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Review, criteria, and expansions for intelligent personal health record systems

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Abstract

Research on the efficacy of PHR systems is ongoing because of the dynamic nature of this subfield of health IT. To that end, we give an assessment of PHR systems that sheds light on their current state in terms of practicality. Its technological capabilities, as well as our enhancements to a selected PHR system, are shown. We basically undertake a systems assessment on a wide variety of existing options using our own composite evaluation technique, which is based on a requirement analysis. We then detail our research and development towards creating a PHR system with artificial intelligence.

1. Introduction

Electronic health systems (e-health systems) are in high demand all over the world because of developments in healthcare practice, the constraints of conventional healthcare procedures, and the need for adaptable access to health information. PHR systems, which store patients' medical histories electronically, are a novel, promising step in this an emerging field that encourages people to take charge of their health and make educated choices for themselves. The fundamental purpose of a PHR system is to allow the patient to keep track of and manage his own personal health record, which is defined as "the systematic gathering of information on an individual's health and health treatment, maintained in electronic format" [1, 2]. Health records for individuals have been well acknowledged [3, 4] for their potential to enhance healthcare delivery and save costs. Numerous PHR systems and supporting tools have been created in recent years [5]. The spectacular rise and widespread interest in electronic health records (EHRs) has prompted researchers to continue their investigation of the systems' efficacy, efficiency, and usability. In this work, we discuss our efforts in developing a smart PHR system and give an assessment study of many PHR systems that places an emphasis on optimum PHR functionality. This study makes two important contributions. To begin, we provide a streamlined yet comprehensive assessment strategy for PHR systems that we use to analyze existing PHR software. An understanding of where PHR systems are at the moment in terms of features and other key technical aspects may be gleaned from the data gathered in this way. As a second step, we detail our development efforts toward a practical, efficient, and smart PHR architecture that can adapt to different healthcare settings and provide its users with the best possible experience. The findings of This research provides a solid foundation upon which to build the periodic assessment and Implementation studies necessary to keep pace with the rapidly developing area of PHR systems. Here's how the remainder of the paper is laid out: In Section 2, we discuss the gaps in the relevant literature that led us to conduct our own research. After laying the groundwork for our evaluation model with a detailed requirement analysis in Section 3, we go on to Section 4 to explore how we put that approach to use in a comparison of several PHR system implementations. In Section 5, we detail the steps we took to put in place an intelligent PHR system in accordance with the findings of our needs analysis. Section 6 wraps up the report and looks forward to possible follow-up research.

2. Related Work

An ideal PHR system cannot be built in one go; rather, it requires a continuous development effort that will, at regular intervals, receive input from assessment studies in order to achieve peak performance in terms of functionality, architecture, and technical specifications. Many PHR systems have been proposed in recent years, and several empirical analyses have been published [6–16]. The studies in [6-9] evaluate PHR system usability and point up problems with certain systems' usability. Several studies [10–13] examined obstacles to the widespread use of PHR systems and issues that need to be addressed, while others [14–16] examined the functional constraints of PHR systems and tried to define the needs for such programs. Collectively, the findings of this research demonstrate that the vast majority of PHR systems have significant shortcomings and give critical suggestions for improving design procedures. These results should serve as inspiration for the design of new PHR systems or the enhancement of existing ones in order to provide more effective, accessible, and user-friendly alternatives. Further assessment studies are needed to supplement the existing literature [6-16], which has a number of flaws in our opinion. Studies [6–13] are useful for needs elicitation but do not provide specific assessment criteria for PHR systems. However, the studies in [14-16] conduct an in-depth analysis of the needs of efficient PHR systems and make use of this knowledge while evaluating certain PHR system implementations. The work in [14], however, is restricted by the used standards of evaluation. Instead of evaluating how well each system fulfils each category of requirements, the research just notes whether or not those elements are there. Comparatively few systems were used in the studies described in [15, 16]. Both [15] and [16] analyze single research projects in Finland, however [15] only compares two systems, one of which is no longer accessible. Despite the large number of studies that have already been conducted and published, it is clear that "...more research is also needed that addresses the current lack of understanding of optimal functionality and usability of these systems, and how they can play a beneficial role in supporting self-managed healthcare." [17].

3. Requirement Analysis

Here, we examine the fundamental criteria for a robust, adaptable, extensible, and smart PHR system. We utilize these criteria to develop an evaluation methodology for PHR system assessments.

The FOSS Requirement

Free and open source software (FOSS) is increasingly being used to power PHR systems (FOSS). The open source idea seeks to provide users the freedom to change software without worrying about licensing fees or distribution restrictions, whereas the free (license) concept tries to liberate users from the constraints of proprietary software. Tailor the program to each individual's specifications. Considering the global nature of the FOSS community, its solutions tend to be of higher quality and come with more robust technical support. The application of FOSS to the realm of PHR systems yields solutions that promise unrestricted access to the source code, less enterprise-related risks, and a free license to copy, distribute, and modify the software to meet the requirements of the healthcare system. For these reasons and more, we see the availability of a PHR system that is both free and open source as essential.

The Web-based System Requirement

In addition to meeting the other criteria, a PHR system must be accessible over the internet. The portability and adaptability of a PHR hosted on the web are significant benefits. Web-based PHR solutions allow users to access their personal health records (PHRs) from any place with an internet connection and a web browser. A web-based PHR system improves accessibility and does away with the requirement to download and install software. In addition, a web-based PHR system may be simply connected with mobile communication devices, allowing for access to the PHR through not only a computer, but also a smart phone or tablet pc. The rapidly developing field of mobile health [18] provides further reinforcement for this need.

Functionality Requirements

To be recognized as a fully functioning, secure product, a PHR system must adhere to high quality functional requirements. As a step in this regard, we've defined the PHR-S FM [19] Functional Model for Personal Health Records Systems. Following research using the PHR-S FM and a Our basic but complete functionality assessment model is made up of five coarse-grained function categories and descriptions of services at a finer granularity, and was established after conducting a thorough functionality study of various PHR implementations. The primary classification includes all tasks that fall under the headings of "Problem," "Diagnosis," and "Treatment" (abbreviated PDT). We characterize a health triplet as a description of a patient's condition, a medical diagnosis, and a prescribed course of action. All operations involving the logging of health triads are within the purview of the PDT basic category (e.g. patient problem recording, diagnostic tests and treatment surgeries). The information collected by these features represents verifiable facts supplied by medical professionals.

Architectural and Technical Requirements

The last condition, although not strictly necessary, concerns architectural and technological choices made throughout the system's development. The architecture of the system should be meticulously planned, and the implementation should be built on cutting-edge frameworks to ensure it can be easily updated. Modularity and disposability. There are three main types of architectural frameworks utilized for PHRs, and they are known as the "standalone," "tethered and interconnected" models [20, 21, and 1]. Patients are responsible for maintaining the accuracy of their records in standalone PHR systems since they do not automatically sync with other EHR systems. Tethered PHRs are offered as a component of an electronic health record (EHR) system, and as such, they are connected to a health system that is managed by clinicians on the inside. Within the confines of a tethered system, information may be exchanged quickly and simply. PHR systems that are interconnected with other health systems from different vendors (EHR, EMR, etc.) are more advanced. They are able to aggregate data from many sources because of their connectivity, and they also act as an external repository to which other health systems may link.

Requirements Summary

Our overall framework for assessing performance is shown in Figure 1. The section 3.3-described, all-inclusive functionality model is shown in the light blue region. Basic necessities are indicated by the yellow five-pointed star, while additional features are denoted by the green plus sign. Symbol indicates a need for a productive PHR system, but one that is not mandatory.

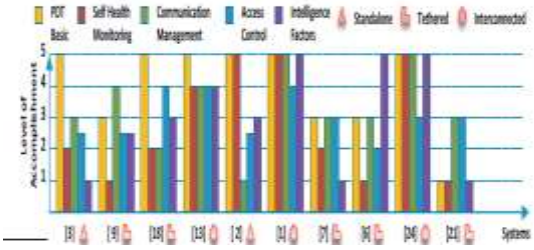
4. Systems Review

Here, we use the previously assessed requirements as criteria to evaluate several PHR system solutions that were found using a systematic methodology provided in [22].

Stage 1 PHR System Review Table 1.

Review	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Free	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	X	X	✓	✓	X	X	X	✓	X	X	✓	X	X	✓	X
Web-based	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	X	✓	✓
Open-Source	X	X	X	X	X	X	✓	X	X	X	X	X	✓	X	X	X	X	✓	X	X	✓	X	X	X	X

There are two phases to the grading procedure. As a first step, we give an analysis of twenty-five different PHR systems against the criteria we call "Web-based, Free and Open Source" (or "W-FOSS"). Each PHR system's ability to meet the W-FOSS criteria is shown in Table 1. The most fundamental take away from this assessment procedure is that only a tiny fraction of PHR systems really meet the criteria set out by W-FOSS. Then, in the second round of assessment, we compare the architectural models of those 10 exemplary PHR systems to their actual functioning. We exhibit the PHR systems' architectural models in Figure 2, along with a metric that indicates how well each system performs in each of the five categories of the functionality model we've outlined. Remember that an IT professional conducted the aforementioned analysis. Unfortunately, space constraints prevent us from providing a detailed description of the procedure. Based on our findings, we can say that most PHR systems fall short of the functional standards we set forth for them, and that linked solutions are head and shoulders above tethered and standalone options. This makes sense, given that its design promotes integration with external resources. We cannot, however, draw the conclusion that connected systems are more functional than isolated ones. There are both high-quality tethered solutions that exceed the capabilities of unmetered ones, and low-quality tethered implementations that fall short. Given that the PHR is often supplied as part of a larger EHR system in the tethered architecture model design, the level of attention given to the PHR's features is left to the discretion of the vendor.



5. Personal Health Record Framework

Here, we detail the work we've done on an intelligent PHR system. In essence, we took the outcomes of the assessment procedure outlined earlier and used them to pick an effective PHR system, which we then used to develop new forms of intelligent behaviour. Our assessment findings reported in Section 4 show that the Indigo-X PHR system best meets our needs. Microsoft Health Vault and Dossier are two more PHR systems that provide a lot of features. However, during the preliminary assessment stage, these platforms did not meet the W-FOSS standards (Table 1). However, as compared to Indivo-X, the successful W-FOSS requirement systems Tolven, MyOscar, and Openers lacked in features. After settling on our PHR system, we tweaked and improved its AI features to meet our needs. In the parts that follow, we detail the software upgrades we've made to Indivo-X and defend our modifications. However, we are limited in space and cannot provide extensive explanations.

Intelligent Data Exchange

Sharing this one, all-encompassing source of health information with one's healthcare professionals and/or family members is a major advantage of PHR [23]. Potentially, this might help close knowledge gaps and improve doctor-patient communication. Conversations and bettering the coordination of treatment for individuals who visit numerous doctors. We've developed new features into Indivo-X to facilitate interoperability with various healthcare platforms. Exporting to common formats including JSON, XML, and RDFS has been included into Indivo-X. Though this is helpful, the majority of healthcare systems only comprehend HL7 communications. To that end, we've built an adaptor that can send HL7 messages. We must emphasize that the content of these HL7 messages is consistent with widely used terminology like SNOMED, RxNorm, and LOINC. The patient may choose to share his information with a particular relative or doctor, or he can export his information straight to an HL7 message consumer. However, importing is also a crucial feature, especially given that most PHR systems need the tedious and error-prone process of manually entering data. The Indivo-X system was modified to directly receive HL7 messages including patient information. Connecting Indivo-X to external services that can respond to SPARQL queries is another handy feature we added. Indivo-X may save data collected directly from SPARQL endpoints, such as forms, lists, etc. Patients will be able to take a more active part in their own health care and will find the information they get to be more relevant and timely.

Profiling Services

In order to create comprehensive patient profiles, a profiling server compiles data from a variety of sources. By including a profiling server, we can better I optimize the flow of information from physicians to patients, (ii) improve the flow of information from patients to doctors based on each individual's profile, and (iii) mechanically detect applicable clinical data, such as open enrolment studies. The PHR (and its add-ons) and the patient's psycho-cognitive information are the cornerstones of our profiling services methodology. We have included a patient profile questionnaire within the Indivo-X PHR system as a step in this direction.

Recommendation Services

Clinicians may be overwhelmed by the sheer quantity of clinical trials and the exclusion and inclusion criteria, which make enrolling patients and discovering appropriate studies for patients a time-consuming manual process. Automatic suggestion is greatly aided by the availability of multidimensional, supplementary data. Healthcare providers and patients both stand to benefit from the introduction of new services. Take, for instance, the process of enrolling participants in clinical studies. We anticipate that the manual examination of fewer patients, CTs, and exclusion/inclusion criteria will be possible thanks to automated matching. Given the breadth of possible solutions, we'll build the recommendation server to be flexible enough to accommodate a wide range of methods and techniques.

6. Conclusions and future work

In this paper, we provide a thorough examination of the criteria that should be met by a powerful and intelligent PHR system, leading to the development of a simple yet thorough evaluation model. We then applied this framework to a wide range of commercial PHR systems; provide a general picture of how things stand right now. Finally, we detailed our ongoing research and development towards an intelligent PHR system, which includes enhancing the Indivo-X PHR platform with smarter features like intelligent data interchange, profiling, and recommendation services. Accessibility of PHR systems for the elderly and the disabled, as well as the evaluation of data quality in a PHR system that may be generated by non-professionals like patients and wellness providers, is two interesting future directions for our work and the generic PHR systems research field, which are only touched on tangentially in [25, 26, and 27]. The clinical efficacy and cost-effectiveness of using PHR systems is another significant yet unproven area for further study. Overall, further research on PHR systems should be undertaken frequently as technology changes and needs are amended, and the findings of the current study may serve as a framework for such studies.

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