

# Highly-Interactive and User-Friendly Web Application for People with Diabetes

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**Abstract** – LifeSensor Diabetes is a module that is coupled with a web-based personal health record (PHR) for patients with type 2 diabetes. In this paper we explain how we designed and built this module. We describe the ICW eHealth Framework and the PHR application on which it is built, the workflow of data acquisition and presentation of the module, the interaction model, and the contextual feedback provided to the users. We also explain the specific techniques used to acquire, validate and display complex, health-related information.

**Index-terms:** *Personal Health Record, Internet, Web Application, Medical Data, Diabetes, Graphic User Interface*

## I. INTRODUCTION

Personal health records (PHRs) provide to patients convenient access to their personal medical data. The benefits of PHRs include improved provider-patient communication, increased patient empowerment [1], and decreased duplication of tests/procedures. Moreover, advanced PHRs can offer consumer health content that is tailored to a given patient's health history. These benefits of PHRs are particularly important for patients with chronic diseases such as diabetes. Indeed, the most relevant and useful PHRs are those that permit patients to manage complex diseases via esthetically-appealing, user-friendly interfaces.

## II. EMPOWERING THE PATIENT

### A. Involving the Patient

To optimize their usefulness, PHRs must be designed such that they fully engage patients during all the phases of the health care value chain: prevention, long-term care, rehabilitation, etc. [1]. These applications must be securely accessible to patients and their caregivers at anytime and from anywhere [2] (e.g., at home, the office or while traveling).

The success of the services offered by such applications can be measured by the frequency of use. In turn, the more that the patients use PHRs, the more accurate and complete are the underlying data set. Likewise, the usefulness of PHRs increases as the data stored in these applications becomes more comprehensive.

### B. Patient Benefits and Satisfaction

Previous studies [3] [4] [5] [7] suggest that PHR designers should consider the following issues if they wish to create a successful application:

- Security, confidentiality and privacy are of great concern to patients.
- Patients need a better way to track non-acute concerns that are often overlooked or ignored.
- Having instant access to their personal record enhances the patient's sense of being in control of their health.
- Patients value instant feedback.
- Any unmet expectations can quickly lead to frustrations.
- Personal health information must be complete and accurate.

With this in mind, we have designed a diabetes care module to maximize usability and user satisfaction. We also attempted to create an enjoyable experience for the user while providing relevant and valuable information to patients about their health condition.

## III. ARCHITECTURE OF LIFESENSOR DIABETES

InterComponentWare's (ICW) personal health record (branded as LifeSensor) is a layered, multi-tier web application which can be accessed by a web browser, a set of web-services, or a software development kit. Each tier is composed of a certain number of modular services. These modules offer a variety of business, presentation and integration functionalities (e.g., data persistence, device integration, electronic communication, etc.).

The LifeSensor PHR itself is built upon the ICW eHealth Framework. This framework provides lower-level infrastructure modules and libraries conforming to HL7 standards and others. The framework enables health application developers to build interoperable, cutting-edge web applications. The ICW eHealth framework consists also of a set of very powerful tools to support the complete software development lifecycle and to help produce quickly a

lean and consistently high-quality code. It also offers a deployment and runtime environment for healthcare solutions in general.

We used both the LifeSensor and ICW eHealth platform to build the LifeSensor Diabetes module. As a result, it is similarly layered and composed of multiple tiers (presentation, business logic, persistence).

#### IV. DATA ACQUISITION AND PRESENTATION

##### A. *Minimizing Initial Data Acquisition*

Users of the diabetes module begin by completing a profile with information such as gender, age, height and weight; and personal targets for diabetes markers such as A1c and cholesterol levels. To make the user experience more interesting and personal, we also offer the patient the possibility to personalize the application. For example, the patient is able to designate a support buddy who will receive information about the patient's progress toward his or her goals.

We reduce the initial data acquisition phase for the user profile to a minimum by offering a quick succession of four optional steps with initial default values for some of the data. Existing historical data, coming from the patient record of the PHR can also be preloaded into the diabetes module. As a result, the user can start to see instant feedback and a preview of what type of information will be provided if he or she decides not to complete the profile during first user session. For example, the home page will summarize the motivation information together with place holders for goal progress and quick entry fields for today's blood glucose results.

##### B. *Motivate the User to Reuse the Application Regularly*

After completing a profile, the user selects one or more action plans that will help them attain their health targets. These action plans pertain to important disease management issues such as diet, exercise, medications and self-testing. On a regular basis, users can track their progress toward completion of these action plans. They may also log specific measurements such as self-monitored blood glucose levels and blood pressure readings. The input of data is facilitated by dynamically offering tips and default recommended values from professional associations such as the American Diabetes Association.

##### C. *Offering a Pleasant User Experience*

During the design phase, we focused on optimizing the responsiveness of the graphical user interface. To this end, we minimized the number of page refreshes and the communication between the presentation layer and the business logic layer.

#### V. INTERACTIVITY AND USABILITY

The diabetes self-care process is very complex. On a daily

basis, people with diabetes must pay close attention to their diet, to their activity level, and to their medication schedule. LifeSensor Diabetes was created to help people manage these numerous tasks. Given the functional complexity of this web application, we deemed it necessary to focus on usability during the design process. This attention to user experience resulted in two important design features: simple, fun functionality and rich contextual feedback.

Perhaps the best example of fun features in LifeSensor Diabetes is what we call the "slider". When a user wishes to log her daily activity level, she drags a button on the slider bar to the appropriate value. As the user drags the button, the slider bar fills with color, appearing much like mercury rising in a thermometer. Another example of a fun feature is the awards system. Upon completion of a goal, the system awards a virtual trophy to the user. We believe that the "fun" aspect of LifeSensor Diabetes results in more frequent usage of the application.

A good illustration of contextual feedback in LifeSensor Diabetes would be the body weight data-entry field. When a user logs his current weight, the input field will turn green if that weight is below the user's target, or red if the weight is above his target. This feedback is delivered immediately without requiring a page refresh.

Following the first iteration of LifeSensor Diabetes, we identified certain areas of usability upon which we can improve. For example, we believe that if we gather data automatically from glucometers, it will greatly improve user satisfaction. The ICW eHealth Framework and LifeSensor currently provide support for devices integration. We intend to use these current features to extend LifeSensor Diabetes. Another possible improvement would be to add auto-completion functionality for certain data entry fields (e.g., meta data such as who ordered a test, where the test was performed, etc.).

We also believe a module specialized in a chronic disease such as diabetes should be able to communicate, exchange and combine data from other add-on modules of the PHR to take into account the fact that a large number of the patients using this module might have other health related problems such as heart disease, obesity or depression. Thus, future development work will focus on integrating LifeSensor Diabetes with other modules.

#### VI. TECHNOLOGY USED

In the presentation layer, we use original widgets and rich graphic content to make the application very appealing to the users. Relying heavily on technologies such as AJAX and FLEX, the module provides a high-degree of interactivity. Furthermore, these technologies ensure rapid system performance by minimizing the number of page refreshes and

the communication between the presentation layer and the business logic layer.

By using a reliable, specialized web application framework based on proven open source technologies and tools (AJAX, FLEX, JSF, Java Enterprise, Spring, Hibernate, Maven, Eclipse), we were able to focus on navigation, content, usability and user-friendly features rather than on infrastructure components. We were able to quickly design and develop our diabetes module by building on top of the LifeSensor stack and by using the development, building, testing and deployment tools of the ICW eHealth Framework. Parts of this proprietary framework are to be released as open source software in the Open eHealth Foundation that was established by ICW, SUN Microsystems, and Agfa HealthCare at HIMSS08 [6].

We were able to quickly design and develop our diabetes module by building on top of the LifeSensor stack and by using the development, building, testing and deployment tools of the Open eHealth Framework [8].

## VII. CONCLUSION

A specialized web application module for people with diabetes will most likely be valuable and used on a regular basis if it provides them with useful information and instant feedback for their illness, but also personal satisfaction. This can be achieved by offering to the patient a very responsive and user friendly interface to manage accurate and relevant personal data in a private and secure environment.

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