health event can be titled as pre-defined classification, in the health summary diseases names will appear on the screen but it will be programmed following ICD (International Classification of Diseases) 11 (WHO, 2022) or the latest version of this code. This will help to make this Gantt chart a universal standard. Any doctor from anywhere in the world would be able to understand the disease name or health complexities. Summary information could be medication, surgery, diagnosis, doctor visit, immunization, or other which represents the action/activity against diseases.

Color Status: The four-color status will help to understand the urgency of these complications. Here, green indicates 'cure', yellow indicates 'not cured but not so risky', orange indicates 'risky', and red indicates 'emergency'. These will be helpful for a quick understanding of the level of complications of each health problem.

Scrolling and Zooming: This smart health Gantt chart can visualize the medical history of any person, be it a child or an old person. There is no age limit. Scrolling zooming options can help to check the large volume of health data.

In summary, the following features will be required:

- Categorization of health events based on year, age, disease, treatment actions.
- List of diseases based on ICD-11
- Categorization of color status by machine learning programming with preset determinants
- Scrolling and zooming options to accommodate all the health events in one window.

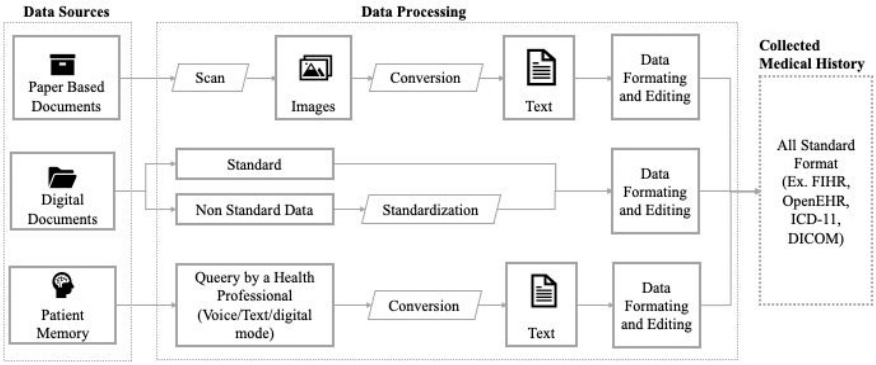

Figure 2: Collection of medical history in a standard manner.

Collection of Medical History in a Standard Manner

Medical history of an individual may not be on a single platform and may not be in the same standard. For the data collection and data integration several steps will be required as shown in Figure 2. Data sources and processing steps are as follows:

Paper Based Documents: Individual medical history can be in paper-based documents (prescription, medical reports, etc.). It will be required to scan the documents to convert them into images. Technologies like Optical Character Recognition (OCR) exist to convert images into digital text.

Digital Documents: Medical history can be collected as digital data from EHR, EMR, PHR or IOT (Internet of Things) devices. These are widely practiced nowadays. There are two kinds of digital data; standard (FHIR/OpenEHR enabled) and non-standard. Standard data can be transferred directly for pre-processing, but non-standard data should pass a gateway to convert into standard format.

Patient Memory: All medical histories of a patient may not be in paper nor in digital documents. A certified health professional can ask questions to obtain the medical history in standard format. It can be done either in text or voice form. Text and voice should be converted in standard medical data format.

To collect standard medical history from three different sources, the following features will be required.:

- Adoption OCR, ASR or STT technology to convert image and voice into text
- All health data should follow the FHIR (Fast Healthcare Interoperability Resources) (HL7, 2019) and OpenEHR (OpenEHR, 2020) standards.
- Data pre-processing/data preparation for checking the errors and to eliminate redundant, incomplete or incorrect data.

Adaptive Behavior of the Tool

The visualization tool should be doctor friendly. Intelligent features can be added to make it smart and effective for doctors.

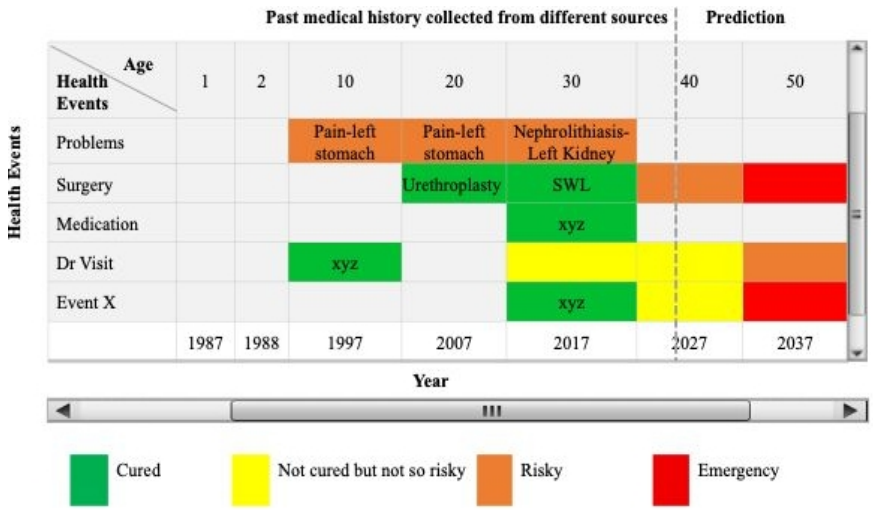

Figure 3: Doctor preference-based health data visualization (Example: for a Urologist).

Doctor preference-based view: An individual may have too many health complexities and may visit different kinds of doctors. For an example, Mr. X has had kidney disease, dental problems, and lower back pain for 10 years and every year he visits the physician. His entire health history is available in the visualization system but when he visits a urologist, the urologist might be interested to see only a urology-related health summary. If all other health data appear in the same window at the same time, it may create confusion for the doctors and it will be time consuming for the doctor to sort out only urology related data. A tool will be required to sort the relevant health events and highlight them as shown in Figure 3.

Prediction of future health status: This smart health Gantt chart could show the prediction of future health status based on available previous medical history. This prediction might be helpful for the doctors in decision making as well as it can be helpful for the patient to maintain a healthy lifestyle. It is not necessary to predict all health events.

In summary, the following two tools will be required to make the system doctor friendly.

- A machine learning based recommender system to visualize doctor discipline based medical history.
- Technology to predict future health status

CONCLUSION

This paper introduces an important issue for the doctors in developing countries. A doctor needs to know a patient's medical history to make an efficient clinical decision. However, the scarcity of doctors in developing countries means that they can spend only limited consultancy time. This paper highlights this issue from our own experience and lists the technical requirements

to build a smart medical history visualization tool to obtain a patient's medical history quickly and accurately. We envision that in the near future, our health activities will be archived digitally, and it will be a challenge for the doctor to sort out the relevant history out of huge amounts of data. Our next task is to develop a prototype to get feedback from the doctors to develop a suitable model. The challenge is to collect the medical history which is not digitally archived. This paper suggests methodologies to obtain untapped medical data.

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