2016

# Technologies to Enhance Optimal Glycemic Control in Young Adults with Type 1 Diabetes

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# TECHNOLOGIES TO ENHANCE OPTIMAL GLYCEMIC CONTROL IN YOUNG ADULTS WITH TYPE 1 DIABETES

by

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A thesis submitted in partial fulfillment of the requirements
for the Honors in the Major Program in Nursing
in the College of Nursing
and in The Burnett Honors College
at the University of Central Florida
Orlando, Florida

Spring Term, 2016

Thesis Chair: Dr. Laura Gonzalez

## ABSTRACT

### Background

People with type 1 diabetes make up approximately two million of the American population. Every day, these two million people struggle to fight this lifelong, sometimes life threatening disease. While type 1 diabetes currently has no cure, there are technologies that can make diabetes management more effective. This study surveyed the type 1 diabetes (T1D) young adult population aged 18-30, to evaluate what technologies and tools are most often associated with achieving optimal glycemic control (OGC).

### Methodology

The instrument is a 35 question, investigator developed survey that is designed to measure how often a participant utilizes the technology identified in each question, with the response choices ranging from 0 (never) to 5 (multiple times daily). In addition, there were some yes/no and fill-in-the-blank questions to identify demographic variables. The technology topics that were explored are 1) mode of insulin therapy, 2) mode of blood glucose monitoring therapy, 3) mode of communication with designated care provider, 4) electronic applications used, 5) demographic variables, and 6) pertinent comorbidities. This information was used to evaluate variables that assist T1Ds in achieving optimal glycemic control. Participants were invited to participate in this study via email using the *Students with Diabetes* email listserv. The email contained the IRB approved explanation of research letter, which informed participants of the study and the research being conducted. If the student chose to participate, they checked a box that served as an electronic signature, and they continued on to the 35-question survey. All

responses to the survey will be kept confidential; as the survey and research did not require any personal identifying information. Data regarding the specific demographics, technologies used for diabetes control, and hemoglobin A1C levels were recorded and analyzed. The results of the survey will be shared with the participants via the same email list-serv by which they were originally recruited.

**Results**

There were 59 participants. A total of 21 out of 59 respondents had optimal glycemic control (A1C less than 7.0, per American Diabetes Association guidelines). Eighty eight percent of those with OGC wore their CGMs all the time, while only 66% of those with IGC wore their CGMs all the time. Ninety five percent of those with OGC used their insulin pumps all the time, while 89% of those with IGC did. It is likely that the combination of both CGMs and insulin pumps worn all the time are the most powerful tools to achieving OGC. Students that were employed, enrolled in classes, and still under their parent's insurance plans had a higher incidence of optimal glycemic control.

**Discussion**

It was hypothesized that those with OGC would have a higher incidence of diabetes technology use. This PI found that even though almost all participants had access to the diabetes technology, still only 37% of the participants had optimal glycemic control. There are many components to diabetes care that impact glycemic control that were not explored within this scope of this diabetes technology study.

**Conclusions**

It is likely that both CGMs and insulin pumps worn all the time are the most powerful tools to achieving OGC. Students who graduate from college and transition to adulthood are vulnerable as they may encounter added stressors such as employment, and financial responsibility that cause them to deviate from the recommendations for diabetes technology use. Care providers need to be cognizant that young adulthood is a vulnerable time in terms of OGC and optimal diabetes management. Providers need to work with young adults, and encourage them to adhere to the recommended diabetes care regime.

# DEDICATIONS

This dissertation is dedicated to Lauren Bonn, a fellow type 1 at UCF that lost her fight to diabetes. May we fight together to improve the lives of all people with diabetes, and create a world where type 1 becomes type none.

To my family: I am what I am because of you. Thank you for your endless love and support and for reminding me that diabetes will never be a limitation, but rather a springboard to leaving my impact on the world. God is good, all the time! I love you all!

To Christian: You are the real MVP. Thanks for keeping me sane. I love you.

To my dad: Thanks for 'saving me from myself' and eating my ice cream for me… You better not join the "beetus" club!

To every T1D in the fight, and especially Dr. Nicole Johnson and *Students With Diabetes*: We are in this together, and one day, there will be no more diabetes. Until then, we are going to make it better, together, one day at a time. Thank you for providing me with a community like none other.

# ACKNOWLEDGEMENTS

To the UCF College of Nursing: Thank you for giving me the greatest nursing education this side of the Mississippi. I am honored to have had the privilege to learn from some of the world's most genuine and caring professors. I will forever be thankful for the solid foundation the CON has provided as I begin my nursing career, and for being taught the difference between what is and is not CCDT.

To all of my UCF CON mentors: Education is the most powerful tool with which we can change the world, and you have forever changed mine. For that, I will be forever grateful. Especially, to

Dr. Gonzalez: Thank you for all your life and nursing advice. I hope to be half the kick-butt ED nurse and researcher you are! Dr. Allred: Roses are red, cyanosis is blue, thanks for putting up with me, and teaching me too!

To my diabetes heroines, Dr. Nicole Johnson and Rachelle Stone: Thank you for showing me how it's done; with faith, perseverance, unrelenting optimism, good friends, and a Dexcom! You have changed my life for the better forever and you will never know what a blessing you have been!

To the Burnett Honors College:

Thank you for providing students with the opportunity to enter the world of research and for helping to empower the innovators of tomorrow. The value of this experience could never be emphasized enough.

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# INTRODUCTION

## Statement of the Problem

Type 1 diabetes currently affects over two million Americans (Zitkus, 2014). While there has been much research on individual factors contributing to optimal glycemic control, there is little in the literature that is specific to the opinions of young adults with type 1 diabetes describing what technology positively impacts their glycemic control. There is a significant amount of literature from well-established authorities, such as the American Diabetes Association, recommending which treatment protocols are the best for T1Ds, but we do not actually know what people are able to implement and use in their daily lives, or how those with type 1 diabetes (T1Ds) actually utilize current resources and technology. There are fewer numbers of T1D's with optimal glycemic control (OGC) than there are with ineffective glycemic control (IGC), as supported by data from the 2015 National *Students with Diabetes* conference, in which there was an average reported A1C of 8.5 following on-site real time A1C checks; in which 46 students were asked what their A1C result was, and 35 reported that it was 7.1 and above, and only 11 with an A1C of 7.0 or below (Dr. Nicole Johnson, personal communication, 2015).

The term 'technology,' for the purposes of this research study, encompasses any device that is used in the daily diabetes care regimen. Such devices may include blood sugar test kits, continuous glucose monitors (CGM), modalities of insulin administration, and any electronic or smartphone applications (Stetson, 2011.) The term 'optimal glycemic control,' referred to from this point on as OGC, is defined as a hemoglobin A1C (or A1C) level of 7.0 or below for adults with type 1 diabetes (Zitkus, 2014). The A1C test measures the amount of glucose that is attached to hemoglobin molecules, and is measured every 3 months. Red blood cells that carry hemoglobin molecules have a lifespan of up to 120 days. In light of red blood cell turnover every 3 months, there is a new reading reflective of average blood sugars. The A1C scale is directly correlated to blood glucose levels.   According to the American Diabetes Association (Zitkus, 2014), a normal blood sugar ranges from 70 mg/dl to 126 mg/dl. This blood glucose level range is optimal for the human body's efficient functional level, without stress or organ damage, and serves as the national diagnostic standard (Zitkus, 2014). A A1C of 7.0 correlates directly to a blood glucose reading of 154 mg/dl. While this level represents a reading higher than the ADA cut of 126 mg/dl, it is important to note that the A1C is a 3-month average blood glucose reading. This incorporates the averages of all blood glucose readings; including the 1-2 hour post-meal normal blood sugar, which can be as high as 180 mg/dl (Lewis, 2002.) An A1C reading below 5.0 indicates an average blood glucose of 96 mg/dl, and may mean that T1D is having too many hypoglycemic episodes. Hypoglycemia is defined as a blood glucose reading of 70 mg/dl or below (Zitkus, 2014). At this level, the body does not have sufficient glucose to support all of the body's functions, and the T1D becomes symptomatic. Untreated hypoglycemia can rapidly progress to coma and death. Therefore, optimal A1C levels are within the 5.0 to 7.0 range, with 7.0 being the maximum desirable A1C reading (American Diabetes Association 2016).

Without sufficient insulin, the blood glucose levels can become dangerously high, and the blood becomes hypertonic and acidic. The symptoms of hyperglycemia include polyuria, polyphagia, polydipsia, altered mental status, ketone production, and eventual ketoacidosis and coma, even death (Lewis, 2002).  Sustained high blood sugars will damage the body's systems, as the cells cannot utilize the excess glucose, and systemic damage occurs over time. This results in later-in-life complications such as diabetic neuropathy, retinopathy, renal failure, vascular disease, and heart disease. Chronically uncontrolled blood glucose levels make diabetes the 7th leading contributor to death in the United States, and further emphasize the need for optimal glycemic control, particularly among the insulin dependent type 1 diabetes population (Stetson, 2011).

There are numerous factors that affect blood glucose levels in diabetes. In order for a T1D to survive, insulin therapy and blood glucose monitoring are necessary, and hence, a daily part of the diabetes care regimen (Hanna, 2013). Some T1D's prefer to use the insulin pump, while others prefer insulin pens or insulin injections with syringes. Daily blood glucose monitoring is vital; and the Juvenile Diabetes Research Foundation (JDRF) recommends checking the blood glucose no less than 4 times per day. A blood glucose test kit is a small pack that diabetes carry with them, that incorporates at a minimum test strip vial, lancing device, and glucose monitor (Wilkinson, 2014). Most care providers prefer that their patients test between 6 to 10 times per day, in order to stay on top of blood glucose trends, and anticipate hypo or hyperglycemic episodes (Stetson, 2011). Some blood glucose test kits, such as the Freestyle™, are independent of any other devices, allowing the T1D to analyze the results manually. The user must then make a decision regarding treatment. Other test kits, such as the Contour Next Link™, communicates with the user's insulin pump, such as Medtronic, and then the pump computes within programmed settings what the next step in treatment should be, leaving less room for human error in on-the-spot decision making (Maurus, 2013). One technology is the continuous glucose monitoring (CGM) system, which incorporates a wireless sensor that is linked to a subcutaneous wire that reads interstitial fluid glucose levels every 3 to 5 minutes, providing T1Ds with real time glucose levels and trends displayed on graphs on the monitors (Langendam, 2011).

Previous research has shown that continuous glucose monitoring systems, or CGMs, greatly reduce A1C levels by allowing T1Ds to correct a high blood glucose sooner, and prevent hypoglycemic episodes by alerting the user as the blood glucose trends downward, making the CGM an invaluable tool to achieve optimal glycemic control (Langendam, 2011). Furthermore, companies such as Dexcom™, have released mobile applications (apps) that further safeguard T1Ds by alerting care providers and family members of the blood glucose levels and trends throughout the day. There are also apps that help T1Ds track their food intake, exercise, etc. all of which could result in improved glycemic control (Skrovseth et al., 2012).

Effective medical support is crucial to effective diabetes care and optimal glycemic control. It is globally accepted that T1Ds should have an appointment with a diabetes (or other) care provider (DCP) every 3 months, to evaluate A1C levels and make adjustments to the care regimen (Stetson, 2011). It is absolutely vital to have a DCP that maintains a comfortable, encouraging relationship with their patients, in order for the T1D to feel comfortable discussing their concerns and asking questions. Sometimes, young adults may have a care provider that does not take the time to determine why the A1C is not optimal, or why their patients may be having certain issues with diabetes management. It can be become a punitive relationship in which the patient does not feel comfortable voicing their concerns with the DCP, and therefore effective problem solving is not achieved and implemented (*Students with Diabetes* open forum, personal communication, 2015). With the advent of share technology such as Dexcom Clarity™, users can email health care providers questions, glucose level reports, and communicate via smartphone applications. This has become a valuable way to bridge the gap between care provider appointments, and increase care provider - patient rapport. The use of such technology to communicate more often than during scheduled face-to-face appointments has been shown to have positive impacts on A1C levels (Kirwan, 2013).

The life of a young adult is difficult to navigate; young adults are concerned with establishing financial stability, starting careers, completing higher education, establishing relationships, and perhaps starting a family, etc. Managing T1D can make this period of life even more challenging (Hanna, 2013). Out from under the watchful eye of parents, young adults with diabetes have to independently manage their chronic condition, and take on new tasks, such as supply re-ordering, dealing with insurance companies, and creating a budget in order to afford the diabetes supplies. Diabetes is a very high maintenance, expensive disease; with monthly costs varying depending on insurance. The average costs for diabetes care can range from $200 to $1000 monthly, depending on patient care needs (Stupiansky, 2013).

# PURPOSE OF STUDY

The purpose of this study is to determine the technologies that young adults with T1D use, and the impact of these technologies on glycemic control. By studying the common factors of those who have optimal glycemic control, the diabetes community at large may have a greater sense of how to better achieve optimal glycemic control.

**Research Aims**

1. Explore the technologies that young adults with T1D use for the daily diabetes maintenance regimen.
2. Explore the modalities of insulin therapy and blood glucose monitoring and optimal glycemic control, when compared to young adults with ineffective glycemic control (IGC), and to assess what trends in technologies are more often correlated to successful diabetes management.
3. Compare the differences in compliance to diabetes technology usage recommendations between the subgroups of participants with optimal glycemic control (OGC) and those with ineffective glycemic control (IGC).
4. Explore the relationship between demographic variables of OGC v. IGC and any differences within the two subgroups.

# METHODS AND PROCEDURES

## Design

This study used an exploratory, descriptive design. A survey developed by the investigators was made available through Qualtrics™ to young adults with T1D through the *Students With Diabetes* email listserv. The research was completed through the Honors in the Major program under the supervision of faculty at the University of Central Florida, College of Nursing.

## Subjects

Participants were 18-30-year-old T1Ds who are associated with the National *Students With Diabetes* population. This population is relatively homogenous in terms of socioeconomic status; most participants are in college or recently completed college. They are all associated with the diabetes support community through *Students With Diabetes*. Because of these factors, this study focuses on the effects of technology use on A1C levels, as most other factors that may affect glycemic control are relatively similar.

## Inclusion and Exclusion Criteria

Inclusion criteria: Must be age 18 to 30 with type 1 diabetes and part of the *Students With Diabetes* organization, and able to read and write English.

Exclusion Criteria: People with type 2 diabetes, individuals not within the 18 to 30-year-old range, individuals who are not part of *Students With Diabetes*.

**Procedures**

Following notification of IRB approval (IRB # SBE-16-11994), students were informed of the study via email through the *Students With Diabetes* listserv. Access to the listserv was granted by Nicole Johnson, DrPH, MPH, MA, and founder of *Students With Diabetes*. The email contained a general greeting from Nicole Johnson, and the informational letter that provided the link to the Qualtrics survey. Consent was implied if they read the informational letter indicating that they understood the implications of the study, and they chose to complete the survey. Participants were free to withdraw from the survey at any time, and results were only derived from the completed surveys. All responses to the survey were kept confidential. Survey results were stored on the investigator and PI's locked laptops, and through the Qualtrics parameters for results, no personal identification was logged or recorded. Each survey response was given a unique random identifying number to separate and organize each response. A1C was the control factor for the study, the results were organized into two separate reports from which results were analyzed; one for responses from participants with optimal glycemic control (OGC) indicating an A1C of $\leq 7.0$, and a separate report for the responses from participants with ineffective glycemic control (IGC) indicating a A1C of $\geq 7.1$ (American Diabetes Association 2016). The survey results will be published through the same email listserv by which participants were recruited.

## Instruments

This study used a 35- question (appendix B), investigator developed survey that explored general socioeconomic and demographic factors of the participants such as age, time since diagnosis of T1D, latest A1C etc. Additional queries included the technologies used for diabetes maintenance and how compliant the user was in terms of these technologies. The Qualtrics™ survey was created to have yes/no, skip logic, multiple choice, and free response questions. For each topic, the initial question was yes/no; if the participant selected ‘yes’ the subsequent questions regarding the topic were revealed. A “no” answer moves (“skips”) the participant to the next topic.

## Data Analysis

This study used descriptive statistics (percentages and means) to answer the research questions. Qualtrics derived a statistics table for each question. Variables were explored for ways to create summation scores for use in analysis. Results were divided into two reports; one for those participants with OGC, and one report for those with IGC.

## Sample Characteristics

The nature of the sample was unique in that it was derived from people with such similar demographics, that it was feasible for this study to focus on the technology used for daily diabetes maintenance and the effects that technology had on A1C levels. The *Students with Diabetes* support group across the nation provides a safe haven for T1Ds unique to the young adult population, where they can sympathize, share concerns, and share successes and trials and error stories. All participants are directly or indirectly involved at a college or university where *Students With Diabetes* is an established group. All participants have either completed a degree or are currently enrolled in college level courses. The survey was sent to all *Students With Diabetes* participants across the country, and the survey was capped and closed at the first 60 responses. No location or tracking data was gathered as to help protect the privacy of the participants.

**Demographic Information**

The age range of participants (N=59) was 18-30 years old, with the median age 24 years and the mean was 23.5. There were 9 males and 51 females. Length of time living with T1D ranged from 1 year up to 24 years. Thirty-five participants were enrolled in college courses, and 25 were not. Forty-five participants were either employed full or part time, and 15 were not employed. All participants were insured either under their own plan (17 participants) or under their parents (43 participants).

# FINDINGS

**Research Aim number one: Explore the technologies that young adults with T1D use for the daily diabetes maintenance regimen.**

Participants stated they use a variety of marketed diabetes technologies. Of the participants with OGC, 100% of participants utilized a manual blood glucose test kit. Between participants with IGC and OGC, 100% of pump users reported that their pumps had computing capabilities, such as carb counting, a carbohydrate index, or automatic carbohydrate to unit ratio bolus calculations. Of those with OGC, 90% of pump users reported using the computing capabilities at least some of the time. Of those with IGC, 100% of pump users reported using the computing capabilities at least some of the time. The fact that IGC had a higher rate of pump computing capability use was contrary to the hypothesis. 100% of participants reported having access to syringes and/or pens as backup modalities of insulin administration. Of those with OGC, 38% of participants reported using an electronic application (app) to help manage their diabetes such as MySugr, Medtronic Connect, Dexcom Clarity, Figwee, and Dexcom Share. Of those with IGC, 38% also reported using apps to help manage diabetes, such as called Dexcom share, CamShare, My Fitness Pal, MySugr, Logbook, and CarbsControl. When asked about any other diabetes related apps that may be used, those with OGC reported using Fitbit and those with IGC reported using Carelink and the Apple Watch. Refer to Appendix D for a visual representation of the significant results.

**Research Aim number two: Explore the modalities of insulin therapy and blood glucose monitoring of young adults with T1D and optimal glycemic control, as compared to young adults with ineffective glycemic control, to assess what trends in technologies used are more often correlated to successful diabetes management.**

Optimal Glycemic Control: 74% of participants declaring they had a 7.0 or less A1C value utilized a continuous glucose monitor (17 participants), while only 26% did not (6 participants.) Of those using the CGM, 16 used the Dexcom™ brand while only 1 used the Medtronic™ brand. All 23 participants (100%) stated that they used a manual blood glucose test kit. The brand of the test kit was highly varied and deemed statistically insignificant for the purposes of this study. 11 participants (55%) stated that they have used their pumps for greater than 4 years, while 9 participants (45%) stated that they have used their pumps for less than 4 years. When inquired about the body areas used for pump site insertion, with the ability to select all that apply, 8 participants (40%) stated use of the thighs, 14 participants (70%) stated use of the front of the abdomen, 9 participants (45%) stated use of the sides of the abdomen, 11 participants (55%) stated use of the back, and 8 participants (40%) stated use of the back of the arms. When participants were asked about syringe versus pen use for any manual insulin administration, 8 participants (53%) stated they explicitly used syringes; 2 participants (13%) stated they used explicitly pens, and 5 participants (33%) stated they used both syringes and pens.

Ineffective glycemic control: 31 participants (82%) stated that they used a continuous glucose monitor, while 7 participants (18%) said they did not. Of the continuous glucose monitors being used, 23 were Dexcom™, 1 was OneTouch™, and 3 were Medtronic™. When inquired whether or not they used an insulin pump, 31 participants (89%) stated that they did, while 4 participants (11%) stated that they did not. When inquired about how long they had been using the pump, 13 participants (42%) stated for over 10 years, 1 participant (3%) stated 8-10 years, 3 participants (10%) stated 6-8 years, 3 participants (10%) stated 4-6 years, 6 participants (19%) stated 2-4 years, 2 participants (6%) stated 1-2 years, 2 participants (6%) stated 6 months to 1 year, and 1 participant (3%) stated less than 6 months. When inquired about body sites utilized for insulin administration, 7 participants (23%) stated that they used the thighs, 23 participants (77%) stated that they used the front of the abdomen, 19 participants (63%) stated that they used the sides of the abdomen, 10 participants (33%) stated that they used the back, and 12 participants (40%) stated that they used the back of the arms. When inquired about syringe and pen use, 6 participants (27%) stated they used explicitly syringes, 12 participants (55%) stated they used explicitly pens, and 4 participants (18%) stated they used both syringes and pens. Refer to Appendix E for a visual representation of the significant results.

**Research Aim number three: Compare the differences in compliance to diabetes technology usage recommendations between the subgroups of participants with optimal glycemic control and those with ineffective glycemic control.**

Optimal Glycemic Control: It is recommended that the CGM is calibrated every 12 hours, and 11 participants (65%) stated that they calibrated the CGM every 12 hours. Only 1 participant (6%) stated that they calibrated their CGM only 2-3 times per week, while 5 participants (29%) stated that they calibrated their CGM once a day. Even with those also using the CGM, 1 participant (5%) used their test kit a few times a week; 5 participants (23%) stated they used their test kits twice a day; 3 participants (14%) stated they used their test kits 3 times a day; 4 participants (18%) stated they used their test kits 4 times a day; 8 participants (36%) stated they used their test kits 5 times a day; and 1 participant (5%) stated they used their test kit greater than 5 times a day. 21 participants (95%) stated that they used an insulin pump, and only 1 participant (5%) denied using an insulin pump. 11 participants (55%) stated they used the computing capabilities 100% of the time. When inquired about the reuse of needles for insulin administration, 10 participants (56%) stated that they did reuse needles, and 8 participants (44%) denied the reuse of needles. When inquired about how often the participants reused the needles, 6 participants (60%) stated that they only reused needles less than once a month, 1 participant (10%) stated that they reused a needle approximately once a month, 1 participant (10%) stated that they reused a needle approximately 2-3 times per week, and 2 participants (20%) stated that they reused needles daily.

Ineffective glycemic control: 31 participants (82%) stated that they used a continuous glucose monitor, while 7 participants (18%) said they did not. Of the continuous glucose monitors being used, 23 were Dexcom™, 1 was OneTouch™, and 3 were Medtronic™. When inquired about how often they calibrated the CGM, 17 participants (59%) stated they calibrated every 12 hours, 1 participant (3%) stated they calibrated once a week, 1 participant (3%) stated they calibrated 2-3 times per week, 9 participants (31%) stated they calibrated daily, and 1 participant (3%) stated they calibrated only when they changed the Dexcom site. When inquired whether or not they used an insulin pump, 31 participants (89%) stated that they did, while 4 participants (11%) stated that they did not. When inquired about how often they change the pump site, 1 participant (3%) stated once a week to once every 2 weeks, and 30 participants (97%) stated every 3 days. When inquired about how often they rotated the pump sites from one body area to the next, 1 participant (3%) stated that they never rotated body sites, 2 participants (6%) stated that they rotated every 2 weeks, 2 participants (6%) stated that they rotated every 6 days (or every other pump site change), and 26 participants (84%) stated that they rotated every pump site change (every 3 days). When inquired about whether their pumps had computing capabilities, 31 participants (100%) stated that they did. When inquired about how often they used the pump's computing capabilities, 20 participants (65%) stated 100% of the time. When inquired about the reuse of needles, 12 participants (43%) stated that they did reuse needles, while 16 participants (57%) denied reusing needles. When inquired about how often participants reused needles, 3 participants (25%) stated less than once a month, 1 participant (8%) stated once a month, 1 participant (8%) stated 2-3 times per month, 3 participants (25%) stated 2-3 times per week, 4 participants (33%) stated they reused needles daily. Refer to Appendix F for a visual representation of the significant results. Refer to Appendix F for a visual representation of the significant results.

**Research Aim number four: Explore the correlation between demographic variables to optimal and ineffective glycemic control, and any differences therein the two subgroups.**

The OGC group had only one participant younger than 20, while the IGC group spanned the 18-30 age range. The OGC group had only 17% male and 83% female, while the IGC group had 14% male and 86% female. Those with OGC had been living with diabetes anywhere from 1 to 17 years, the average being 8 years. Those with IGC had been living with type 1 anywhere from 1 to 23 years, with the average being 14 years. 61% of those with OGC were enrolled in college courses, while 55% of those with IGC were enrolled in courses. 87% of those with OGC were employed, and only 66% of those with IGC were employed. 100% of all participants in both the OGC and IGC groups were insured by self or parents. After evaluating the results, the variables that were nonsignificant, particularly brand names of technologies, were eliminated and not discussed due to lack of statistical significance. Refer to Appendix G for a visual representation of the significant results.

# DISCUSSION OF FINDINGS

**Research Aim number one: Explore the technologies that young adults with T1D are able to use for the daily diabetes maintenance regimen.**

All participants had insurance, so there are minimal discrepancies in access to the medical supplies and technologies. Participants with OGC had a 74% rate of owning a CGM, while those with IGC had an 82% rate of CGM ownership. All participants with OGC also used a manual blood glucose test kit, while 3% of the IGC group stated that they never use a manual blood glucose test kit. The brands of test kits were highly varied among all groups, with OneTouch Ultra™ being the most popular brand. 95% of those with OGC used an insulin pump, while 89% of those with IGC use an insulin pump. Based on the technology usage alone, we cannot assume that the advanced technology itself is relevant to achieving optimal glycemic control, because all participants had insurance and access to the technologies. This leads the researchers to believe that glycemic control is directly related to compliance, and not technology used, as previously hypothesized. The highest occurrence of optimal glycemic control occurred with the most compliant T1D's using both the CGM and the insulin pump. The only other statistically differing data was that those who used preliminarily more syringes (n=8 or 53%, vs n=6 or 27%) had a greater instance of glycemic control. The data that was statistically the same or unremarkable included the questions regarding pump computing capabilities, setting alarms to help with diabetes care compliance, using electronic applications, and communicating electronically with the care providers and the support systems. Again, data purely focusing on the technologies used does not determine a direct correlation to achieving optimal glycemic control, because statistically equal numbers of participants, and the vast majority, had access to all diabetes technologies, yet 37% of the respondents had optimal glycemic control and 63% fell into the ineffective glycemic control group. This leads us to believe that achieving optimal glycemic control, when considering diabetes technology, falls directly to compliance.

**Research Aim number two: Explore the modalities of insulin therapy and blood glucose monitoring of young adults with T1D and optimal glycemic control, as compared to young adults with ineffective glycemic control, to assess what trends in technologies used are more often correlated to successful diabetes management.**

There was a higher percentage of CGM ownership in the IGC group, rather than the OGC group, as hypothesized (82% vs 74%). However, 95% of those with OGC do use a pump, while only 89% of those with IGC use a pump. It was hypothesized that those with OGC would have a higher percentage of insulin pump and continuous glucose monitor use, and these statistics essentially disprove that. This should alert care providers to the knowledge that simply getting T1Ds the technologies they need is not enough. They have to correctly use to the technologies for them to be effective. What may be remarkable is the amount of time the participants have been using the pumps. While OGC had 65% using the pump for more than 2 years, IGC had 85%. This may be related to "user fatigue," in which a T1D is so used to using the pump the same way, it is very hard to break habits and begin to use them differently or as should be.

**Research Aim number three: Compare the differences in compliance to diabetes technology usage recommendations between the subgroups of participants with optimal glycemic control and those with ineffective glycemic control.**

This research aim is the most statistically significant. Whereas the data did not show any at recommendations to use that the companies have set forth. There is a strong association with greater compliance and more frequent optimal glycemic control. The CGM should be worn daily for best glycemic control, and 88% of those with OGC wore their CGMs daily, while only 66% of those with IGC wore it daily. 65% with OGC calibrated the CGM every 12 hours while only 59% of those with IGC did. The OGC group identified as 65% using the pump for 2 or more years, while 85% of the IGC group used the pump for 2 or more years. Item 19 was a select all that apply question, and the OGC group demonstrated a greater variety in which areas they used as insulin administration sites. 55% of those with OGC stated they used the pump computing capabilities 100% of the time, while those with IGC had a greater percentage at 65%. This contradicts the theory of user fatigue, but could be an anomaly to the theory of compliance being more closely associated with glycemic control than technology itself. The other data that was contraindicative of compliance was that 56% of those with OGC that stated they used syringes admitted to reusing their needles, while only 43% of those with IGC stated they reused needles. 20% of those with OGC stated they reused daily, while, 33% of those with IGC stated they reused daily. This may then negate the fact that those with OGC had a higher rate of reusing needles, because within the IGC group, those that reused did so more often. Due to the fact that those with OGC were more compliant with wearing the Dexcom, it may be inferred that wearing the CGM and pump 100% of the time was most strongly associated to have optimal glycemic control.

**Research Aim number four: Explore the correlation between demographic variables to optimal and ineffective glycemic control, and any differences therein the two subgroups.**

There were far fewer males than females; but this trend was consistent throughout the two groups. The age was consistent throughout the two groups as well, and therefore statistically unremarkable to overall glycemic control. The only significant demographic fields were college enrollment, employment, and insurance status. Those with OGC had 61% of the group enrolled full time, none part time, and 39% not enrolled. Those with IGC had 42% enrolled full time, 13% part time, and 45% not enrolled. 61% vs 42% is statistically significant; it may be inferred that those students are still in college and receiving more parental assistance than those with IGC who may not be, and this can help alleviate stress and there lead to greater glycemic control. Employment was also significant, in that those with OGC, 48% were employed full time, and another 39% were employed part time, leaving only 13% unemployed. Those with IGC had 34% full time, 13% part time, and 45% non-employed. It can be inferred that those with OGC may adhere to a set schedule, allowing for routines and healthy eating habits that follow such a regular working/school schedule. Those with OGC may also possess greater discipline; that by handling work and school, they also keep their diabetes more closely in check. Insurance status was also significant, as those with OGC were 78% insured on their parents' plan, and those with IGC were only 66% on their parents' plans. All other participants were still under their own plans. It can be inferred that more of the OGC group was still receiving some kind of parental financial assistance, as so many of them are still bearing the financial insurance burden for their children. The mix of parental insurance support, working more often, and being enrolled in classes points at the current college student having a greater likelihood of obtaining optimal glycemic care than does the student who may be in the vulnerable young adult, post-grad stage, who is taking on finding a job and good insurance and creating their own independent financial stability. This stage is particularly hard for any young adult, but the financial burden on T1Ds makes this stage even more vulnerable.

# LIMITATIONS

Limitations that should be explored in the next research study on the subject should absolutely include questions on where the student is at in the young adult phase, such as being currently enrolled in classes versus within the first year of graduation. The demographic data points to those students who are responsible enough to be employed while in classes and yet still on parents' insurance plans have the greatest incidence of optimal glycemic control.

The study should have asked what the brand of the insulin pump was, in order to track correlations between optimal control and any particular brand; necessitating changes to the research aims and the opportunity for corporate funding. It could also have explored what the functions of the blood glucose test kit were; such as the ability to wirelessly send data to the pump, or supplemental test kit use to CGM use.

Furthermore, this study was conducted primarily by a novice researcher and did not have statistics run on the data other than what Qualtrics™ provided. The next study on the subject should have a statistician's analysis in order to determine more accurate correlations in the data.

The study relied on the honesty of the participants and was self-selected by participants. There was no way to verify accurate A1C readings, or have an equal amount of males vs females take the survey. It may be that males are just far less likely to participate in surveys than females are.

# NURSING IMPLICATIONS

This data is significant to care providers everywhere, in that there is a strong possibility that young adults who are just graduating college and taking on sole financial responsibility are vulnerable and may experience stress and become less compliant to the diabetes care regimen. Care providers should take extra precautions to ensure that all questions regarding insurance and healthy lifestyles are addressed, and adherence to usage guidelines are maintained. Care providers need to also be aware that just because a T1D has access to diabetes technologies, does not necessarily mean they are adhering to usage guidelines and using them properly. This study clearly shows that although this population all has access to insurance and the most modern diabetes technology, which disproved the hypothesis that those with IGC would have less use of these technologies, achieving optimal glycemic control comes from compliance to the recommendations for use. Young adults may require ongoing education to re-emphasize healthcare practices moving forward, and to minimize the development of diabetes complications. Care providers should reiterate even the most basic concepts of diabetes care to ensure that technologies are being used properly and are used in conjunction with healthy eating and exercise and sleep habits.

## SUMMARY

In summation, possession of diabetes technologies alone does not render achievement of optimal glycemic control. All participants, regardless of having OGC or IGC, had access to the insulin pumps and the CGMs. The survey results prove that those who use the CGMs and insulin pumps 100% of the time, while adhering to use guidelines, had a greater incidence of achieving optimal glycemic control. Those participants enrolled in college courses, who were employed, and who were still on their parents' insurance plans were also more likely to have optimal glycemic control, inferring that the late college student who has not yet accepted full financial independence, is more likely to have optimal glycemic control. Care providers should take extra precautions to provide support through the young adult's transition from college into the first stages of financial independence post-college graduation, and to ensure that the T1Ds are not only using the recommended diabetes technologies, but are also adhering to the recommendations for use.

# APPENDIX A: INTRODUCTION LETTER

University of Central Florida

## EXPLANATION OF RESEARCH

Title of Project: **Technologies to Enhance Optimal Glycemic Control in Young Adults with Type 1 Diabetes**

Principal Investigator: Dr. Laura Gonzalez, PhD, ARNP, CNE, CHSE, Faculty Chair

Other Investigators: Shannon Hassett, College of Nursing Class of 2016

You are being invited to take part in a research study. Whether you take part is up to you.

- The following survey is designed to determine what different types of technology and tools used to manage type 1 diabetes are correlated to achieving optimal glycemic control. The survey is directed at young adults aged 18 to 30 that are either in college or have graduated college and are affiliated with a Students with Diabetes support group. The target population is relatively homogenous; allowing the focus to be on querying students on which modalities and tools for diabetes management are used; and then, correlating the data to identify the most effective ways to achieve optimal glycemic control.
- This survey consists of 25 questions, and will take approximately 3-10 minutes to complete from the comfort of your personal computer, laptop, or Wifi compatible device. The survey will ask very broad demographic questions, regarding what kind of tools and technology (i.e. Dexcom) you use to help you control your diabetes. Please answer each question as truthfully as possible. The latest HgBA1C (within the last 6 months) is fine, but a reading from the last 3 months is preferable.
- Information collected from this survey may be used for future research and publications. The survey will be confidential and your participation is voluntary. You may withdraw your consent at any time without penalty. There are no direct risks, benefits, or forms of compensation to you for participating in the survey. All data will be managed by the Student Investigator, Shannon Hassett and her faculty chairperson and Principal Investigator, Dr. Laura Gonzalez, and will be analyzed in de-identified and aggregate form. Your identity will be kept confidential to the extent provided by law. By continuing on to the survey, you are giving your consent to participate.

You must be 18 years of age or older to take part in this research study.

**Study contact for questions about the study or to report a problem:** If you have questions, concerns, or complaints, please direct them to Shannon Hassett, UCF College of Nursing, at shannon47@knights.ucf.edu, or Dr. Laura Gonzalez, at laura.gonzalez@ucf.edu.

**IRB contact about your rights in the study or to report a complaint:** Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

## APPENDIX B: SURVEY QUESTIONS

| | Question Content | N=21<br>OGC | N=37<br>IGC |
|---|---|---|---|
| 1 | What is your current age? | Mean: 23.5<br>Median: 24<br>Mode: 24 | Mean: 23.6<br>Median: 22<br>Mode: 20, 24 |
| 2 | What is your gender? | Male: n=4 or 17%<br>Female: n=19 or 83% | Male: n=5 or 14%<br>Female: n=32 or 86% |
| 3 | How many years have you been living with type 1 diabetes? | 1-24 years | 1-23 years |
| 4 | What is your latest HgA1C value? (Within the last 6 months is acceptable, but within the last 3 months is preferable.) | ≤7.0<br>Range: 5.0-7.0 | ≥7.1<br>Range: 7.1-11.4 |
| 5 | Are you currently enrolled in college courses? | Yes, full time: n=14 or 61%<br>Part time: n=0<br>No: n=9 or 39% | Yes, full time: n=16 or 42%<br>Part time: n=5 or 13%<br>No: n=17 or 45% |
| 6 | Are you currently employed? | Yes, full time: n=11 or 48%<br>Part time: n=9 or 39%<br>No: n=3 or 13% | Yes: n=13 or 34%<br>Part time: n=5 or 13%<br>No: n=17 or 45% |
| 7 | Are you currently insured? | Yes, under parents: n=18 or 78%<br>Yes, under self: n=5 or 22%<br>No: n=0 | Yes, under parents: n=25 or 66%<br>Yes, under self: n=13 or 34%<br>No: n=0 |
| 8 | Do you use a continuous glucose monitor? | Yes: n=17 or 74%<br>No: n=6 or 26% | Yes: n=31 or 82%<br>No: n=7 or 18% |
| 9 | What is the brand of your CGM?* | See details for explanation | See details for explanation |
| 10 | How often do you wear your CGM? | Daily: n=15 or 88% | Daily: n=19 or 66% |

| | | | |
|---|---|---|---|
| 11 | How often do you calibrate your CGM? | Q12h: n=11 or 65% | Q12h: n=17 or 59% |
| 12 | How long have you owned your CGM? | ≤ 1 year: n=11 or 65% | ≤ 1 year: n=13 or 45% |
| 13 | Do you use a manual blood testing kit? | Yes: n=23 or 100%<br>No: n=0 | Yes: n=35 or 97%<br>No: n=1 or 3% |
| 14 | What is the brand name of your test kit? * | See details for explanation | See details for explanation |
| 15 | How often do you use your test kit? | ≥ once a day: n=21 or 95% | ≥ once a day: n=31 or 94% |
| 16 | Do you use an insulin pump? | Yes: n=21 or 95%<br>No: n=1 or 5% | Yes: n=31 or 89%<br>No: n=4 or 11% |
| 17 | How long have you been using the pump? | ≥2 years: n=13 or 65% | ≥2 years: n=26 or 85% |
| 18 | How often do you change the pump site? | Q3days: n=20 or 100% | Q3days: n=30 or 97% |
| 19 | What body sites do you utilize for insulin administration? | Thighs: n=8 or 40%<br>Front of abd: n=14 or 70%<br>Sides of abd: n=9 or 45%<br>Back: n=11 or 55%<br>Back of arms: n=8 or 40% | Thighs: n=7 or 23%<br>Front of abd: n=23 or 77%<br>Sides of abd: n=19 or 63%<br>Back: n=10 or 33%<br>Back of arms: n=12 or 40% |
| 20 | How often do you rotate pump sites from one area to the next? | Q3days: n=16 or 80% | Q3days: n=26 or 84% |
| 21 | Does your pump have computing capabilities such as carb counting, a carbohydrate index, or automatic carb to unit bolus calculations? | Yes: n=20 or 100% | Yes: n=31 or 100% |
| 22 | Do you use the computing capabilities in your pump? | 100% of the time: n=11 or 55% | 100% of the time: n=20 or 65% |
| 23 | Do you have any alarms set to help remind you to take insulin or check your blood sugar? | Yes/sometimes: n=8 or 38%<br>No: n=13 or 62% | Yes/sometimes: n=14 or 40%<br>No: n=21 or 60% |
| 24 | What kind of insulin are you using? * | See details for | See details for |

| | | | |
|---|---|---|---|
| | | explanation | explanation |
| 25 | Do you use syringes or pens? | Syringes: n=8 or 53%<br><br>Pens: n=2 or 13%<br><br>Both: n=5 or 33% | Syringes: n=6 or 27%<br><br>Pens: n=12 or 55%<br><br>Both: n=4 or 18% |
| 26 | What is the brand name of your syringes/pens? | See explanation for details | See explanation for details |
| 27 | Do you ever reuse needles? | Yes: n=10 or 56%<br><br>No: n=8 or 44% | Yes: n=12 or 43%<br><br>No: n=16 or 57% |
| 28 | How often do you reuse needles? | Daily: n=2 or 20% | Daily: n=4 or 33% |
| 29 | Do you take oral medications with the insulin? | Yes: n=5 or 24%<br><br>No: n=16 or 76% | Yes: n=9 or 26%<br><br>No: n=26 or 74% |
| 30 | What is (are) the name of your oral medication(s)? | See details for explanation | See details for explanation |
| 31 | Do you have any applications (apps) that help you manage your diabetes? | Yes: n=8 or 38%<br><br>No: n=13 or 62% | Yes: n=13 or 38%<br><br>No: n=21 or 62% |
| 32 | What is the name of the app? | See details for explanation | See details for explanation |
| 33 | Do you have any other technology that helps you control your diabetes? If so, explain. | See details for explanation | See details for explanation |
| 34 | Do you communicate electronically (using smartphone, apps, email, computer, texts) with your primary care provider? | Yes: n=10 or 48%<br><br>No: n=11 or 52% | Yes: n=17 or 52%<br><br>No: n=16 or 48% |
| 35 | Do you have apps that help you share your diabetes information with your support system? | Yes: n=11 or 52%<br><br>No: n=10 or 48% | Yes: n=18 or 55%<br><br>No: n=15 or 45% |

# APPENDIX C: IRB APPROVAL LETTER

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

## Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
**FWA00000351, IRB00001138**

To: **Laura Gonzalez** and Co-PI: **Shannon Louise Hassett**

Date: **March 03, 2016**

Dear Researcher:

On 03/03/2016, the IRB approved the following activity as human participant research that is exempt from regulation:

| | |
|---|---|
| Type of Review: | Exempt Determination |
| Project Title: | Technologies to Enhance Optimal Glycemic Control in Young Adults with Type 1 Diabetes |
| Investigator: | Laura Gonzalez |
| IRB Number: | SBE-16-11994 |
| Funding Agency: | |
| Grant Title: | |
| Research ID: | N/A |

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Patria Davis on 03/03/2016 01:15:20 PM EST

IRB Coordinator

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# APPENDIX D: RESEARCH AIM 1 TABLE

| | Question Content | N=21<br>OGC | N=37<br>IGC |
|---|---|---|---|
| 8 | Do you use a continuous glucose monitor? | Yes: n=17 or 74%<br>No: n=6 or 26% | Yes: n=31 or 82%<br>No: n=7 or 18% |
| 9 | What is the brand of your CGM?* | See details for explanation | See details for explanation |
| 12 | How long have you owned your CGM? | ≤ 1 year: n=11 or 65% | ≤ 1 year: n=13 or 45% |
| 13 | Do you use a manual blood testing kit? | Yes: n=23 or 100%<br>No: n=0 | Yes: n=35 or 97%<br>No: n=1 or 3% |
| 16 | Do you use an insulin pump? | Yes: n=21 or 95%<br>No: n=1 or 5% | Yes: n=31 or 89%<br>No: n=4 or 11% |
| 21 | Does your pump have computing capabilities such as carb counting, a carbohydrate index, or automatic carb to unit bolus calculations? | Yes: n=20 or 100% | Yes: n=31 or 100% |
| 23 | Do you have any alarms set to help remind you to take insulin or check your blood sugar? | Yes/sometimes: n=8 or 38%<br>No: n=13 or 62% | Yes/sometimes: n=14 or 40%<br>No: n=21 or 60% |
| 25 | Do you use syringes or pens? | Syringes: n=8 or 53%<br>Pens: n=2 or 13%<br>Both: n=5 or 33% | Syringes: n=6 or 27%<br>Pens: n=12 or 55%<br>Both: n=4 or 18% |
| 31 | Do you have any applications (apps) that help you manage your diabetes? | Yes: n=8 or 38%<br>No: n=13 or 62% | Yes: n=13 or 38%<br>No: n=21 or 62% |
| 33 | Do you have any other technology that helps you control your diabetes? If so, explain. | See details for explanation | See details for explanation |
| 34 | Do you communicate electronically (using smartphone, apps, email, computer, texts) with your primary care provider? | Yes: n=10 or 48%<br>No: n=11 or 52% | Yes: n=17 or 52%<br>No: n=16 or 48% |
| 35 | Do you have apps that help you share your diabetes information with your support system? | Yes: n=11 or 52%<br>No: n=10 or 48% | Yes: n=18 or 55%<br>No: n=15 or 45% |

# APPENDIX E: RESEARCH AIM 2 TABLE

| | Question Content | N=21<br>OGC | N=37<br>IGC |
|---|---|---|---|
| 8 | Do you use a continuous glucose monitor? | Yes: n=17 or 74%<br>No: n=6 or 26% | Yes: n=31 or 82%<br>No: n=7 or 18% |
| 9 | What is the brand of your CGM?* | See details for explanation | See details for explanation |
| 12 | How long have you owned your CGM? | ≤ 1 year: n=11 or 65% | ≤ 1 year: n=13 or 45% |
| 13 | Do you use a manual blood testing kit? | Yes: n=23 or 100%<br>No: n=0 | Yes: n=35 or 97%<br>No: n=1 or 3% |
| 16 | Do you use an insulin pump? | Yes: n=21 or 95%<br>No: n=1 or 5% | Yes: n=31 or 89%<br>No: n=4 or 11% |
| 21 | Does your pump have computing capabilities such as carb counting, a carbohydrate index, or automatic carb to unit bolus calculations? | Yes: n=20 or 100% | Yes: n=31 or 100% |
| 23 | Do you have any alarms set to help remind you to take insulin or check your blood sugar? | Yes/sometimes: n=8 or 38%<br>No: n=13 or 62% | Yes/sometimes: n=14 or 40%<br>No: n=21 or 60% |
| 25 | Do you use syringes or pens? | Syringes: n=8 or 53%<br>Pens: n=2 or 13%<br>Both: n=5 or 33% | Syringes: n=6 or 27%<br>Pens: n=12 or 55%<br>Both: n=4 or 18% |
| 31 | Do you have any applications (apps) that help you manage your diabetes? | Yes: n=8 or 38%<br>No: n=13 or 62% | Yes: n=13 or 38%<br>No: n=21 or 62% |
| 33 | Do you have any other technology that helps you control your diabetes? If so, explain. | See details for explanation | See details for explanation |
| 34 | Do you communicate electronically (using smartphone, apps, email, computer, texts) with your primary care provider? | Yes: n=10 or 48%<br>No: n=11 or 52% | Yes: n=17 or 52%<br>No: n=16 or 48% |
| 35 | Do you have apps that help you share your diabetes information with your support system? | Yes: n=11 or 52%<br>No: n=10 or 48% | Yes: n=18 or 55%<br>No: n=15 or 45% |

# APPENDIX F: RESEARCH AIM 3 TABLE

| | Question Content | N=21<br>OGC | N=37<br>IGC |
|---|---|---|---|
| 4 | What is your latest HgA1C value? (Within the last 6 months is acceptable, but within the last 3 months is preferable.) | ≤7.0<br>Range: 5.0-7.0 | ≥7.1<br>Range: 7.1-11.4 |
| 8 | Do you use a continuous glucose monitor? | Yes: n=17 or 74%<br>No: n=6 or 26% | Yes: n=31 or 82%<br>No: n=7 or 18% |
| 10 | How often do you wear your CGM? | Daily: n=15 or 88% | Daily: n=19 or 66% |
| 11 | How often do you calibrate your CGM? | Q12h: n=11 or 65% | Q12h: n=17 or 59% |
| 12 | How long have you owned your CGM? | ≤ 1 year: n=11 or 65% | ≤ 1 year: n=13 or 45% |
| 13 | Do you use a manual blood testing kit? | Yes: n=23 or 100%<br>No: n=0 | Yes: n=35 or 97%<br>No: n=1 or 3% |
| 15 | How often do you use your test kit? | ≥ once a day: n=21 or 95% | ≥ once a day: n=31 or 94% |
| 16 | Do you use an insulin pump? | Yes: n=21 or 95%<br>No: n=1 or 5% | Yes: n=31 or 89%<br>No: n=4 or 11% |
| 17 | How long have you been using the pump? | ≥2 years: n=13 or 65% | ≥2 years: n=26 or 85% |
| 18 | How often do you change the pump site? | Q3days: n=20 or 100% | Q3days: n=30 or 97% |
| 19 | What body sites do you utilize for insulin administration? | Thighs: n=8 or 40%<br>Front of abd: n=14 or 70%<br>Sides of abd: n=9 or 45%<br>Back: n=11 or 55%<br>Back of arms: n=8 or 40% | Thighs: n=7 or 23%<br>Front of abd: n=23 or 77%<br>Sides of abd: n=19 or 63%<br>Back: n=10 or 33%<br>Back of arms: n=12 or 40% |
| 20 | How often do you rotate pump sites from one area to the next? | Q3days: n=16 or 80% | Q3days: n=26 or 84% |
| 21 | Does your pump have computing capabilities such as carb counting, a carbohydrate index, or automatic carb to unit bolus calculations? | Yes: n=20 or 100% | Yes: n=31 or 100% |
| 22 | Do you use the computing capabilities in your pump? | 100% of the time: n=11 or 55% | 100% of the time: n=20 or 65% |
| 25 | Do you use syringes or pens? | Syringes: n=8 or 53%<br>Pens: n=2 or 13%<br>Both: n=5 or 33% | Syringes: n=6 or 27%<br>Pens: n=12 or 55%<br>Both: n=4 or 18% |
| 27 | Do you ever reuse needles? | Yes: n=10 or 56%<br>No: n=8 or 44% | Yes: n=12 or 43%<br>No: n=16 or 57% |
| 28 | How often do you reuse needles? | Daily: n=2 or 20% | Daily: n=4 or 33% |

# APPENDIX G: RESEARCH AIM 4 TABLE

| | Question Content | N=21<br>OGC | N=37<br>IGC |
|---|---|---|---|
| 1 | What is your current age? | Mean: 23.5<br>Median: 24<br>Mode: 24 | Mean: 23.6<br>Median: 22<br>Mode: 20, 24 |
| 2 | What is your gender? | Male: n=4 or 17%<br>Female: n=19 or 83% | Male: n=5 or 14%<br>Female: n=32 or 86% |
| 3 | How many years have you been living with type 1 diabetes? | 1-24 years | 1-23 years |
| 4 | What is your latest HgA1C value? (Within the last 6 months is acceptable, but within the last 3 months is preferable.) | ≤7.0<br>Range: 5.0-7.0 | ≥7.1<br>Range: 7.1-11.4 |
| 5 | Are you currently enrolled in college courses? | Yes, full time: n=14 or 61%<br>Part time: n=0<br>No: n=9 or 39% | Yes, full time: n=16 or 42%<br>Part time: n=5 or 13%<br>No: n=17 or 45% |
| 6 | Are you currently employed? | Yes, full time: n=11 or 48%<br>Part time: n=9 or 39%<br>No: n=3 or 13% | Yes: n=13 or 34%<br>Part time: n=5 or 13%<br>No: n=17 or 45% |
| 7 | Are you currently insured? | Yes, under parents: n=18 or 78%<br>Yes, under self: n=5 or 22%<br>No: n=0 | Yes, under parents: n=25 or 66%<br>Yes, under self: n=13 or 34%<br>No: n=0 |

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