Impact of a Web-Based Diabetes Program and Personal Health Record on Diabetes Quality of Care

Jay A. Johnson, MD, FACC, and Rahul Singal, MD

Summary

Diabetes mellitus is a chronic disease that affects approximately 6.2 percent of the adult U.S. population. Improvement in diabetic, glycemic control, and risk-factor modification has been shown to reduce complications of the disease and can result in reduced healthcare expenditures. The objective of this study was to evaluate the impact of a web-based education program and personal electronic health record (EHR) on glycemic control and risk-factor modification in patients with diabetes in a large employer group. Patients with the diagnosis of diabetes mellitus were identified and given a $15 incentive to participate. The tools provided feedback on goals for glycemic control (hemoglobin A1C), and risk-factor modification (cholesterol, blood pressure control). Participants' data (total and LDL-cholesterol, HbA1c, and blood pressure) were imported into the EHR, used in the web-based educational tools, and transmitted electronically to the treating physician. Data were collected at baseline and six months after the program onset.

Key Results

- After six months, participants had a significant reduction in HbA1C from 8.0 percent to 7.3 percent ($p = 0.039$), whereas the control group had no change (7.7 percent to 7.7 percent; $p = 0.49$).
- Total cholesterol also fell during study period in the participant group (187 to 171 mg/dl; $p = 0.024$) but increased in the control group (188 to 198 mg/dl, $p = <0.01$).
- Similar results occurred with LDL-cholesterol.
- These data suggest that a web-based diabetes education program with feedback on laboratory data and recommended treatment goals can significantly improve glycemic control and cholesterol measurements in an employee-based population of patients with diabetes. The magnitude of improvement seen would be expected to result in a healthier population and reduced healthcare expenditures.

TYPE 2 DIABETES MELLITUS is a serious medical condition with potentially devastating complications. In the past two decades, the number of Americans diagnosed with diabetes has more than doubled.[1,2] Currently there are an estimated 18.2 million people in the United States with diabetes. The direct and indirect cost of diabetes care in 2005 is estimated at more than $132 billion.[1] Appropriate management of diabetes and associated risk factors has been shown to reduce the incidence of cardiovascular disease[3] and many other the devastating complications,[4] and lower healthcare costs.[5] Currently, however, the quality of diabetes management in the U.S. does not keep up with evidence-based practice guidelines.[6] Preventive care and screening practices also lag behind. In 2003, more than 30 percent of U.S. adults with diabetes did not receive an annual foot or eye examination.[7]

Patient self-management education is an integral part of the treatment plan for diabetes, according to accepted national standards.[8,9] Involving patients in their care improves diabetes management, adherence to treatment and screening recommendations, glycemic control,[10] and outcomes.[11] Patients with diabetes have an added burden over those with other chronic diseases in that they must understand treatment goals for risk

factors, such as hypertension and high cholesterol, and preventive services recommendations in addition to blood glucose management. Several computer-based patient education models have been shown to improve diabetes management.[12] However, utilization depends on access, ease of use, and readability of the information. Web-based tools are emerging as effective educational programs and provide the opportunity to shift the focus of diabetes management toward patient self-management[13], but little is known about the impact of using the web in the clinical care of patients with chronic disease.

The merger of personal electronic health records (EHR) with web-based educational tools offers an opportunity to improve patient self-management of diabetes.[14] The Institute of Medicine has identified key features of patient-controlled personal health records, which can lead to improved quality of care.[15] Electronic health records alone have not been shown to improve the quality of diabetes care.[16] Combining patient-controlled EHR with educational support has been proposed as an effective mechanism to improve diabetes care. To date, we are aware of no study examining the impact of combining web-based educational tools with electronic personal health records on the effectiveness of diabetes management. This study was designed to determine the impact of a web-based educational tool containing laboratory data accessible through a personal EHR on the quality of diabetes care—in terms of glycemic control and risk-factor modification.

Methods

A web-based, consumer-focused, health education and decision support system (WorldDoc Inc., Las Vegas), incorporating personal EHR and electronic healthcare provider visit (e-visit) technology served as the platform for the study. The system includes a chronic care decision-support tool for diabetes that incorporates a diabetes "report card," which was developed in collaboration with the National Association of Managed Care Physicians (NAMCP, www.namcp.org) described below. The advisory board of WorldDoc Inc. approved the study design, and all participants gave informed consent and authorization to release personal health information to their providers.

Participants

A large employer group (Coast Hotels and Casinos Inc., Las Vegas) served as the population base of study participants. Pharmacy claims data (patients receiving anti-diabetes drugs) were used to identify those with diabetes. All individuals identified as having diabetes were notified by postal mail of the program, were offered an incentive of $15 to participate, and asked to

Exhibit 1: Baseline Characteristics of the Study Group

Characteristics	Participants (n=91)	Control (n=163)	P Value
Sex			
Male – no. (%)	45 (49%)	93 (57%)	
Female – no. (%)	46 (51%)	70 (43%)	
Age			
Years	54.5	52.6	0.066
Glycosylated hemoglobin			
(%)	7.9	7.5	0.195
Systolic blood pressure			
(mmHg)	129	133	0.082
Total cholesterol			
(mg/dl)	187	183	.453
LDL cholesterol			
	106	104	.411

complete a survey assessing their current understanding of diabetes management. Participation in the program was voluntary, and kept confidential, so the employer was not aware of individual participation.

The medical care for this population is provided by a single, large medical group, which allowed a central source for collecting laboratory and biometric data. Laboratory data (most recent hemoglobin A_{1C}, total cholesterol, and LDL-cholesterol) and most recent blood pressure were imported into the personal EHR for all patients with diabetes in accordance with privacy and security standards.

Intervention

Participation in the program required each person to create a user name and password on the web-based health management system (WorldDoc Inc.) and complete a diabetes assessment questionnaire as part of the chronic care management tool. The tool provides participants with an assessment that includes a diabetes report card displaying user-specific information on treatment goals, care-gap analysis, risk-factor management, and screening tests and examination status in an easy-to-understand format. The tool provided each user with a concise summary of his/her results (from the EHR), as compared to the recommended target or treatment goal for each of the following measurements: hemoglobin A_1, blood pressure, LDL-cholesterol, body mass index, dietary intake, fitness level, and smoking status. In addition, a summary was provided showing how the user's prior care compared to recommendations for the timeliness of the following screening examinations and tests: urine protein, retinal examination, foot examination, influenza immunization, hemoglobin A_{1C} testing, blood pressure measurement, and lipid profile testing.

Assessment results are customized based on the participant's answers to the questionnaire and treatment guidelines published by national organizations including American Diabetic Association[9] (hemoglobin A_{1C} and screening examinations), National Heart, Lung and Blood Institute, JNC7[17] (blood pressure), and the Adult Treatment Panel III report[18] (cholesterol).

The assessment results were stored in the user's personal EHR and accessible through his/her secure web portal. In addition, the assessment results were delivered electronically to the healthcare provider of each participant and follow-up with the provider was encouraged. Data were collected from the healthcare provider via the EHR system.

Results

Among a total of 5,545 employees, 319 (5.8 percent) were identified as having diabetes. Laboratory and biometric data were available on 254 employees. The average follow-up was six months. Out of the 254 patients with diabetes, 91 agreed to participate in the program, and the remaining 163 nonparticipants served as a control population. The baseline characteristics were similar in both groups and are shown in Exhibit 1. HbA_{1C} data were available for 65 percent of the study participants and 66 percent of the controls. On average, neither group was at the recommended HbA_{1C} goal of less $\leq$7.0 percent, or the LDL cholesterol level of $\leq$100 mg/dl at baseline.

During the six months following web-based diabetes education and goal setting, HbA_{1C} fell significantly from 8 percent to 7.2 percent (P=0.039) in the participants but not in the controls (7.5 percent to 7.9 percent, P=0.498). See Exhibit 2.

Similarly, total cholesterol and LDL cholesterol were reduced in the participants (from 187 to 171 mg/dl,

Exhibit 2: Hemoglobin A_{1C}

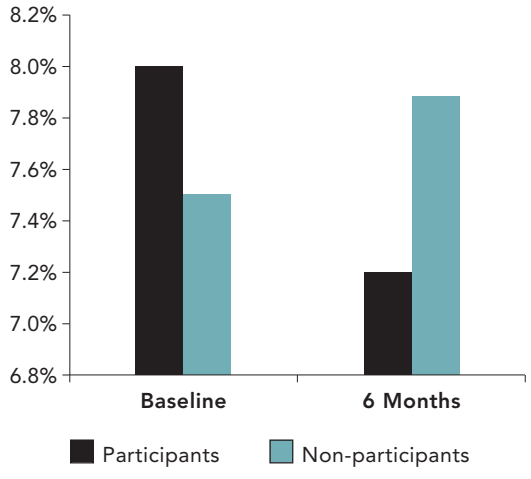
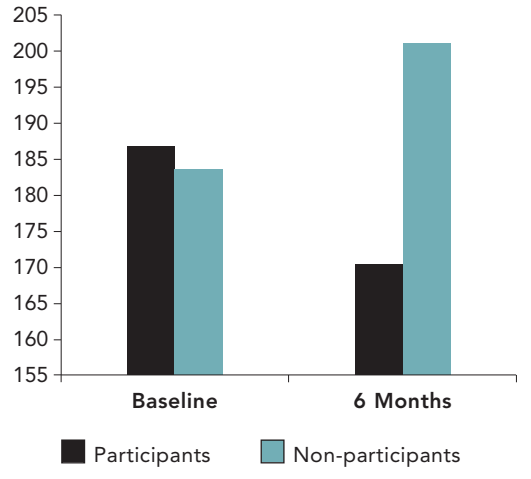


Exhibit 3: Total Cholesterol



P=0.024, and from 106 to 94 mg/dl, *P*=0.054, respectively) and not in the controls (183 to 202 mg/dl, p=0.285, and 104 to 115 mg/dl, *P*=0.335 respectively). See Exhibits 3 and 4. There was no significant change seen in systolic blood pressure between the two groups, see Exhibit 5.

Discussion

These results demonstrate the effectiveness of combining a web-based education and decision-support tool with a personal EHR in improving quality of care management of diabetes. Improvement was seen in glycemic control and in risk-factor modification—cholesterol reduction. These results were similar in men and women and are consistent with other studies demonstrating the positive impact of patient education programs on glycemic control in patients with diabetes.[19]

The magnitude of the improvement in HbA_{1C} in the treatment group (-0.80 percent) is a clinically significant reduction that would be expected to result in improved clinical outcome. This is a larger reduction than seen in other studies. In a meta-analysis of 31 studies of self-management education for adults with type 2 diabetes, Norris et al. showed an average reduction of 0.76 percent initially in the treatment group as compared to the controls, but only 0.26 percent by six months.[10] The same study demonstrated that a high degree of patient contact was needed for most education programs. The authors estimated 23 hours of contact were needed for every 1 percent absolute reduction in HbA_{1C}. Therefore, a reduction of 0.8 percent, as seen with this self-guided education tool, compares favorably to other methodologies.

Several factors could explain the greater-than-expected improvement in glycemic control seen in this study. One important factor is that the education program used in this study focused on patient empowerment and emphasized the importance of each patient knowing that the HbA_{1C} target of 7 percent included feedback of user values, and involved the care providers. Other studies have involved more didactic education methods. It is noteworthy that the population was a relatively well-managed group at baseline. It has been suggested that it is more difficult to have a positive impact on the management of a well-managed group as compared to a population with a poor quality of care. It would be reasonable to expect a greater impact of this method on a more poorly managed population with diabetes.

This study was not designed to assess the impact of improved diabetes management on healthcare expenditures. Early studies suggested that there is a high incremental cost in improving glycemic control[20] and that it takes a long time for improved glycemic control to result in improved outcome,[20] raising economic concerns about the willingness of employers and health insurers to implement such programs. In contrast to this idea, more recent studies have shown that quality management of patients with diabetes to achieve target levels, after controlling for confounding factors, can result in a 32 percent reduction in healthcare expenditures over one year.[22] Gilmer et al. support this notion and suggest that HbA_{1C} at any one time independently predicts healthcare cost over the subsequent three years, and they propose that a reduction in HbA_{1C} would be followed by a substantial reduction in costs.[23] Therefore, the magnitude of impact on diabetes control seen in this study would be expected to significantly reduce healthcare expenditures.

Future Direction

The rapid growth of information technology and its applications to healthcare create many possibilities

Exhibit 4: LDL Cholesterol

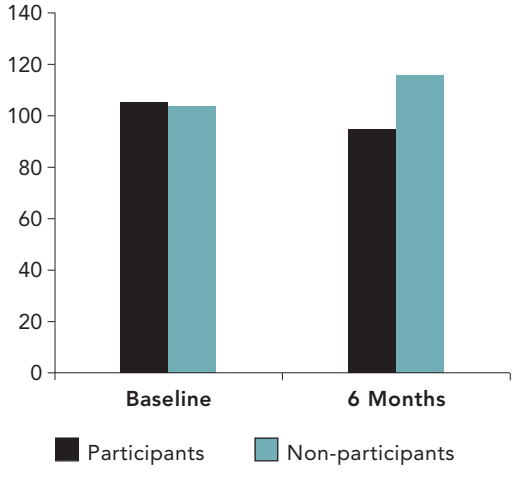
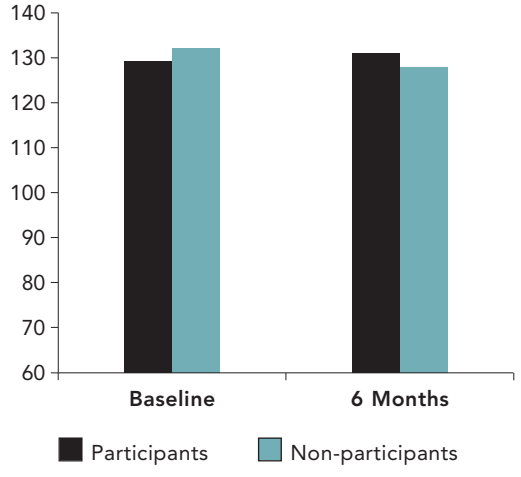


Exhibit 5: Systolic Blood Pressure



to expand on the model of patient empowerment and more active involvement of patients in the delivery of healthcare and management of disease. The more ubiquitous use of the Internet, in combination with portable, secure personal health records, offers an opportunity to provide meaningful, personal information and goal-setting on an ongoing basis. Engaging providers and health educators in personalized interactions with patients can further enhance the involvement of patients in their care.

Studies that include variations of this model are currently under way. Examining the flexibility will provide important insights into the applications of this program to a variety of populations. Adding predictive modeling to stratify the diabetics into appropriately targeted programs, excluding physician involvement, and expanding patient contact with outbound communications are some of the variations that need to be investigated.

Advances in methods for collecting and storing data, such as home monitoring equipment with wireless and telecommunication capabilities linked to web-based personal electronic health records, will provide an opportunity to put patients at the center of their healthcare delivery systems. Additional incentives provided by the consumer-driven healthcare models in which patients understand the health and cost implications of their choices will impart even more control on the patient. The healthcare provider and the patient working as a team, with full transparency of practice standards, treatment goals, and therapeutic options, could create a setting for unprecedented quality-of-care improvements.

Limitations

This study has several limitations. It was a small group in one geographical area. The control population was not randomized, but rather self-selected as nonparticipants, possibly introducing bias. Other parameters, such as biometric data—weight, height, waist circumference—and medications were not measured. The study was not designed to measure the impact on clinical outcomes or healthcare expenditures. A single medical group provided the medical care for this population. This allowed for easy access to pertinent data, but is a situation that is not reproducible for many other populations.

Conclusion

A web-based diabetes education and goal-setting program, which focused on patient empowerment and included personal electronic health records for laboratory data feedback, resulted in a significant improvement of glycemic control and cholesterol reduction compared to a nonparticipant control population. The improvements were seen in six months and with a relatively simple, low-cost intervention. **JMCM**

Jay A. Johnson, MD, FACC, is an attending staff physician with Stanford University Medical Center and chief medical officer for WorldDoc Inc., an online consumer education and decision-support service based in Las Vegas. **Rahul Singal, MD,** is CEO for WorldDoc, Inc. in Las Vegas.

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