E-Diabetes: A Low Cost Approach to Diabetes Care in India

Jagit Singh Bhatia, Center for Development of Advanced Computing, India; E-mail: jsb@cdac.mohali.stpi.in
Mandeep Kaur Randhawa, Center for Development of Advanced Computing, India; E-mail: mandeeprandhawa@cdac.mohali.stpi.in
Harpreet Kaur, Center for Development of Advanced Computing, India; E-mail: harpreet@cdac.mohali.stpi.in
Sagri Sharma, Center for Development of Advanced Computing, India; E-mail: sagrisharma@cdac.mohali.stpi.in

ABSTRACT

As a result of our R&D efforts, we have developed an integrated telemedicine application "e-Diabetes" in accordance with the vision of Govt. of India to provide multi-specialty healthcare to all at an affordable cost. Its primary aim is to develop a world-class telemedicine technology solution for providing health care to all at affordable cost. This paper describes the potential benefits made available by this technology in diabetes care, and how this new E-Diabetes solution complements the daily care of diabetic patients. This Telemedicine Diabetes Application will deliver diabetic care to the patients of under-served rural areas of India at very low cost.

Keywords: E-Diabetes, Tele-Radiology, Tele-Cardiology, Tele-Pathology, Internet Information Services (IIS), Electronic Medical Recorder (EMR)

I. INTRODUCTION

Diabetes in India is increasing in prevalence, and now considered an epidemic. The World Health Organization (WHO) has concluded that India, which has the largest number of diabetic patients (32 million in 2000), is expected to have nearly 80 million patients by 2030. E-Diabetes is an emerging technology for the delivery of patient care in diabetes through telemedicine. Telemedicine has the potential to improve the delivery of health care in India by bringing a wider range of services such as radiology, pathology, cardiology, mental health services and dermatology to underserved communities and individuals in both urban and rural areas. At present, the position of diabetes care in the rural areas of India is not good. The number of primary health care centers in the State is less and thus vital medical facilities necessary for the population are not provided.

In rural areas of Northern India there is a high prevalence of curable diabetes disease, which remains untreated due to lack of resources. E-Diabetes can help the population of Northern India by providing specialized medical care, services and treatment to the patients in the far flung, remote and inaccessible areas from the specialty hospitals. Thus to provide effective solution to such an increasing number of diabetes cases, Center for Development of Advanced Computing (C-DAC), Mohali, India has taken an initiative in designing a web based E-Diabetes solution.

Deployment of "e-Diabetes" will help the poor and needy sitting at remote and rural places where specialized treatment is not available. With this the poor can easily have the advice of the specialists and suffer less.

II. VISION

I. Primary Stage

The purpose of this research work was to design and implement a Web-based e-Diabetes system tailored to provide an expert advice in the intake of insulin dose.

Initially following design goals were set:

1. The system should be tailored to support the workflow of the developed store-and-forward telemedicine software 'Sanjeevani'.
2. The system should be Web-based for true Internet operation.
3. The system should be built upon Open Source components and support multiple platforms for the ease of adoption.
4. The system must be secure and user friendly.

II. C-DAC & Telemedicine

Centre for Development of Advanced Computing (C-DAC), Mohali (Erstwhile CEDTI) is a premier Institute of Ministry of Communications & Information Technology, Govt. of India. CDAC is working in the field of Telemedicine since 1998 and has successfully developed state of the art telemedicine application packages namely, Sanjeevani and e-Sanjeevani that complies with the International telemedicine Standards.

We have established telemedicine sites at various locations in India. Our first endeavor was establishing telemedicine sites at AIIMS, New Delhi, PGIMER, Chandigarh, and PGI Lucknow. We expanded it in the second phase to connect three more medical colleges namely, IGMC, Shimla, Medical College in Rohtak and Cuttack.

Our second effort is to establish telemedicine sites at different states of Himachal Pradesh, and in rural areas of Punjab.

III. Objectives

E-Diabetes is a web-based application and its beta version is hosted on a central server for trial purposes at present. It can be opened with common Internet browser being bundled with any operating system software installed on the computer. The most sophisticated technology on date for developing web based solutions, namely ASP.Net has been used.

By integrating e-Diabetes with our existing Telemedicine software we hope to prevent diseases related to diabetes like cataract, kidney failure, Heart attack, BP, Neuropathy in those areas of Northern India where basic health amenities are not available.

The telemedicine diabetes care procedure aims:

1. To make available the expertise of the specialists at institutes like PGI Chandigarh, to common people at remote places.
2. To improve communication of the patient with the hospital-based diabetologist, in between the patient's visits to the specialized clinics.
3. To allow doctors to assess the patient's condition on a frequent basis.
4. No need to move the diabetic patient from remote areas to specialty hospital at far away places unnecessarily.

IV. Features of E-Diabetes

1. User-friendly interface facilitating doctors to navigate through the database.
2. Comprehensive Electronic Medical Recorder (EMR) with unique patient ID.
3. Structured investigation using clinical reports.
4. Secured environment through encryption and hashing algorithms.
5. Standard communication protocols.
6. Single point entry for operation through user name and password.

7. Multi-point, Multi-referral access to a number of Tertiary Institutes.
8. Central repository to keep the large patient data for backup.
9. Cost effective as no system softwares are required.
10. The application is designed for supporting client server Internet environment.

This e-Diabetes application uses forms authentication for the purpose of security. Every hospital that intends to use this application is provided with an administrative level user name and password. The administrator need not be a computer knowledgeable individual. Their duty is confined to creation of user names and passwords for the doctors employed in their hospital. Only the administrator is allowed to create accounts for doctors for security reasons. The user information passwords have been stored in encrypted form in the database table carrying users' information.

Other than e-Diabetes following modules are also part of E-Sanjeevani application software. Provision of inclusion of other modules is also there which can be implemented as per the requirement of the site.

1. Tele-Radiology
2. Tele-Cardiology
3. Tele-Pathology
4. Nephrology

III. WORKING MODEL

The system's architecture comprises of following main components: the Medical equipment, Workstation, Application software, Video-Conferencing to be used by rural based physicians and nurses at Health Centre in rural areas, and a telemedicine workstation, Multi-Videoconferencing Kit used to provide consultation to multi hospitals at same time at specialist centres in urban areas.

A dedicated internet website, allows the physician to monitor daily blood glucose information of the patient, and allows the patient to access his own blood glucose patterns. With the use of the developed e-diabetes software the doctor or other paramedic staff present at remote area health centers will enter the patient's diabetes data. Then the expertise doctors at institutes like PGI Chandigarh, will provide consultation to the common people at remote places. In the Software, analysis of Diabetes values can be made on daily, weekly or monthly basis by these expert doctors to provide feedback on the amount of insulin intake.

The basic functions of e-Diabetes application software include:

- Telemonitoring of patient's blood glucose data.
- Self-management actions, and
- Remote care from doctors to diabetic patients.

The developed software can handle up to four of 16 possible insulin types. Patient details like Carbs intake, Blood sugar, Protein, Cholesterol, Calories and weight values are filled in his EPR (Electronic Patient Record). The daily Average Line and Bar Graph of all these test figures is available to the doctor present in remote area as well as to the specialists in the urban area hospitals, which helps them to provide an expeditious care to the diabetic patient. Line graphs (Fig 1) and Bar chart graphs and the Print Colors option added to the Graph provides a visual effect to the readings and thus helps in better analysis of the patient data.

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Through consultation between two or more geographically separated physicians and with the availability of accurate and updated patient's diabetes data, an improved patients' glycemic control is achieved. Hence the use of telemedicine diabetes will allow diabetes case management of patients at remote distance and in those cases, where an in-person case management visit is not available or not feasible.

Work flow of the e-Diabetes solution once it is implemented at Health centers of rural areas in Northern India is as shown in Fig.2

Figure 1. Line graph using dummy diabetes values

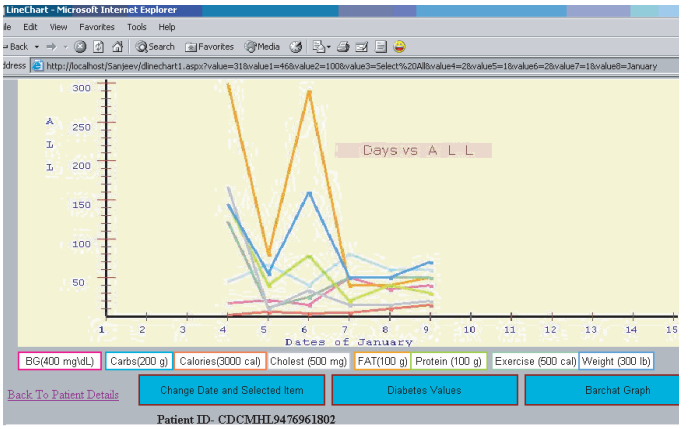
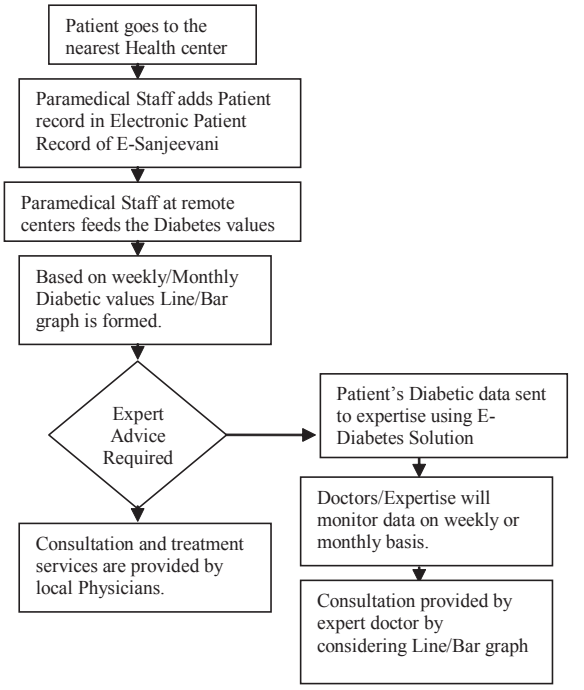


Figure 2. Work flow of e-diabetes



IV. APPLICATION ARCHITECTURE

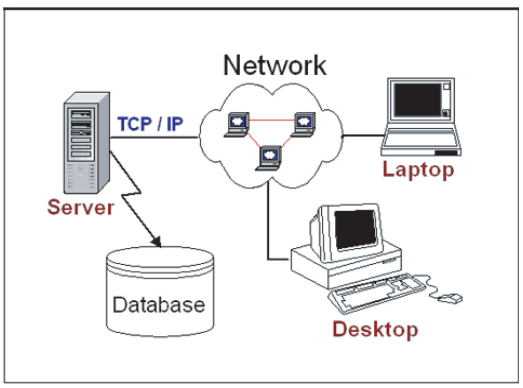
Web applications use client/server architecture. The Web application resides on a server and responds to requests from multiple clients over the Internet, as shown in Figure 3.

I. Client/Server Interaction in a Web Application

The Web application composes responses to requests from resources found on the server. On the client side, a browser hosts the Web application. The application's user interface takes the form of HTML pages that are interpreted and displayed by the client's browser.

On the server side, the Web application runs under Microsoft Internet Information Services (IIS).

Figure 3. Web application architecture



IIS manages the application, passes requests from clients to the application, and returns the application's responses to the client. These requests and responses are passed across the Internet using Hyper Text Transport Protocol (HTTP).

Web applications are much like traditional Web sites, except that the content presented to the user is actually composed dynamically by executable, rather than being served from a static page stored on the server.

The executable portion of the Web application enables you to do many things that you can't do with a static Web site, such as:

1. Collect information from the user and store that information on the server
2. Perform tasks for the user such as placing an order for a product, performing complex calculations, or retrieving information from a database
3. Identify a specific user and present an interface that is customized for that user
4. Present content that is highly volatile, such as inventory,

pending order, and shipment information

What makes a Web application special is that the client/server interaction takes place over the Internet.

II. Platform Chosen

ASP.NET is the platform that we have chosen to create Web applications that run under IIS. ASP.NET provides a high level of consistency, easy to create, debug, and deploy across Web application development.

V. CONCLUSION

During the ongoing trial period, large set of feedback records from the expert doctors and effect of remote Doctors and patients will be studied to develop novel measures of diabetes control in Northern India. Simultaneously many more specific measures will now be considered to update the presently developed beta version of e-Diabetes.

Thus this paper describes the potential benefits made available by this technology in diabetes care, and how this new e-diabetes solution complements the daily care of diabetic patients. This telemedicine diabetes application will deliver diabetic care to the patients of under-served rural areas of India at very low cost.

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