Original Paper

Diabetes Educators’ Insights on Connecting Smartphone- and Wearable- Collected Self-Monitoring Information to a Nationally Used Electronic Health Record System for Diabetes Education

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Abstract

Background Diabetes educators are integral to clinical team in providing diabetes self-management education and support, current mobile and web-based self-management tools do not support diabetes educators’ efforts in utilizing these tools integrated into clinical diabetes care.

Objective The purpose of this study is to seek diabetes educators’ insights in developing an interface within Chronicle Diabetes system, a nationally used electronic health record system for diabetes education documentation with behavioral goal setting functions, to transfer smartphone and wearable collected self-monitoring information from patients to diabetes educators to facilitate behavioral goal monitoring.

Methods A descriptive qualitative study was conducted to seek educators’ perspectives in usability and interface development preferences in developing such a connected system. Educators can use the Chronicle Diabetes system to set behavioral goals with their patients. Individual and group interviews were used to seek educators’ preferences on how they would like to view smartphone and wearable tracker collected diet, physical activity, and sleep information in Chronicle Diabetes system using open-ended questions. Interview data were transcribed verbatim and analyzed for common themes.

Results Five common themes emerged from the discussion. First, educators show enthusiasm and concerns for viewing diet and physical activity data in Chronicle. Second, educators value viewing detailed dietary macronutrients and activity data; however, they prefer different kinds of details depending on patients’ needs, conditions, behavioral goals, and educators’ training background. Third, all like integration of smartphone-collected data into Chronicle Diabetes and preferably with current electronic health record (EHR) systems. Fourth, a healthcare team and central EHR system needs to be formed for educators to share summary of self-monitoring data
with other providers. Fifth, Educators desire advanced features for mobile application and
connected interfacethat can show self-monitoring data.

**Conclusions** Flexibility for educators to track details of smartphone- and wearable-collected diet
and activity information is needed, and integration of such data into Chronicle Diabetes and
EHR systems is valuable for educators to track patients’ behavioral goals, provide diabetes self-
management education and support, and share with other health care team members to facilitate
team care in clinical practice.

**Keywords:** Wearable, connected health, mobile health, diabetes, self-management, lifestyle
intervention, electronic health record, self-monitoring, behavior modification, usability
Introduction

Research has demonstrated the effectiveness of behavioral lifestyle intervention that focused on goal-setting and diet and physical activity self-monitoring in improving glycemic control for type 2 diabetes patients [1]. Recent efforts had used mobile and web-based technologies to enhance the goal setting and self-monitoring interventions in diabetes care [2, 3]. A recent systematic review of reviews examining the literature on technologies used for diabetes self-management education and support revealed that four essential elements in effective technologies in improving glycemic control: communication, patient-generated health data (PGHD), education, and feedback [4]. However, the highlighted technologies that enabled 2-way communication and patient-generated health data did not mention utilization of electronic health record systems (EHR) that health care provider team used on a daily basis for care management or connection of PGHD to EHR. Furthermore, previous studies only demonstrated the effective use of mobile [5, 6] and web-based systems [7, 8] that are not connected with EHRs in supporting diabetes self-management behaviors. Connected systems that engage both patients and clinical health care providers and diabetes educators are essentially important to ensure expert care for diabetes patients while taking advantage of engaging patients in self-care behaviors through mobile health technologies including smartphone applications and wearable trackers. Thus far, none of the published literature has explored the integration of PGHD collected via mobile technology to EHR to facilitate translation of effective technology-based interventions into clinical practice.

Diabetes educators are frontline health care professionals providing diabetes self-management education and supports for diabetes patients across the United States [7]. Chronicle Diabetes
system is a nationally used web-based system for diabetes education documentation with behavioral goal setting functions, which is freely available to all American Diabetes Association (ADA)- recognized diabetes education programs [9]. While it is a comprehensive system for diabetes educators to set, document, and track behavioral goals, ways to monitoring and follow up patient behavioral goals can be challenging for both patients and diabetes educators. [9] In order to facilitate the evidence-based goal setting and self-monitoring intervention into the diabetes education process, we propose to use Chronicle Diabetes system currently available to diabetes educators to set patient diet and physical activity goals, and connect patient self-monitoring information collected from mobile devices to Chronicle Diabetes system to facilitate educators’ monitoring of patient adherence to their goals. To seek educators’ insights in developing an interface within Chronicle Diabetes system, we conducted individual and group interviews to gain educators’ perspectives on usability and interface development preferences in developing such connected system.
Methods

A qualitative descriptive study was conducted to investigate diabetes educators’ insights in developing an interface within Chronicle Diabetes system to connect mobile collected self-monitoring information. Individual and focus group interviews were used. One moderator used a protocol with open-ended questions to obtain detailed information on mobile collected information and how diabetes educators would like this to be shown in Chronicle Diabetes system [10].

Sample and Setting

The diabetes educators were recruited from western PA, where Chronicle Diabetes system was first implemented, and Houston, TX, where educators had little knowledge about the system, in order to get a balanced sample of educators’s views on such system. Educators were informed of the study through an email. Those who replied to the email and expressed interest were then invited to participate in the study. The study was approved by the University of Texas Health Science Center at Houston and University of Pittsburgh Institutional Review Boards.

Chronicle Diabetes System

Chronicle Diabetes system provides tools for diabetes educators to document, track, and report on their patients’ education process according to the National Standards for Diabetes Self-Management Education and ADA education recognition program (ERP) requirements. Educators use Chronicle Diabetes system to record required behavior goals at baseline, and continue, modify, or discontinue them at follow-up visits with their patients. The 7 goal categories are: nutrition, activity, medications, monitoring, prevention and treatment of acute complications, prevention and treatment of chronic complications, psychosocial adjustment/healthy coping. Patient goal achievement at baseline and follow-up can be scored at 0%, 25%,
50\%, 75\%, and 100\%. In addition to goal setting, patient education plans and program processes are recorded. After the 1-to-1 or group class education session is completed and documented, all aspects of the education process are automatically summarized in a format that meets ADA ERP documentation requirements.

**UP 24 Jawbone Wristband and Companion Smartphone Application**

UP 24 by Jawbone is a wristband that objectively tracks individuals’ physical activity and sleep, along with a companion smartphone application showing these tracking information, as well as features to search/track food intake.

**Data Collection Procedures**

The moderators are comprised of an experienced researcher who understands both Chronicle Diabetes and Jawbone UP 24 systems, and a developer who developed the Chronicle Diabetes system and was going to develop the interface in Chronicle to integrate Jawbone collected information. Interview questions were based on what Jawbone UP24 can provide with its app and wristband tracking devices. Educators were shown PowerPoint slides with images containing this information and were asked about which information is more valuable for them to see and use during diabetes education and how they would like to view such information in Chronicle Diabetes system. Eight diabetes educators responded to the recruitment email and participated in either an individual or group interview. The interviews were recorded using a digital audio recorder.

**Data Management and Analysis**

Topics discussed in the interviews were centered on the usability of the features in Chronicle and Jawbone UP24, and specifically how educators would like the Jawbone UP24-collected information to be displayed in Chronicle Diabetes system. All audiotapes were
transcribed verbatim in English by a professional transcription service company. Transcribed data, combined with the notes taken in interviews, were analyzed to identify recurring themes, using content analytic methods[11, 12] appropriate to our qualitative descriptive methodology. Two trained professionals independently reviewed the transcribed qualitative data and developed a categorization scheme to organize the data. Using the categorization scheme, all transcribed texts were coded, themes and categories were developed and concluded. Instead, they think physicians may be able to obtain information indirectly from other health care providers, such as an educator or a dietician. In case of divergence of opinions, two coders had open discussions to come to an agreement. Common themes emerged from the analysis, together with example quotations, were presented.
Results

Sample Characteristics

Eight diabetes educators (3 RNs, 5 RDs) were recruited from Pittsburgh, PA and Houston, TX. They had an average of 22 years of general practice and an average of 13 years of practice experience in diabetes education. On average, the participants had approximately 1.75 years using Chronicle Diabetes system.

Thematic Analysis Findings

Five individual interviews and one focus group were conducted. Each interview lasted from 30 to 60 minutes, and all six interviews generated about 233 pages of transcribed texts. There are five common themes emerged from the interview responses.

Enthusiasm and concerns for viewing self-monitoring data in Chronicle Diabetes.

All diabetes educators showed strong enthusiasm to view diet and physical activity information in Chronicle Diabetes system. Some educators consider certain information on diet and activity data are more or less important than other information. Most educators do not think monitoring sleep is necessary unless patients have sleep disorders, or they feel that sleep data is beyond the scope of diabetes education practice, while one educator considered total hours of sleep may be helpful to understand general health of the patients.

“if I was visually looking at it, my number one things would be calories, carbs, protein, and fiber... But I work in the Weight Management Center, and protein and fiber are all we really focus on.”
“Total active time..total burn calories would be important for me... I would like to know total times that they’re active throughout the day... total burned calories would be important so we know...their caloric intake is matching up or negative, if they want to lose weight.”

“I wouldn’t exactly know what to do with all the information (sleep). Like if some, if somebody ... sleep apnea, you could talk about it, but it’s not something I’m as familiar with as a diabetes educator.”

Some educators express their concerns regarding how often patients monitor their activities. They think constant self-monitoring can cause patients to feel overwhelmed. Instead, they prefer patients monitor themselves only for a few weekdays or on weekends, and educators can still detect discernable patterns in patients’ self-monitoring behaviors. Another concern that the educators have is patient compliance. Data collected on mobile device might not exactly reflect patients’ real activities because some patients may log their data based on how their behaviors are perceived by health care providers. Also, some patients may not be fully compliant with self-monitoring on a regular basis.

“Don’t overload them” “Don’t put the expectations so high-“ “So there’s a lot of information on that page that might be a little bit overwhelming, even from my perspective, as a professional.”

“... it would be used mainly for educational reasons, but after a while...I think that patients would get wise to it and put in the food that look good... “

“...after a couple of months, if they’re seeing that they’re not pleasing their physician
or whoever is looking at this stuff, they’ll start putting in the things that they know calculate to be the right thing.”

Varied preference toward different kinds of details depending on patients’ needs, conditions, behavioral goals, and educators’ training background.

Educators value viewing detailed dietary macronutrients and activity data. When viewing patient self-monitoring data, some educators factor in patients’ health conditions and status to select specific information that are more relevant to individualized diabetes education.

“…RDs for sure want to track food logs and carb counting, fiber, and calories calories…”

“Fiber, protein, calories are important for weight loss purpose…Depending on the patient issues, the needed values are different…personalize which factors to see individualized to each patient. For example, if the patient has high lipid, cholesterol is important to see. If the patient have kidney issues, protein and sodium are important to see.”

Some educators prefer viewing information about calorie counting and carbohydrates, whereas others want to see percentages of calories from fat, carbohydrates, and protein in a graphical chart on a daily basis.

“Most say macronutrients are more important than % while RDs may have different views. Some want to calculate carbs specifically from sugar, and calculate other carbs altogether… Others want to see what percent of carbs come from sugar”
“my number one things would be calories, carbs, protein, and fiber... But I work in the Weight Management Center, and protein and fiber are, like, all we really focus on”

Preference toward a connected and integrated system with EHR.

All found it extremely helpful to integrate smartphone and wearable collected self-monitoring data into Chronicle Diabetes system and particularly favored current EHR system integration with Chronicle Diabetes system. Documenting detailed diabetes self-management education and support information, along with required information for education program recognition in Chronicle Diabetes system, and required documentation in hospital and practice EHR system should be all integrated to support one connected system.

“then we wouldn’t have to double document it. If we could put it in there and it would automatically go, that would be nice.”

“Well that’d be great because then I wouldn’t have to chart so dang much. Like, it—all the information would already be in the chart.”

Interprofessional team-based care utilizing connected EHR.

A healthcare team and central EHR system need to be formed for educators to share summary of self-monitoring data in order to communicate with other health care providers.

Most educators agreed that the information would be helpful for primary care providers such as family physicians. Some agreed they would like to see all this information but other educators think physician would not have time to use Chronicle Diabetes system. Instead, they think physicians may be able to obtain information indirectly from other health care providers, such as
an educator or a dietician. Diabetes educators like to have a space in the Chronicle Diabetes system to comment and to share opinions with other health care providers. The preferences on frequency and timing of writing comments varied across the educators.

“The information in Chronicles will be good supporting data.”

“…they would develop teams. It would be the educator on the team. If there was a team approaching a physician practice…to collaborate and take [it] to the physicians…that would be very helpful. It would have to come from another health professional …”

“And you would think that they would look at using this kind of technology, but they’re being pushed in so many different directions…I’m sure they don’t perceive that they have the time for this.” “I don’t know if people have time to read. I think doctors like to have it there and if they need to refer to it, they really like that” “(who else need to view such data) primary care physicians or the nurse practitioners, physician assistants. Whoever their primary care is and who’s ever following them through the diabetes.” “No.” “I wish we could say yes.” “They don’t. Unless-unless they would develop teams. It would be the educator on the team. If there was a team approaching a physician practice” If Rob had this data to collaborate and take to the physicians… Yes….that would be very helpful. It would have to come from another health professional …Right…to the physician to pay attention to it. The patient brought it in. They’d scan through it. Say—pretend like they were really digesting it and say, “Oh. This is great! You need to exercise more.”
Educators desired advanced features for mobile application, Chronicle, and the display of patient self-monitoring data.

For mobile application, educators suggest adding voice search over instead of barcode scanning or app manual entry to help patient log their foods more easily, and a function to that automatically records physical activity to allow more accurate real-time data.

“If they had an app that could—if you could…talk into your phone…and it types what you say…People would love that as opposed to choosing it on an app where you have to go in or the one that reads the scanning bars.”

Some educators comment on adding a new function to Chronicle that can allow them to merge their preferred self-monitoring data at once in order to observe the effects of multiple-behavior interactions in diet and activity with blood sugar or weight.

“when we’re talking about blood glucose…in addition to just knowing the number or the time of day…if they’re doing exercising, you can track their blood sugar level with relation to movement….. And the same with food…”
“… I need a place where the patient can put in their carbs, their weight, their calories, and their glucose all in one place, and to be able to see how the amount of carbs that they ate corresponded to their blood sugar…”
“ I would like the blood glucose to interact with the exercise and the blood glucose to interact with the nutrition.”
Several educators like to view a variety number of data, (i.e., such as nutrition, exercise, or blood glucose data), on separate tabs in Chronicle, and different formats for daily, weekly, or monthly summary reports.

“the blood sugar level, and on the graph, show the exercise…but I know I would want a separate tab for exercise and a separate tab for nutrition.”

“...I would like to have a tab that—where you can see all the blood sugar levels no matter what time of the day. “

“... I would want to look at the carbs and the protein and...I would want to look at their total fat intake as well...”

“I like the summary ones the best, for the week...I’m not liking the daily one again as much...”

“... if they’re coming to me with a problem, I want to look at the past seven days more than the month because then it’ll dilute the statistics…”

Discussion

Our study demonstrates that diabetes educators are enthusiastic about the incorporation of self-monitoring (SM) information into Chronicle Diabetes system to monitor patients and ensure patient adherence to behavioral goals toward diabetes self-management education and support. Collecting such data in a centralized system facilitates robust data collection, synthesis and analysis, and has the potential for developing precision diabetes management with context-aware, individualized guidance presented to the patient and caregivers in a coordinated fashion [13]. The diabetes educators’ insights on information display, interface design, and data integration effectively show how the wearable fitness tracker and its companion dietary self-
monitoring application can support diabetes educators’ clinical work on the improvement of
diabetes self-care behaviors, care coordination, and patient outcomes. The National Standards
Diabetes Self-Management Education and Support recommends the provision of individualized
diabetes education based on patient medical history, health beliefs and attitudes, diabetes
knowledge and self-management skills [7]. A recent study conducted in the United Kingdom
exploring patients’ unmet diabetes self-management education and support highlighted patients’
needs in support behavior change, particularly in physical activity and dietary change, using
digital technology [14]. Based on our findings, diabetes educators prefer the reporting of SM
information that are closely relevant to improving diabetes outcomes and are within the scope of
diabetes educators’ practice. Accordingly, patient diet and physical activity reports were thought
to be of greater relevance than sleep activity since the latter was deemed to be beyond the scope
of diabetes education practice. The educators in our study also suggested that all types of macro
nutrition (protein, carbohydrate, calorie, fat, etc.) and activity information (both exercise type,
duration, and steps) are needed so that educators with different training backgrounds can always
find information relevant to enhance diabetes education and outcomes even with different patient
health conditions.

While the mobile application itself does not provide personalized education or therapeutic
support to patients, the integration of mobile-based self-monitoring information into Chronicles
Diabetes system would overcome this limitation by enabling educators to focus and interpret SM
diet and exercise information that is relevant to specific patient needs, rather than spending
education time on dietary recalls with patients. Other studies have investigated the use of a health
coach or a certified diabetes educator that is not part of a health care team to provide diabetes
self-management support based on smartphone or wirelessly connected device collected SM data [2, 8]. Our study investigating the insights from diabetes educators who are part of the current health care team can provide some unique perspectives. In our study, diabetes educators expressed the needs to connect Chronicle Diabetes system with existing EHR systems for managing patient care and think that they can take a more active role in reviewing mobile data and connect with physicians and other prescribing providers such as nurse practitioners in providing team-based care. Researchers found that in a study where patients were provided with mobile self-management support, the physician’s prescribing behaviors did not seem to change [15]. It remains a question whether an integrated system with mobile data connected with EHR will influence physician prescribing behavior through an inter-professional team-based approach where a diabetes educator takes the leading role to review mobile collected SM data.

**Conclusions**

Full range of tracking details of smartphone- and wearable-collected diet and activity information is needed to support educators’ preferences, and integration of such data into Chronicle Diabetes and EHR systems is valuable for educators to track patients’ behavioral goals and provide precision diabetes self-management education and support. Diabetes educators’ perspectives need to be incorporated as we develop future mobile and connected systems to support team-based diabetes care and education in clinical practice. The study findings were used to inform the development of a connected interface in Chronicle Diabetes to integrate Jawbone collected self-monitoring diet and physical activity information, and the connected system is currently being tested in a multi-site randomized clinical trial [16].
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