Design Experiments. Identifying areas for intervention and designing medical technology for adolescents and young adults with type 1 diabetes

Gillian M. McCarthy\textsuperscript{a*}, Edgar R. Rodríguez Ramírez\textsuperscript{a}, Brian J. Robinson\textsuperscript{b}

\textsuperscript{a}School of Design, Victoria University of Wellington, New Zealand
\textsuperscript{b}Graduate School of Nursing, Midwifery and Health, Victoria University of Wellington, New Zealand
\textsuperscript{*}Corresponding author e-mail: Gillian.McCarthy@vuw.ac.nz

Abstract:
Adolescents and young adults with type 1 diabetes are frequently required to use medical devices to manage their condition. While the devices are clinically effective, they have many psychosocial impacts on their users. Identifying the user requirements of young medical device users could benefit the design and development of these devices. In this study, interviews regarding medical technology use were conducted with seven females with type 1 diabetes aged 13-21. Five resulting user requirements were used to inform design experiments with 28 undergraduate industrial designers. Finally, a selection of the designs was shown to six of the participants with diabetes to both validate the initial analysis of the interviews and as a prompt to facilitate further discussion about user experiences and medical technology preferences. We argue that while the clinical efficacy of medical technology is significant, so too is the effective use of these technologies by a variety of users in everyday contexts.

Keywords: Type 1 diabetes, Medical technology, Adolescents, Human-centred design, user requirements

1. Introduction
Adolescents and young adults with type 1 diabetes are frequently required to use medical technologies to monitor their blood glucose levels and calculate and administer insulin doses (D’Alberton, Nardi, & Zucchini, 2012). This intensive treatment regimen can delay the onset and slow the progression of long-term diabetes complications (Craig et al., 2011; DCCT Research Group, 1988). While it is imperative that medical technologies such as insulin pens, insulin pumps and blood glucose meters are clinically effective, they must also be designed to be used effectively by
adolescents and young adults in a variety of daily contexts. These technologies are not neutral, and can be stigmatising for users (Polgar, 2010).

Research has indicated a variety of psychosocial benefits and barriers to the use of these medical devices (Alsaleh, Smith, & Taylor, 2012; Hirose, Beverly, & Weinger, 2012; McCarthy, Rodríguez Ramírez, & Robinson, 2016; Ritholz et al., 2007). In one study, blood glucose testing was a source of social discomfort, with adolescents’ self-management being influenced by observers, different contexts, and anticipated negative reactions to high or low blood glucose levels. Participants wanted devices to mimic popular consumer devices such as phones (Carroll et al., 2007). In another study, adolescents were reluctant to try or stopped using insulin pumps because they might be cumbersome during exercise and because they were highly visible (Beck et al., 2010).

Identifying the non-clinical user requirements of young medical device users can benefit the design and development of these devices (Lang, Martin, Sharples, & Crowe, 2011). General and device-specific user requirements have been developed previously for health interventions for type 1 diabetes and other conditions (Cafazzo, Casselman, Hamming, Katzman, & Palmert, 2012; Consolvo, Everitt, Smith, & Landay, 2006). Additionally, using vignettes portraying design concepts and stories in interviews with adolescents can prompt discussion around sensitive topics and medical devices (Barter & Renold, 2000; Lang, 2013). As such, this paper aims to firstly identify medical technology-related user requirements of female adolescents and young adults with type 1 diabetes and secondly, to use design experiments to populate vignettes to validate these requirements and facilitate further discussion.

2. Adolescent interviews

2.1 Methodology

Semi-structured interviews regarding medical technology-related self-management were conducted with seven females with type 1 diabetes aged 13-24 who had been diagnosed with type 1 diabetes for between 4 months and 15 years. Interviews covered diagnosis, daily self-management, changes to lifestyle, support networks and psychosocial barriers to management.

Five adolescent user requirements of medical technologies used in the self-management of type 1 diabetes were constructed from the interviews: to help to comfortably disclose and explain type 1 diabetes when appropriate, minimise or eliminate feelings of stigma or embarrassment while using medical technology, facilitate spontaneity and participation in everyday activities, communicate data and information to facilitate decision making, and to facilitate a daily self-management routine that fits with lifestyle. These requirements reflected the necessity to manage diabetes in various contexts, and to foster a broader psychosocial understanding of the impacts of medical technologies. The requirements were constructed from the interviews, but also relate to existing theories and requirements.

2.2 User requirements of medical technologies

Help to comfortably disclose and explain type 1 diabetes when appropriate. Participants had varying views on disclosing diabetes, with some comfortable to tell others they had the condition. “I told everyone. I was never taught that it was something that should be hidden. I have talked to a couple of people around my age with diabetes and a couple of them are like, ‘We pretend that we don’t have it.’” Commonly, teachers at school and close friends were informed, though as participants left school fewer of their new acquaintances were aware of their condition. The importance of others
knowing about the condition in case of a medical emergency was mentioned often. “I don’t really like telling people… I think, I probably should; in case I go really low.” Previous research has shown that adolescents face dilemmas about disclosing type 1 diabetes, and prefer to disclose to people they trust. In choosing whether to disclose they balance increased safety in possible emergencies with the possibility of negative social reactions (Wang, Brown, & Horner, 2010). To not disclose a health condition can put adolescents at greater risk of non-adherence and poorer psychosocial adjustment (Warner & Hauser, 2009; Thompson & Gustafson, 1996).

A common account was encountering people who misunderstood the aetiology and management of type 1 diabetes, with individuals often conflating their knowledge of type 2 diabetes. Participants were frustrated by assumptions their condition was caused by poor diet, by acquaintances remarking with surprise that they were not overweight, and by others questioning or reprimanding their food choices. One participant recalled, “My dentist told my mum that it was because I ate too many lollies as a child.” Strategies for managing these encounters were context-dependent and included ignoring the person or informing them about type 1 diabetes.

While attention garnered from diabetes was generally spoken of neutrally or negatively, two participants spoke about positive aspects of the attention, with one feeling it made her a more interesting person, and another describing the social currency of a lift pass she was granted at school, and how other teenagers vied to ride the lift with her instead of taking the stairs. “This is probably the weirdest way to think about it but I think on some level it makes me more interesting... I got a new insulin pen and it’s one of the ones that has the memory; it tells you how many units you gave yourself and how long ago. I got very excited about that. All of my friends were shown this pen and expected to pretend to be really excited for me.”

Minimise or eliminate feelings of stigma or embarrassment while using medical technology. Some participants felt embarrassed using or carrying medical devices and having to break rules such as not eating in public places. There was discomfort about being different from their peers, and an anxiety about how others might react if they noticed self-management behaviours or devices. At times, negative social encounters stemmed from other people’s discomfort with blood and needles. “This new friend that I have at school, she hates injections and needles and she won’t be in the room when I do it.” While some chose to manage in public areas, such as a classroom, others moved to private spaces such as bathrooms.

This phenomenon reflects Goffman’s (1963) theories on stigma. The adolescent is ‘discreditable’, as the process of exposing and using medical technologies acts to involuntarily disclose their medical condition at any point in time, transforming the medical devices into ‘stigma symbols’. Choosing to manage in private may be seen as an attempt at ‘normification’.

Facilitate spontaneity and participation in everyday activities. Managing diabetes made participating fully in everyday activities challenging. Exercise was a recurring difficulty, with participants struggling to manage blood glucose levels and requiring additional blood glucose tests, isolating them from teammates or impairing their performance. “I used to go jogging up the hills, but then when I was diagnosed I started just walking them instead... about half way through, my sugar levels would dip. So I was scared to do anything more intensive than that because I didn’t want to end up having hypos halfway through the night.” Exercise is an important part of the diabetes treatment regimen, and can improve both physical and psychological wellbeing in addition to glycaemic control.

However, adolescents with type 1 diabetes have an increased risk of exercise-induced hypoglycaemia during and after exercise, and fear of hypoglycaemia is a major barrier to exercise (Roberts & Taplin, 2015).
For one participant, managing diabetes caused her to significantly reprioritise her health above her goals around university education, resulting in her beginning to miss many lectures and tutorials where previously she had a high attendance record.

Communicate data and information to facilitate decision making. By testing blood glucose levels throughout the day, people with type 1 diabetes collect data which could be helpful to their management but isn’t fully utilised. One participant tested often to see trends in her blood glucose levels. “I like to manage my tests 15, 20, 25 times a day... I monitor all the trends to see if they’re up or down and to pre-empt and try and keep that line as steady as possible.”

Prior research has shown that visualising the cornerstones of diabetes management (food intake, insulin dose, physical activity, and blood glucose levels) when logging data can increase adolescents’ applied knowledge and understanding of type 1 diabetes management (Frøisland, Årsand, & Skårderud, 2012).

Despite this, many of the participants had stopped recording their tests in a logbook, as although they recognised having access to a log of data may be beneficial to clinicians, they did not perceive enough personal benefit from the logbook when weighed against the effort of keeping it. “I’ve got a collection of physical logbooks for eight or nine years, every single day. I didn’t think I’d ever stop recording but then I realised that I’m getting great HbA1c’s. I’m not really getting a benefit because I don’t really look at it.” While some mentioned that visually displaying the data would be helpful, having to do this manually was tedious. “There’s just so much other stuff that you are doing and you don’t want to be writing down stuff on top of everything else.”

Facilitate a daily self-management routine that fits with lifestyle. Intensive self-management had to fit adolescents’ lifestyles. Some found that they forgot to manage as they were busy with activities, or surrounded by peers. “It still happens that I might get caught up in what I’m doing and maybe only test once or twice.” There was a need for greater organisation and advance planning which took time and preparation. “I think my problem is that I am really disorganised. I am not very good at keeping up with all of my various tests and things.” Adolescents had to manage shifting routines between rigid schedules at school versus weekends and holidays and moving out of the family house when beginning university or a working life. Some adolescents made an effort to establish a routine and found this facilitated better management. This is supported by prior research, where parents found routine improved management and ability to participate, though it could be at odds with spontaneous participation (Quirk, Blake, Dee, & Glazebrook, 2014).

3. Design experiments and review

3.1 Methodology

Following the interviews with young females with type 1 diabetes, the user requirements were used to inform design experiments. Participants in the design experiments were twenty-eight undergraduate industrial design students. They were in the required to design a tangible interaction that facilitated adolescents’ management of type 1 diabetes through addressing at least one of the user requirements. This tangible interaction could be a medical device or any design that helps in a broader psychosocial way (e.g., an item of clothing, or an accessory). Students completed these design experiments over six weeks. This time included structured teaching and unstructured working time where students were able to conduct secondary research, develop design concepts and obtain feedback from the authors.
In week one a lecture was delivered describing type 1 diabetes, how it is self-managed, and concepts around adherence and engagement. Students created infographics about type 1 diabetes to aid their understanding. One infographic is pictured in Figure 1 below.

![Infographic](image)

Figure 1. Infographic exploring blood glucose levels, diabetes complications and the daily self-management tasks. This student’s focus on finger pricking led her to design the blood glucose monitoring compact in Figure 6.

A second lecture introduced the user requirements and two personas for the students to consider. Based on the initial interviews, these personas were and were a sporty 15-year-old girl using insulin pens and a blood glucose meter, and an 18-year-old female university student who was living away from home and used an insulin pump and blood glucose meter. Students selected a persona and one of the user requirements, chose an everyday context where this requirement would be important (e.g., while playing a football) and sketched a scenario of how diabetes would currently be managed in this situation, and a second scenario of how a tangible interaction could fulfil the user requirement.

In week two a third lecture described current strategies for addressing stigma through medical device design semantics (e.g., making the device less visible or disguising it) and students developed their design concepts. Students presented concepts based on the brief individually in week three, then were assigned groups of 2-4 members to continue developing the most successful concepts. For the following two weeks, students iteratively sketched and prototyped concepts and submitted their final designs.

Vignettes containing the user requirements, quotations from the prior interviews, and the designs that responded to them were presented to the adolescents with type 1 diabetes in a follow-up interview. The adolescents were asked to comment on whether these requirements were accurate and the merit of the design concepts. This was to both validate the initial analysis of the interviews and prompt further discussion about experiences with and preferences for medical technologies.
3.2 Design outcomes and reviews

Five of the designs and participants’ reactions to them are described below. Each design responds to user requirements.

Table 1. User requirements addressed by student design concepts.

| Design concept                           | User requirements addressed                                                                 |
|------------------------------------------|---------------------------------------------------------------------------------------------|
| Blood glucose monitoring phone case      | comfortably disclose and explain type 1 diabetes when appropriate, communicate data and information to facilitate decision-making |
| Blood glucose monitoring jewellery       | minimise or eliminate feelings of stigma or embarrassment while using medical technology    |
| Blood glucose monitoring bike attachment | facilitate spontaneity and participation in everyday activities                             |
| Blood glucose reminder watch for testing | facilitate a daily self-management routine that fits with lifestyle, minimise or eliminate feelings of stigma or embarrassment while using medical technology |
| Blood glucose monitoring compact         | facilitate a daily self-management routine that fits with lifestyle, minimise or eliminate feelings of stigma or embarrassment while using medical technology |

3.2.1 Help to comfortably disclose and explain type 1 diabetes when appropriate, and communicate data and information to facilitate decision-making

In response to these two user requirements, students designed a mobile phone case that contained blood glucose measuring equipment and a phone app that displayed and recorded blood glucose and other daily management data. Designs for the phone case are pictured in Figure 2. The designers addressed the issue of disclosure by creating a playful interaction, with the lancing motion appearing as a dog licking the user’s finger, or being bitten by a monster. They hoped to draw attention to the action, but in a positive and playful manner. The design utilised the phone to display and record data about aspects of management (e.g., blood glucose levels, exercise, insulin taken) and to automatically sync data from blood glucose tests.
Participants had mixed feelings about disclosing diabetes. One participant thought it was straightforward because she is not at fault for developing type 1 diabetes. Medical devices were described as eliciting attention, with devices prompting others to ask questions about what they were being used for. One participant described a friend being uncomfortable when she was in the same room as the participant doing a blood glucose test at school, as she was afraid of needles. Contrastingly, another participant tested openly amongst peers, and described attempting to trick new members of her sports team, trying to convince them they would have to test their blood glucose levels as part of their sports training.

Most participants thought the phone concept was funny, and some thought that it would not be stigmatising and instead might draw positive attention. This would give an opportunity to disclose and explain type 1 diabetes if they wanted to. Some participants felt it would be more suitable for children. Using a phone was convenient as participants already carried these with them, though one participant mentioned that at school they borrow each other’s phones, so needle safety could be problematic. She suggested the device could be detached from the phone when not in use. One participant suggested a game could be developed where players looked after a digital pet, creating a playful reminder to test blood glucose levels.

In terms of transforming data into meaningful information, many participants described automatically syncing data to the phone as a positive aspect. Having the data on the phone might allow them to graph and visualise trends more easily and possibly share these with a clinician. Two of the younger participants’ parents currently logged their blood glucose results manually and tried to get them to engage with the subsequent logs or graphs. Multiple participants had stopped using logbooks, and felt that looking at previous levels and patterns was only helpful when trying to make a significant change. One participant felt that by logging blood glucose levels she paid too much attention to the numbers and started to develop obsessive thinking. She noted that focusing on visualisations and trends was better than seeing individual numbers. While one participant noticed
patterns in her levels without prompting, another thought an app prompting the user of recurring patterns in blood glucose levels would be beneficial.

3.2.2 Minimise or eliminate feelings of stigma or embarrassment while using medical technology

A blood glucose monitor in the form of jewellery, pictured in Figure 3, was designed to address aspects of embarrassment and stigma. The designers attempted to disguise the technology as jewellery, to both give users the choice of disclosing their diabetes and making it wearable so it need not be carried. They noted that while this design may draw attention, it might be a positive form of attention.

Figure 3. Blood glucose monitoring jewellery in a choker and pendant combination

Some participants felt that using medical devices could be embarrassing in certain contexts, particularly around new people or acquaintances who they didn’t know well. Notably, participants were not as concerned about the reactions of strangers. Nonetheless, many participants were frustrated by people who did not understand type 1 diabetes commenting on their condition, particularly making comments in surprise about them not being overweight, or questioning whether they should be eating certain foods. One participant recalled, “My friend’s parents thought I was doing drugs because they saw a needle fall out of my bag.” Some participants chose to move to a private space to use medical devices.

The participants recognised that a jewellery-based design would give them the option to conceal the device as regular jewellery, or to explain its purpose. They thought they might be more proud of the device and more likely to explain its purpose if somebody complimented it. There were mixed feelings about disclosing diabetes, with one participant saying the more people who knew the better in case of a medical emergency, while another thought that while this was true for friends and acquaintances, she’d prefer not to disclose diabetes to everybody. Some participants thought this design was ‘cool’ and liked its aesthetics, while another thought making it more generic by making it smaller and silver like a medic alert bracelet would allow it to be worn in more situations. Concerns about the device included the secure storage of affordable test strips and having sufficient memory capacity. One participant thought it would be less likely to be lost or forgotten as she would be wearing rather than carrying the device.
3.2.3 Facilitate spontaneity and participation in everyday activities

Exercise was frequently mentioned as an activity where young people with diabetes needed to stop participating to manage their blood glucose levels. The design in response to this, pictured in Figure 4, was a blood glucose meter adapted to be affixed to a bike, with a one-handed gear-like lever which triggered a lancet and shifted a new test strip into place so users could test their blood glucose levels while cycling.

Many of the participants thought testing blood glucose levels without having to stop riding would be great, though two noted this would have to be done carefully, such as on a smooth uphill section of road. While one participant was weary of introducing more items that she might need to find when heading out, she thought this item would be fine because it could stay attached to her bike. One participant specifically noted the importance of exercising, finding that levels could be more steady on days including exercise, but that testing and eating need to be fine-tuned to achieve stable levels. Another emphasized the need to test to distinguish low blood glucose levels from regular feelings of exertion during exercise.

3.2.4 Facilitate a daily self-management routine that fits with lifestyle, minimise or eliminate feelings of stigma or embarrassment while using medical technology

The designers noted that while some young people forgot to test their blood glucose levels, they were also reticent to use a device with alarms or vibrations that may draw unwanted attention. This design concept, pictured in Figure 5, explored using a subtle reminder, where a watch face could be
twisted to set a white reminder hand, with the user to take a test when the silver hour hand met the reminder hand.

![Figure 5. Blood glucose test reminder watch with twistable watch face](image)

Most of the participants commented that having subtle reminders, rather than feeling pestered or having alarms drawing attention would be positive, though one noted that this watch would only be useful for a select group of people who do forget to test but are motivated to test more. While one participant noted that she liked the aesthetics of the watch, only one felt she currently required a regular reminder to test her blood glucose levels. All the participants felt that having routine embedded into their days improved their management.

The next design concept, pictured in Figure 6, was intended to encourage users to use multiple fingers for their blood glucose tests and to change lancets frequently. It also afforded some privacy and adopted a disguise strategy by using the visual language of a makeup compact. Alternately to a traditional lancet that is moved in relation to the hand, here the hand is moved in relation to the device.

![Figure 6. Blood glucose monitoring compact with lights to prompt use of different fingers and replacement of lancets](image)
The participants were all encouraged by health professionals to use a variety of fingers for testing blood glucose levels, but all felt that they had ‘favourite fingers’. Despite this, many recognised using more fingers may be beneficial. Participants currently used their pinkies and ring fingers on their non-dominant hand predominantly, because these fingers were easy to angle the device towards, they bled the best, hurt the least, were easy to stop bleeding, and were less likely to get in the way during following activities (e.g., holding a pencil). Many reported they didn’t change the lancet often, and one mentioned she wasn’t aware of how often it was supposed to be changed, and would wait until it felt blunt. Two mentioned that the design looked like a makeup compact. While this could be helpful if they didn’t want anybody to know what they were doing, it might be disadvantageous if somebody picked it up and hurt themselves or stole the device. Important considerations were maintaining the small size of the device and being able to change the lancets quickly. Uniquely, one participant said she would try using all the lancets simultaneously at least once.

4. Discussion

As with previous research, user requirements of medical technologies were constructed from interviews with adolescents and young adults. It is important to note that these were based on a small number of female participants, and that participants’ experiences and preferences differed. Future research will focus on male user requirements. Although the design students were unable to meet the participants with diabetes, they were able to work from the requirements to create design concepts which were presented along with quotations and requirements as vignettes. As with previous research, we found showing adolescents these vignettes prompted a discussion around their requirements, helping to both validate the requirements and elicit further, detailed discussion. In the next stage of research, designers and young people with type 1 diabetes will be brought together for a participatory design workshop to explore one of the requirements in further detail.

The research implies that while medical technologies function well, some young females with type 1 diabetes have requirements which are currently unmet. These medical technology requirements go beyond clinical efficacy, and towards integration into a multitude of daily contexts.

5. Conclusion

Five design requirements for the design of medical technologies for adolescents’ self-management of type 1 diabetes were constructed: help to comfortably disclose and explain type 1 diabetes when appropriate, minimise or eliminate feelings of stigma or embarrassment while using medical technology, facilitate spontaneity and participation in everyday activities, communicate data and information to facilitate decision making, and facilitate a daily self-management routine that fits with lifestyle. This paper illustrates how medical technologies can be designed to respond to user requirements, and the use of the designs as a tool for validation and discussion with young participants. Through these design experiments, we demonstrate the next phase of medical technology design: how designers can go beyond clinical efficacy and create technology that responds to adolescents’ psychosocial needs, creating a more positive experience and facilitating engagement for its users.
References

Alsaleh, F. M., Smith, F. J., & Taylor, K. M. (2012). Experiences of children/young people and their parents, using insulin pump therapy for the management of type 1 diabetes: qualitative review. *Journal of Clinical Pharmacy and Therapeutics, 37*(2), 140–147.

Barter, C., & Renold, E. (2000). “I wanna tell you a story”: Exploring the application of vignettes in qualitative research with children and young people. *International Journal of Social Research Methodology, 3*(4), 307–323.

Beck, P., Habacher, W., Neeser, K., Pieber, T. R., Rakovac, I., Schmidt, L., ... Weber, C. (2010). Attitudes towards insulin pump therapy among adolescents and young people. *Diabetes Technology & Therapeutics, 12*(1), 89–94.

Cafazzo, J. A., Casselman, M., Hamming, N., Katzman, D. K., & Palmert, M. R. (2012). Design of an mHealth App for the Self-management of Adolescent Type 1 Diabetes: A Pilot Study. *Journal of Medical Internet Research, 14*(3), e70.

Carroll, A. E., Downs, S. M., & Marrero, D. G. (2007). What adolescents with type I diabetes and their parents want from testing technology: A qualitative study. *CIN: Computers, Informatics, Nursing January/February, 25*(1), 23–29.

Consolvo, S., Everitt, K., Smith, I., & Landay, J. A. (2006). Design requirements for technologies that encourage physical activity. In *Proceedings of the SIGCHI conference on Human Factors in computing systems* (pp. 457–466). ACM.

Craig, M. E., Twigg, S. M., Donaghue, K. C., Cheung, N. W., Cameron, F. J., Conn, J., Jenkins, A. J., Silink, M. (2011). National Evidence-Based Clinical Care Guidelines for Type 1 Diabetes in Children, Adolescents and Adults. *Australian Government Department of Health and Ageing, Canberra.*

D’Alberton, F., Nardi, L., & Zucchini, S. (2012). The onset of a chronic disease as a traumatic psychic experience: A psychodynamic survey on type 1 diabetes in young patients. *Psychoanalytic Psychotherapy, 26*(4), 294–307.

DCCT Research Group. (1988). Effect of intensive diabetes treatment on the development and progression of long-term complications in adolescents with insulin-dependent diabetes mellitus: Diabetes Control and Complications Trial. *The Journal of Pediatrics, 125*, 177–188.

Frøisland, D. H., Årsand, E., & Skårderud, F. (2012). Improving diabetes care for young people with type 1 diabetes through visual learning on mobile phones: mixed-methods study. *Journal of Medical Internet Research, 14*(4), e111.

Goffman, E. (1963). *Stigma: Notes on the Management of Spoiled Identity*. Englewood Cliffs: Prentice-Hall.

Hirose, M., Beverly, E. A., & Weinger, K. (2012). Quality of life and technology: impact on children and families with diabetes. *Current Diabetes Reports, 12*(6), 711–720.

Lang, A. R., Martin, J. L., Sharples, S., & Crowe, J. A. (2011). Patients/Patience in research: The challenges of interviewing adolescent medical device users in hospital clinics. In *Contemporary Ergonomics and Human Factors 2011: Proceedings of the international conference on Ergonomics & Human Factors 2011, Stoke Rochford, Lincolnshire, 12-14 April 2011* (p. 336). CRC Press.

Lang, A. R., Martin, J. L., Sharples, S., & Crowe, J. A. (2013). The effect of design on the usability and real world effectiveness of medical devices: A case study with adolescent users. *Applied Ergonomics, 44*(5), 799–810.

McCarthy, G. M., Rodríguez Ramírez, E. R., & Robinson, B. J. (2016). Dissonant technologies: Health professionals’ impressions of adolescents’ interactions with medical technologies for managing type 1 diabetes. In *Well-Being 2016: Co-creating Pathways to Well-Being* (pp. 36–39). Birmingham: Birmingham City University.

Polgar, J. M. (2010). The Myth of Neutral Technology. In M. M. Oishi, I. M. Mitchell, & H. F. Ven der Loos (Eds.), *Design and Use of Assistive Technology*. New York: Springer Publishing Company.
Quirk, H., Blake, H., Dee, B., & Glazebrook, C. (2014). You can’t just jump on a bike and go: a qualitative study exploring parents’ perceptions of physical activity in children with type 1 diabetes. *BMC Pediatrics, 14*, 313.

Ritholz, M. D., Smaldone, A., Lee, J., Castillo, A., Wolpert, H., & Weinger, K. (2007). Perceptions of psychosocial factors and the insulin pump. *Diabetes Care, 30*(3), 549–554. https://doi.org/10.2337/dc06-1755

Roberts, A. J., & Taplin, C. E. (2015). Exercise in Youth with Type 1 Diabetes. *Current Pediatric Reviews, 11*(2), 120–125.

Thompson Jr., R. J., & Gustafson, K. E. (1996). *Adaptation to chronic childhood illness* (Vol. xii). Washington, DC, US: American Psychological Association.

Wang, Y., Brown, S. A., & Horner, S. D. (2010). School-Based Lived Experiences of Adolescents with Type 1 Diabetes: A Preliminary Study. *Journal of Nursing Research, 18*(4), 258–265.

Warner, D. E., & Hauser, S. T. (2009). Unique Considerations when Treating Adolescents with Chronic Illness. In W. T. O’Donohue (Ed.), *Behavioral Approaches to Chronic Disease in Adolescence* (pp. 15–28). Springer New York.

About the Authors:

**Author 1** Gillian conducts human-centred design research with a focus on eliciting user experiences and facilitating engagement with medical products and services. Her PhD research focuses on medical technology use by adolescents with type 1 diabetes.

**Author 2** Edgar leads the Smart Interactions Design team as an investigator in the Centre of Research Excellence in Medical Technologies (MedTech CoRE). Smart Interactions Design investigates how to improve people’s medical conditions and management through smart devices connected to digital interfaces.

**Author 3** Brian’s research experience includes clinical pathophysiology. His current research interests include the design, safety and ergonomics of biomedical devices leading to the safe introduction new health technologies.

**Acknowledgements:** This research is funded by the Victoria Doctoral Scholarship. Additional funding comes from the Centre of Research Excellence in Medical Technologies (MedTech CoRE) New Zealand.