Mobile Apps for Managing Adolescent Type 1 Diabetes: Usability Considerations

Produced by the HIMSS HIT Usability Workgroup
Learning Objectives

• Develop a guide for the developer of mobile apps for juvenile Type 1 diabetes (T1D) management

• Outline some basic design considerations for this population based on current usability recommendations and best practices

• Leverage the HIMSS guide “Selecting a Mobile App: Evaluating the Usability of Medical Applications”, June 2012

• Develop a document that can also potentially be utilized as part of the evaluation criteria by ambulatory care provider practices which are considering recommending diabetes management apps to young patients and their parents
Contributors

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Adolescent Diabetes in America

“The numbers”*

- 25.8 million Americans have diabetes (2011)
  - 215,000 are 20 years old or younger
- 15,600 youth are diagnosed with diabetes annually
- 23% increase in cases of Type 1 diabetes (T1D) in youth between years 2001 and 2009
- 1 in 3 Americans will have diabetes by 2050

*Source: American Diabetes Association (ADA) SEARCH for Diabetes in Youth Study
Adolescent Smartphone Use*

• 37% of adolescents under 17 years old have smartphones

• Only 2% of those with diabetes use apps on their smartphones to manage their diabetes related tasks.

*Source: Research2Guidance
The Adolescent with T1D – A Typical Day of Health Monitoring

• Measure blood glucose (BG) levels before and sometimes after meals, before and after any strenuous exercise, at bedtime and sometimes during the night.

• Administer insulin - factors affecting the amount of insulin needed to keep levels in the normal range are:
  – exercise
  – diet
  – blood sugar level
  – stress
  – normal physical growth and development

• Count carbs, read food labels, estimate carbs
Navigating the Challenges of Adolescent Type 1 Diabetes

- Before and after strenuous exercise
- Before & sometimes after each Meal
- At bedtime & sometimes during night

Count Carbs
Estimate carb intake
Read food labels
Carbohydrate coverage dose
Mealtime insulin dose
low blood sugar correction

- Estimate carb intake
- Read food labels
- Count Carbs
- Mealtime insulin dose
- Carbohydrate coverage dose
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Food labels
Carbohydrate coverage dose
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low blood sugar correction

HIMSS
transforming health through IT
**Manual vs. Automated Insulin Dose Calculation**

- **Easy Formula***:
  \[
  \text{Insulin Dose} = \text{Fixed Meal Dose} + \text{Current BG} - \text{Target BG} \\
  \text{Correction Factor}
  \]

- **Advanced Formula***:
  \[
  \text{Insulin Dose} = \frac{\text{Grams of Carbohydrates}}{\text{Insulin-to-Carbohydrate Ratio}} + \text{Current BG} - \text{Target BG} \\
  \text{Correction Factor}
  \]

- **App with Dosage Calculator**

Purpose of Diabetes Management App

• Automate and expedite the logging of the blood glucose measures and other data such as weight, carbohydrates, and insulin administered

• See trends in levels by activity

• Flag measures outside of acceptable ranges

• Share information with family and members of the T1D healthcare team.
Diabetes Management App Basic Features

Common features of diabetes management apps:
- Log blood sugar levels (manually)
- Sync to glucometer to download blood sugar data
- Generate graphs, stats, and export results
- Log other measures such as: blood pressure, weight, activity, carb intake, insulin, water consumption
- Infer hemoglobin A1C levels
- Create reminders to check levels regularly
- Compute carbs for specific foods to determine amount of insulin to inject

Features that are of value to adolescent diabetics:
- Post to social networks, ask questions, share progress, share feelings
- Earn rewards for logging blood sugar levels
- Learn about diabetes through videos, games, and quizzes, as well as feedback on specific events
- Share data with family and/or health care team
Manual Log of Blood Glucose

• Most of the apps reviewed utilized manual logging of blood glucose and other measures
• Various data entry methods used:
  – Keypads
  – Spinners
  – Buttons
  – Calendars
• Simple, uncluttered

app: Glucose Buddy

app: OnTrack Diabetes
Sync with Glucometer

• Simple, automated transfer of glucometer readings was recommended by Cafazzo JA, et al. ([Design of an mHealth App for the Self-management of Adolescent Type 1 Diabetes: A Pilot Study, July 2013](https://example.com))

• Transfer via cable or Bluetooth®

app: Glooko
• Per Pullman, et al. (Ideas and Enhancements Related to Mobile Applications to Support Type 1 Diabetes, 2013), it is also important to include the ability to:
  – set personal goals/targets and flagged if they are met or missed
  – include historical colorful graphs

apps: bant, Blood Sugar Tracker, Glooko
Share information

• With an app called **bant**, named after Canadian Doctor Frederick Banting, who discovered insulin, a teen can view others' posts regarding his/her blood glucose via automatic feeds to the teen’s twitter account.

• Other apps such as **Glucose Companion** and **WaveSense Diabetes Manager** allow sharing of blood glucose data and/or charts with family, friends, and providers.
Learn

• Frøisland D, Årsand E, Skårderud F (Improving Diabetes Care for Young People With Type 1 Diabetes Through Visual Learning on Mobile Phones: Mixed-Methods Study, Aug 2012) also determined that visualization of information related to diabetes self-care into one picture (i.e., diet, insulin dosage, physical activity, and pre- and post-meal glucose measurements) in the mobile diary was found to be an important educational tool through reflections in action.

• Similarly, researchers from Open mHealth noted the ability to see different activities (like exercise) alongside BG levels allows the diabetic to better understand the effect of that activity on BG.

app: MyNet Diary
Process Flow

- **mSugr Junior** is an app that uses a cartoon character to guide young diabetics (who still need parents’ help) through the logging process. The child can earn points for each log entry.

- A young teen can download another version called the **Companion** that encourages the teen to tame his/her “diabetes monster” and gives feedback for each entry.

Source: *mSugr Junior*
Usability Considerations*

- The **data** is the focus. The interface should be simple and intuitive, with design elements not interfering with the data on a potentially small screen.

- The **layout** incorporates typographic elements that communicate meaning and are consistent across screens.

- **Feedback** can be provided directly to the design team.

- **Interactions** with the interface engage directly with the content and task at hand, keeping cognitive burden to a minimum.

*Source: Selecting a Mobile App: Evaluating the Usability of Medical Applications*
Usability Considerations – Adolescent Type 1 Diabetic perspective

• Entering the data (blood glucose level, carbs, insulin dose, etc.) should be simple and quick.

• Navigation and interactions should be intuitive and layout of blood measures, dates, and timestamps should be consistent across screens, so that they can easily see previously logged measures, current blood glucose levels, and are alerted that levels are climbing, plunging, and/or in need of immediate attention.

• There should also be a means to provide feedback to the app developers about bugs or areas of improvement.
Key Usability Findings

• **Employ user-centered design.** Per Pullman et al. 2013, young people with type 1 diabetes have a radically different view of technology than either their parents and practitioners. Therefore, it is very important elicit their input and recommendations in development of T1D apps.

• **Use of incentives.** Use of incentives improved the adolescent’s compliance with blood glucose monitoring. Further analysis on the use of incentives tied to the adolescent’s actions and decisions tied to additional blood glucose control is recommended (Cafazzo et al. 2012).

• **Consider different ways to visualize data.** Adolescents in Frøisland et al. study said the ability to see pictures of food they had consumed along with integrating pre- and postprandial glucose measurements and insulin dosages as well as information on physical activity together, provided a better visual understanding of how physical activity, food intake, and insulin dosage interact and affect postprandial glucose measurements.

• **Simplify T1D self-management tasks.** For example, providing a simple, automated transfer of glucometer readings
Ongoing Research - Examples

- **Flash Glucose Monitoring** – Abbott Diabetes Care, system collects continuous glucose data when the person with diabetes scans a reader over a subcutaneous sensor patch.

- **Bionic pancreas** – Developed by Ed Damiano, Boston University, with funding from the National Institutes of Health and the Juvenile Diabetes Research Foundation, iPhone app monitors BG and communicates wirelessly with insulin and glucagon pumps. It monitors via a small monitor attached to body.

- **Apple iOS8 Health app and HealthKit** – coming this fall, framework for collecting, storing, and visualizing health and fitness data from health apps (often associated with wearable sensors).
Conclusions

• Based on this analysis, this committee recommends that developers of T1D mobile apps for the adolescent population understand the adolescent’s use of technology within the context of their current environment.

• Low glycemic control compliance among adolescents with T1D places them at greater risk for short- and long-term complications and use of T1D apps has been found to be a more viable means to improve compliance of some tasks.

• Automating and simplifying the entry T1D tasks, providing better ways to visualize interdependent T1D tasks, incorporating simple, uncluttered displays and different data entry methods as well as including colorful graphs and providing incentives for task completion have improved the adolescent T1D user satisfaction and acceptance and use of T1D mobile apps.
Appendix A – Key Findings from Studies of Mobile Apps for Adolescents with T1D

- poor treatment adherence among the population using traditional treatment methods.
- use of diabetic mobile apps to assist adolescents in gradually assuming responsibility for the intensive T1D self-management tasks
- simplify T1D self-management tasks (ex: sync glucometer)
- developing and testing apps with input from the adolescent T1D improved app acceptance and use.
- use of incentives in apps for task completion improved compliance with glucose monitoring and improved app data visualization improved comprehension of T1D task interdependencies.

<table>
<thead>
<tr>
<th>Study</th>
<th>Author(s)</th>
<th>Date</th>
<th>Objective</th>
<th>Study Population</th>
<th>Usability Findings</th>
<th>Key App Features for Diabetic Adolescents</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Facts and Chat: Go Online: What is important for Adolescents with Type 1 Diabetes?</td>
<td>Nordfjell T, Angenent-Ullenbärg T, Nordfall M, Billing J, and Barkard C</td>
<td>Jun 2013</td>
<td>To understand the information-seeking and online social networking behavior, internet use of T1D adolescents.</td>
<td>24 Swedish T1D adolescents aged 10-17</td>
<td>user-centered design practice, recognize adolescents’ perspectives when considering communication tools and apps. Adopt to adolescents’ needs and expectations to develop useful online resources for T1D adolescents.</td>
<td>Social networking - The need for contact with other adolescents with T1DM varied immensely. “Friends” did not have to have T1D. But it was valued that their friends knew about their diabetes for emergency situations.</td>
</tr>
<tr>
<td>Design of an ontology for the self-management of adolescent Type 1 Diabetes: A Pilot Study</td>
<td>Colappa IA, Casademunt N, Hamming N, Katzman, DN, Paltoc MR</td>
<td>Jul 2013</td>
<td>To design, develop, and pilot an app for the management of type 1 diabetes in adolescents.</td>
<td>20 Canadian adolescents aged 12–16 years</td>
<td>simple, automated transfer of glucometer readings, need for fast, discrete transactions, use of a social community</td>
<td>role of data collecting rather than decision making, need for fast, discrete transactions, need for ad-hoc information sharing, specification and incentives</td>
</tr>
<tr>
<td>Designing Mobile Applications to support Type 1 Diabetes education</td>
<td>Bultman A, Taylor J, Obin F</td>
<td>Oct 2012</td>
<td>Investigate how young T1D adults engage with web</td>
<td>4 British adolescents aged 18-21</td>
<td>empathetic understanding, reflection of the life experiences of patients, and</td>
<td>Four prototype apps were chosen for development based on the feedback from the qualitative interviews</td>
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9 research articles reviewed
- Objective
- Study population
- Usability findings
- Key app features
Appendix B – Example Diabetes Management apps
Features and User Satisfaction Ratings

- iTunes Apps Store and Google Play Store data includes average ratings (on a scale from 1 to 5) for 27 apps based on all versions of each app (as of March 2014).
- Ratings reflect overall satisfaction with a particular app.
- Platform, average user ratings, cost, features

<table>
<thead>
<tr>
<th>Name</th>
<th>Platform</th>
<th>Average User Ratings</th>
<th>Features</th>
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<tbody>
<tr>
<td>Name</td>
<td>iPhone</td>
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<td>Diabetes Watch</td>
<td>☑</td>
<td>☑</td>
<td>3.1</td>
</tr>
<tr>
<td>dbees.com - Diabetes</td>
<td>☑</td>
<td>☑</td>
<td>4.1</td>
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- Used human factors methods in the app design: Conducted ethnographic interviews and cognitive walkthroughs with teens and their parents to better understand the potential needs and behaviors of target users. Stepped through iterative screen designs and informal users testing to gather user experience feedback.
- Automatically feeds in tweets, so user can view others' posts regarding their blood glucose (BG).
- Advanced version of the app will use a LifeScan OneTouch Mini blood glucose meter to collect and wirelessly transfer readings directly into InsulinTracker using a Bluetooth adapter.

- Data stored in the cloud.
- Not available in the U.S. iTunes store.
Questions, Comments, Suggestions?

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