

The HealthPia GlucoPack™ Diabetes Phone: A Usability Study

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ABSTRACT

Background: Type I diabetes is a common chronic disease of childhood. Both the growing influence of peers and the shifting away from parental influence have been implicated as prime elements contributing to poor glycemic outcomes in adolescents. Mobile technology that can be directed towards providing self-management support and modifying potentially negative child-parent interaction holds promise to improve control in adolescents with diabetes.

Methods: HealthPia, Inc. (Palisades Park, NJ) has developed a prototype system, the HealthPia GlucoPack™ Diabetes Monitoring System, which integrates a small blood glucose monitoring device into the battery pack of a cell phone. A pilot study used mixed quantitative and qualitative methods to evaluate user satisfaction with the integrated system, including the potential of the device to transmit self-monitoring data to a website for review and analysis by clinicians, parents, and patients.

Results: Adolescents in our study liked the integration of the two technologies and agreed that the glucometer was easy to use and that the tool was useful in the management of their diabetes.

Conclusions: Future work will focus on the utilization of the diabetes phone as a component of a care delivery system for adolescents with diabetes, including involvement of the health care team and enhancement of the web services that support the use of the phone.

INTRODUCTION

TYPE I DIABETES is a common chronic disease of childhood.^{1,2} Many children, especially adolescents, have suboptimal control of their blood glucose levels, largely resulting from still-developing self-management practices.³⁻⁶ Although increasing insulin resistance during adolescence may contribute to this, the social and developmental needs of growing adolescent have also been suggested as factors contributing to the poor self-management often observed in pediatric patients.^{5,7,8} Both the

growing influence of peers during adolescence and the shifting away from parental influence have been implicated as prime elements contributing to poor glycemic outcomes. Clearly, any intervention that hopes to improve an adolescent's competence in diabetes self-management will have to address this developmental dynamic.^{5,9,10} In this context, mobile technology that can be directed towards providing self-management support and modifying potentially negative child-parent interaction holds promise to improve control in adolescents with diabetes.

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BACKGROUND

Adolescents, as a group, typically experience poor glycemic control.^{11–14} Certainly some of the reasons for this are beyond the control of any child. However, adolescents are in a transitional period—from children who are cared for by their parents to young adults who are more responsible for self-care, independent judgment, and self-directed problem solving. The challenges of this transition materialize in all sectors of growth and development, including the management of a chronic condition, such as diabetes. Parents, concerned about their child's well-being, often try to dictate or enforce therapeutic behavior to their child who is expected to "be responsible" for his or her diabetes self-care. In a recent study by our group, adolescents with type I diabetes admitted that they did not test as much as they were supposed to.¹⁵ This apparent lack of responsibility caused great anxiety in their parents who worry about the long-term complications associated with the disease.¹⁶ The resulting conflicts between parent and child were viewed as a key point of stress in their relationship. Too little or too much parental involvement can lead to poor control and adverse outcomes.^{17–19} Clearly, finding a balance can be difficult.

Mobile technology may be usefully applied to help parents and their adolescent children with diabetes negotiate a more effective communication style surrounding their self-management. Cell phones can create an active link between the adolescent and both parents and health care providers. When a cell phone is directly linked to glucose monitoring technology, it can have the ability to provide self-management data directly to the adolescent's health care provider so that parents are not solely responsible for monitoring their child's management. We hypothesize that if parents are aware that their children have an active link to their health care provider, and that they can use the technology for self-management decision support, reductions in problems associated with parental hypervigilance and manipulation of the regimen would occur.

To explore this and other potential interventions, we conducted a series of focus groups with adolescent diabetes patients and their parents. Ten focus groups were conducted involving a to-

tal of 59 participants (28 parents and 31 adolescents between the ages of 13 and 18 years). At the conclusion of the groups, the participants were introduced to a prototype cell phone that had a glucose monitoring system integrated into the device. It was explained that test results could be automatically sent to a host computer for review by either parents, providers, or both.

When considering technology in general, the adolescents indicated that they want their testing equipment to integrate into the social realm in which they live, to be "cool," and to mimic devices already ubiquitous in their peer groups.¹⁶ The integrated glucometer cell phone was viewed positively in these terms. They were willing to accept such devices as a safety net for glucose excursions, but preferred that their parents did not get values as they are checked. Interestingly, they were not opposed to the health system, including their physicians, receiving real-time values. From this initial qualitative study, mobile technology appears to be an excellent vehicle for meeting the needs and desires of adolescent patients with diabetes.¹⁶

Parents in the focus groups indicated that the demands of diabetes self-management required their children to assume more responsibility than was the norm for children their age.²⁰ However, this transfer of management had not absolved parents of their feelings of responsibility. They reported often finding themselves caught in an impossible situation—letting go of some things while pushing others. Parents felt that mobile technology that created a link among parent, provider, and adolescent could help them to navigate the fine line between helping their children and nagging them.²⁰

HealthPia, Inc. (Palisades Park, NJ) has developed a prototype system that integrates a glucose monitoring system onto a conventional cell phone. The HealthPia GlucoPack™ Diabetes Monitoring System has a small blood glucose monitoring device integrated into the battery pack of a cell phone (Fig. 1a). The device consists of a strip sensor, analog circuit, microcontroller unit, communication interface, and phone input/output. When the strip is inserted, a current is generated and passed through the measurement device, converted into a voltage, amplified, and then sent into the microcontroller unit. Analog data from the mi-

crocontroller unit are converted to digital data according to the measurement table and temperature correction table. These data are then sent to the specific phone input/output protocols. The information is sent both to the phone display (Fig. 1b) and to a secure server through a cellular signal. The software for the phone application is supported on many platforms, including BREW, J2ME, and WIPI.

Glucometer data are transmitted to a server that, through a website, allows patients, parents, and clinicians to view these blood glucose values in a number of formats over a secure Internet connection (Fig. 2). The user can also use the cell phone to discuss therapeutic options with his or her provider. By supporting self-management this combination of features has the potential to reduce parent-child conflicts around diabetes management. The HealthPia GlucoPack has been studied for accuracy and safety, and has received Food and Drug Administration approval.

Usability study

A pilot study was initiated to evaluate user satisfaction with the integrated system, including

the potential of the device to transmit self-monitoring data to a website for review and analysis. These data would be instrumental in making changes to the device and system before engaging in further studies. In addition, the user satisfaction with the web system and the ease of transmission of measurements was evaluated.

SUBJECTS AND METHODS

The pilot study was conducted in the pediatric endocrinology clinics at the Riley Hospital for Children in Indianapolis, IN. These clinics care for the majority of children and adolescents with diabetes in the state of Indiana and beyond. There are over 20 practitioners at these sites caring for over 800 adolescents with diabetes.

Identification of patients

All patients in the Pediatric Diabetes Clinic were invited to participate in focus groups discussing their diabetes and how mobile technology might be used to improve the manage-

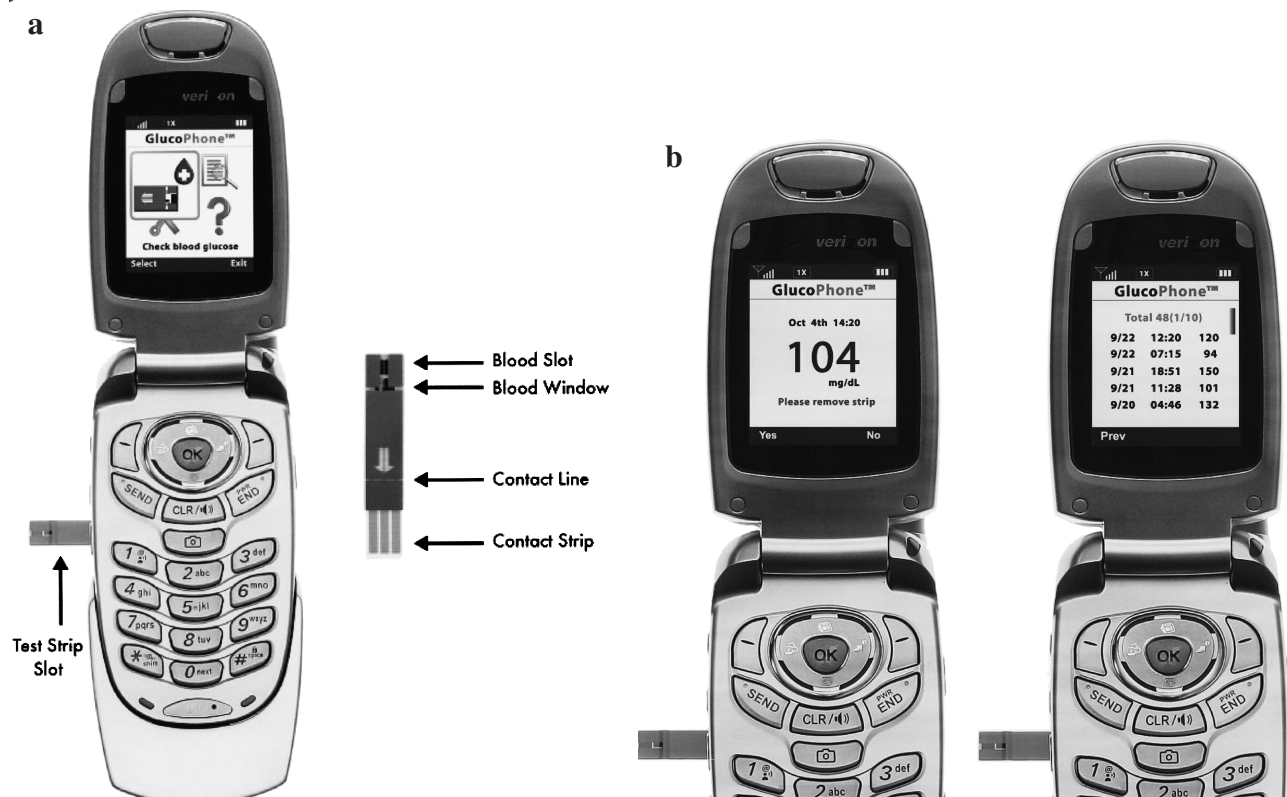


FIG. 1. (a) The HealthPia GlucoPack Diabetes Phone. (b) Phone displays of blood glucose value.

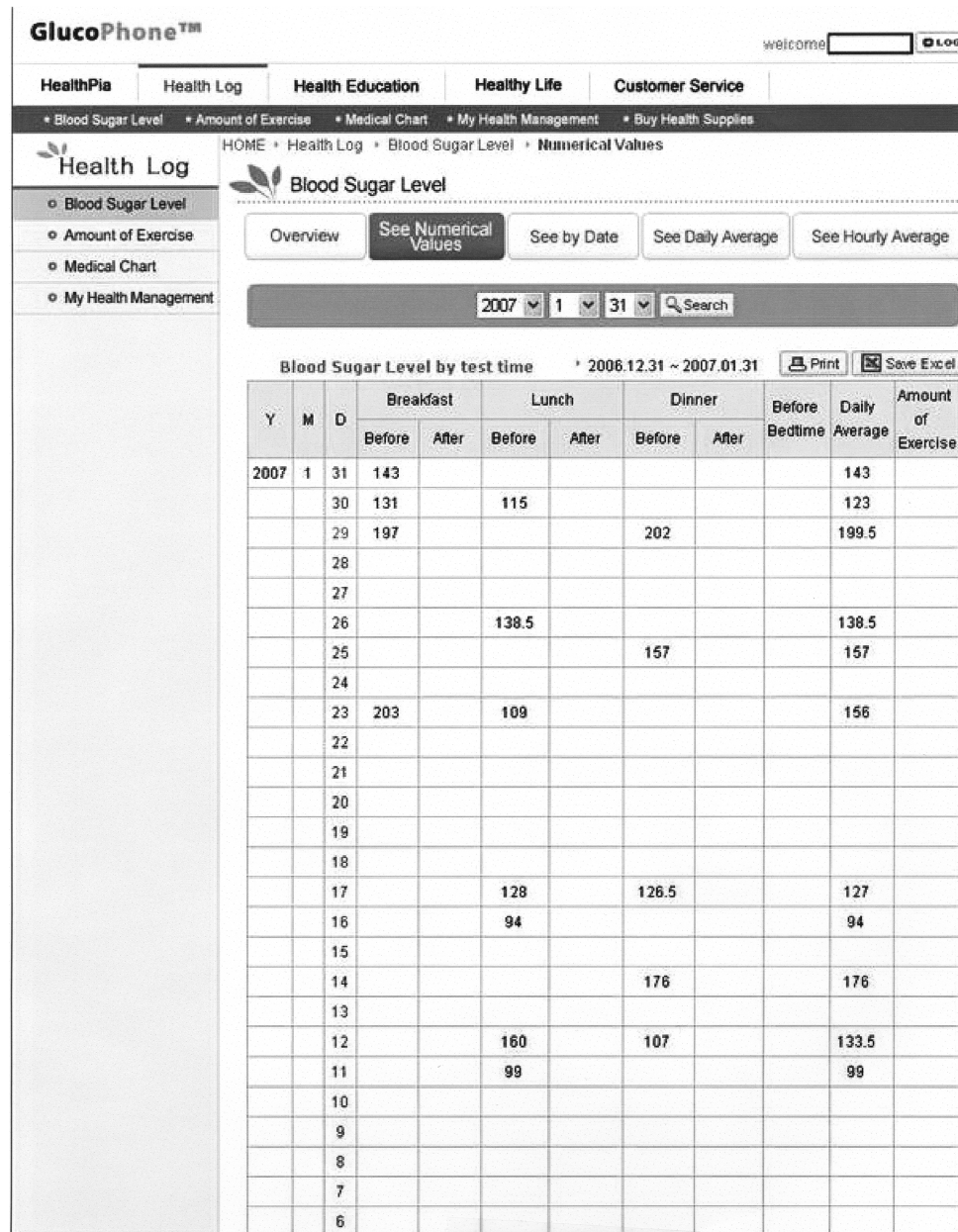


FIG. 2. The HealthPia secure website displaying blood glucose history.

ment of their condition.^{15,16} Participants for this study were volunteers from that sample. The characteristics of these patients were previously reported and were felt to be a reasonable representation of different types of patients from excellent to poor control.^{15,16} The study was restricted to 10 children between the ages of 13 and 18 years with type I diabetes. Eligibility criteria also included grossly normal cognitive development and having no other chronic diseases except well-controlled asthma. Adolescents in the study had to intend to re-

main in the care of participating clinics for the extent of the study, have access to a telephone, and be literate in English. In addition, all subjects had to have parental consent to both participate in the study and to use a cell phone during the duration of the study.

Patient consent

After identification, families of potentially eligible participants were contacted by letter and recruited in a visit to the investigator's office.

Only one patient per family was allowed to participate. During the consent process, specific rules concerning the use of the cell phone for telephone interactions were described. Ten participants were recruited for this study.

Participation incentives

Participating adolescents were given the cell phone for the length of the study. All phone charges were paid for by the study. In addition, subjects were provided test strips for the integrated glucose meter.

Procedure

Subjects were oriented to the diabetes phone system by a member of the research team. They were provided the device and an instruction manual detailing its use. The adolescent and his or her parent(s) and research team member went through the manual together, and any questions were answered. Each adolescent and/or parent was also oriented to the use of the HealthPia website, and its potential functionality for tracking glucose measurements, exercise, and diet. The patient and parents were provided with the means to contact study personnel with questions throughout the course of the study. As a precaution, adolescents were instructed to confirm each glucose reading on their usual glucometers; to maintain a real-world setting, however, we did not monitor this any more than actual testing would be monitored. For the purposes of this study, there were no changes made to the clinic's procedures or monitoring of glucose values as our intent was to assess the usability of the device, not how it changed behavior. Therefore, many potential uses of the device (such as feedback or decision support) were not utilized.

Outcome measures

Our focus in this study was assessment of usability. These data were collected from the 10 adolescent participants after 3 months of using the mobile technology. Usability data were collected with an instrument composed of 15 questions scored, using a 7-point Likert scale, ranging from 7 ("strongly agree") to 1 ("strongly disagree"). These questions assessed ease of tool use, fondness of technology, usefulness in

diabetes management, and impact on relationships with physicians and others (i.e., parents and school). The survey instrument also allowed participants to identify features of the tool that they particularly liked or disliked.

RESULTS

Data were collected from all 10 participants in this study. The mean age of the participants was 15.5 years, 50% were male, and most were Caucasian (80%). Descriptive statistics were used to assess participant perceptions of the mobile technology after 3 months of use. These findings are summarized in Table 1. Although no statistical tests comparing the use of the device to their normal glucometers, as this was not the issue being studied, participants reported that they used the device the same amount or more than they did their normal glucometers. In general, participants reported that they were very fond of the mobile technology, liking the size of the diabetes phone (mean = 6.3, SD = 0.82), having their glucometer contained within the cell phone (mean = 6.6, SD = 0.97), and using the diabetes phone as a communication tool (mean = 6.6, SD = 0.84). Although mean scores were not quite as high, participants agreed that the glucometer was easy to use and that the tool was useful in management of their diabetes. Participants were more neutral in their feelings about the usefulness of the diabetes phone website (mean = 4.2, SD = 1.55). Concerning the impact of the mobile technology on relationships with others, the adolescents agreed that the diabetes phone made it easier to get along with their school (mean = 5.1, SD = 1.91), but were not favorable about the impact of the phone on the relationship with their parents (mean = 3.7, SD = 1.95). Participants were neutral in their perceptions about whether the mobile technology made it easier to get along with their physicians (mean = 4.0, SD = 1.25) and whether it made it easier to contact their physicians (mean = 4.1, SD = 1.45). Participants did, however, indicate that utilizing the diabetes phone made them contact their doctors less often (mean = 3.5, SD = 1.18).

Features of the diabetes phone that partici-

TABLE 1. PERCEPTIONS OF THE MOBILE TECHNOLOGY TOOL TESTED

	<i>Mean</i>	<i>SD</i>	<i>Minimum</i>	<i>Maximum</i>
Ease of tool use				
1. It is easy to place the required amount of blood on the test strip.	5.1	1.73	2	7
2. It is easy to obtain a blood glucose reading with the diabetes phone.	5.3	1.06	4	7
3. The directions for the diabetes phone are easy to follow.	6.6	0.70	5	7
"Fondness" of the technology				
4. I like the size of the diabetes phone.	6.3	0.82	5	7
5. I like using the diabetes phone.	6.6	0.84	5	7
6. I like having my glucometer in a cell phone.	6.6	0.97	4	7
Usefulness to diabetes management				
7. I found the diabetes phone to be useful for my diabetes, as a whole.	5.3	1.49	3	7
8. I found the cell phone, alone, to be useful for my diabetes.	5.9	1.73	2	7
9. I found the diabetes phone website to be useful for my diabetes.	4.2	1.55	2	7
Impact on relationship with others				
10. The diabetes phone made taking care of my diabetes easier.	5.0	1.76	2	7
11. The diabetes phone made it easier to get along with my parents.	3.7	1.95	1	7
12. The diabetes phone made it easier to get along with my school.	5.1	1.91	1	7
Impact on relationship with physician				
13. The diabetes phone made it easier to get along with my doctor.	4.0	1.25	1	6
14. The diabetes phone made it easier to contact my doctor.	4.1	1.45	1	7
15. The diabetes phone made me contact my doctor more often.	3.5	1.18	1	5

pants particularly liked included the number of test results stored (60%), size of the phone (60%), the cell phone service itself (80%), fast analysis of test results (60%), and the easy-to-follow directions (80%). Thirty percent of participants cited that they found it difficult to easily apply the correct amount of blood, and 20% disliked the internet website. In all, however, 80% of participants said they would consider purchasing the diabetes phone for their own use.

DISCUSSION

We conducted preliminary testing of an integrated mobile tool for use by adolescents with type I diabetes in the self-management of their disease. This diabetes phone integrated cell phone technology with a blood glucose monitor that allowed for test results to be transmitted automatically to a host server that maintained a website where the patient and his or her health care providers can view the results. The patients were also able to utilize the cell phone directly to discuss therapeutic options with his or her provider.

Adolescents in our study liked the integration of the two technologies and agreed that the glucometer was easy to use and that the tool was useful in the management of their diabetes.

Participants also indicated that the diabetes phone had a positive impact on their relationship with their school. However, participants did not feel that the diabetes phone had a positive impact on their relationship with their parents or their physician. This is not surprising given that this usability study did not involve active participation of clinicians or the health care system.

Our methods have several limitations that warrant consideration in interpretation of our findings. This study was not randomized or blinded in any way. Therefore, we can draw no conclusions about the effect of the diabetes phone on any significant outcomes. This was not, however, the objective of the study, which focused on participants' perceptions of the device. We also did provide the incentive of free cell phone use, which may have had an impact on how users felt about the device, and we did not directly measure frequency of use of the device. Finally, this study was limited to 3 months, and actual use of the device was not studied.

Future work will focus on the utilization of the diabetes phone as a component of a care delivery system for adolescent diabetics, including involvement of the health care team and enhancement of the web services that support the use of the phone. This work will look

more specifically at the impact on patient glycemic control, quality of life, and competence in diabetes management. Future work will also determine if the diabetes phone, as part of a health care system, can affect family dynamics as well as the patient's relationships with other parties such as physicians, peers, and his or her school.

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